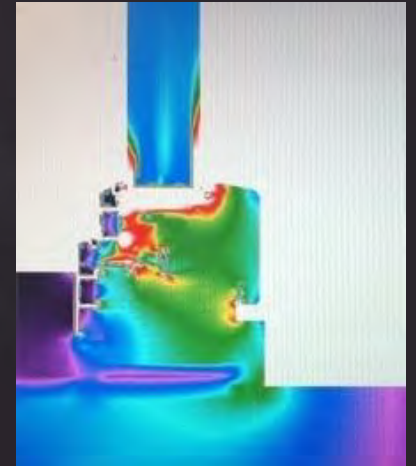
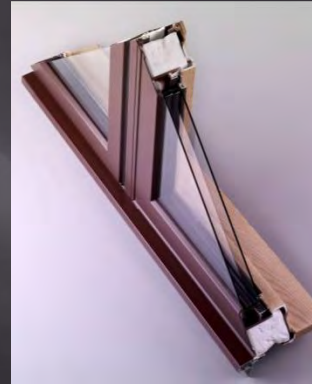


# 8<sup>th</sup> Annual North American Passive House Conference

## Very High Performance Passive House Windows

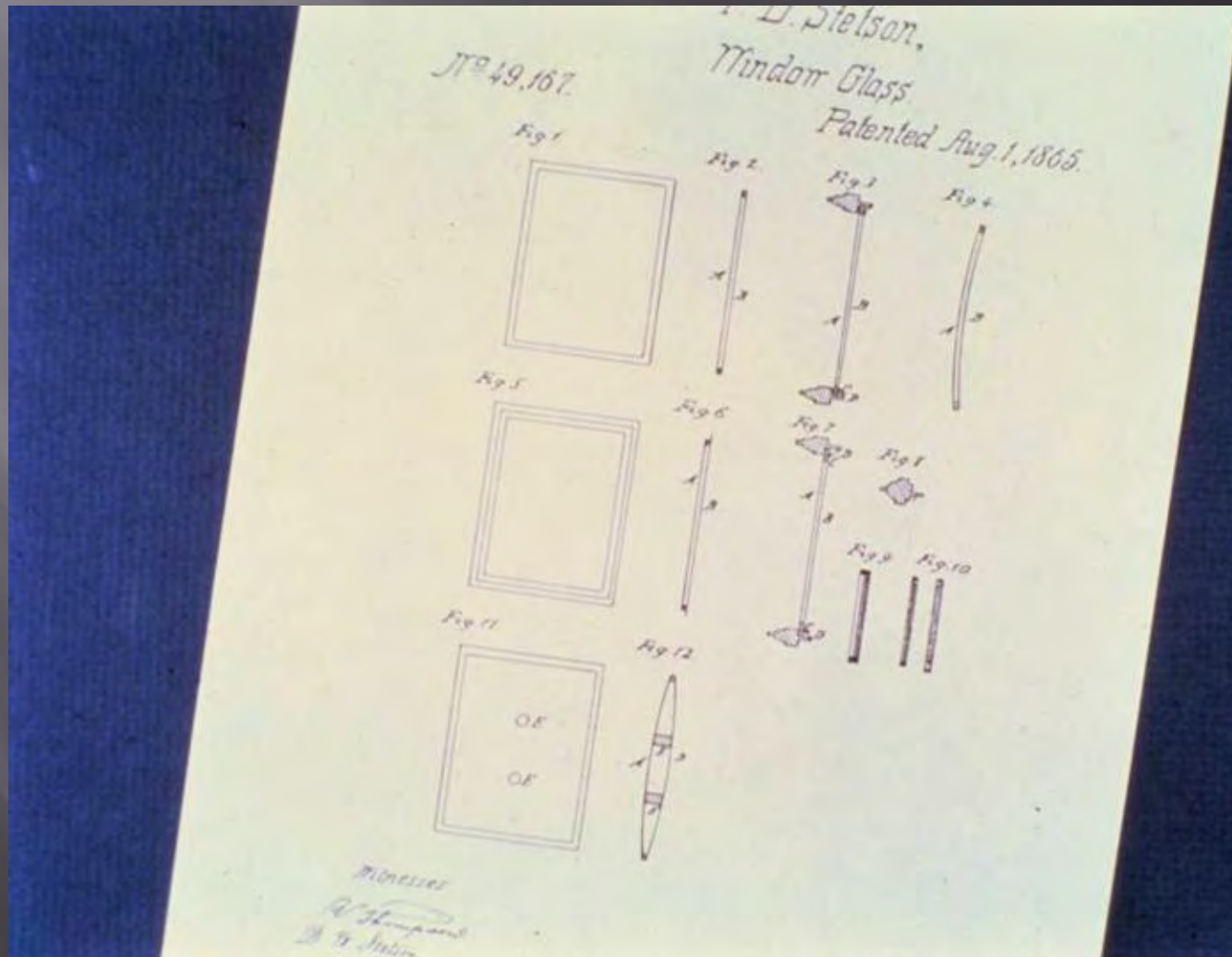
Pittsburgh – October 2013



# DOUBLE GLASS PATENT

Thomas Stetson – 1865

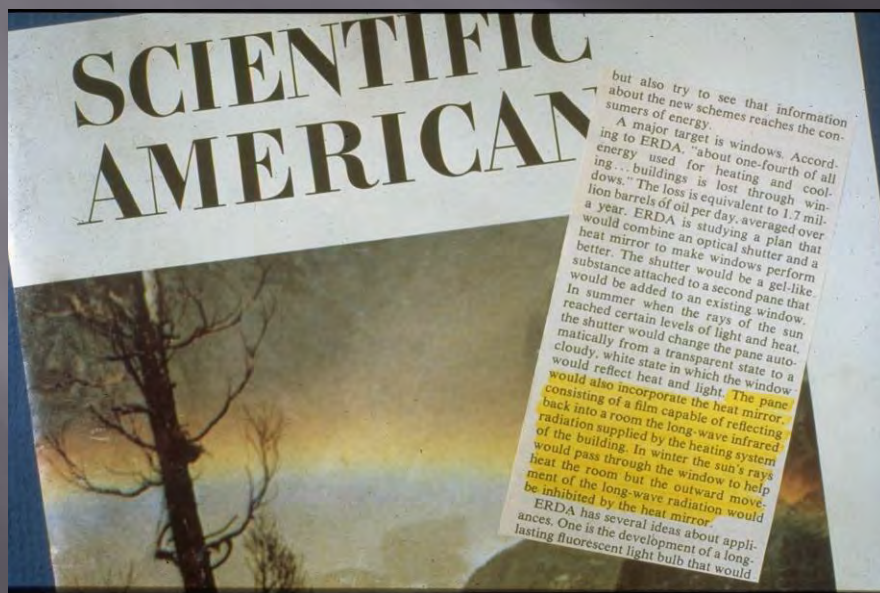
144 Years Later: R-20 versus R-2 Insulating Value



# SUSPENDED COATED FILM (SCF) HISTORY

## Weightless Transition: Double To Triple Glazing

(MIT: 1974 Research – 1990 Application)



**1974 First SCF Produced  
“Vacuum Silver  
Deposition” On Clear  
Polyester**



**1190 MIT Rotch Library  
SCF Glazing (Super  
Insulation & UV Blockage)**

# COATED FILM “PLANAR MAGNETRON SPUTTERING”

## Heat Mirror Facility – Dresden, Germany

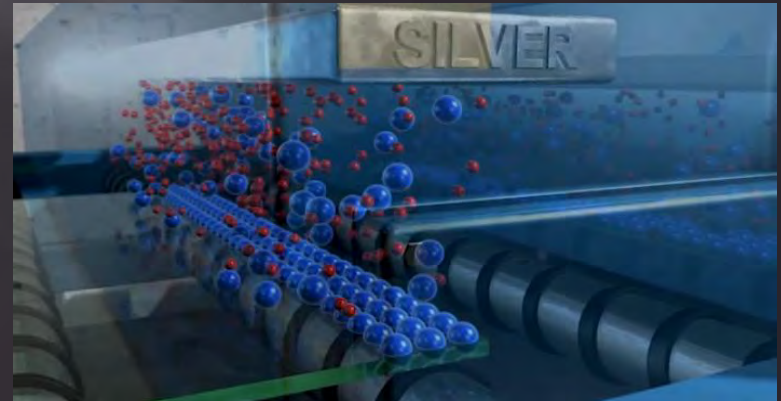


- ▣ **SCF Production:**  
**\$18.5M Vacuum**  
**“Sputtering”**  
**Machine. SFC:**  
**79” Wide By**  
**5,000’ Long**
- ▣ **10 Different SCF**  
**Technologies**  
**Address**  
**Residential, Instit**  
**utional And**  
**Commercial**  
**Architecture**

# CARDINAL INSULATING GLASS



**Vertically Integrated –  
From Melted Sand To  
Coated-Insulating Units**



From: <http://www.cardinalcorp.com/technology/reference/video-gallery/>

# SOUTHWALL INSULATING GLASS CHICAGO



- SCF Unit Production In 30-45 Seconds
- First Truly Continuous Heat Mirror Production Worldwide

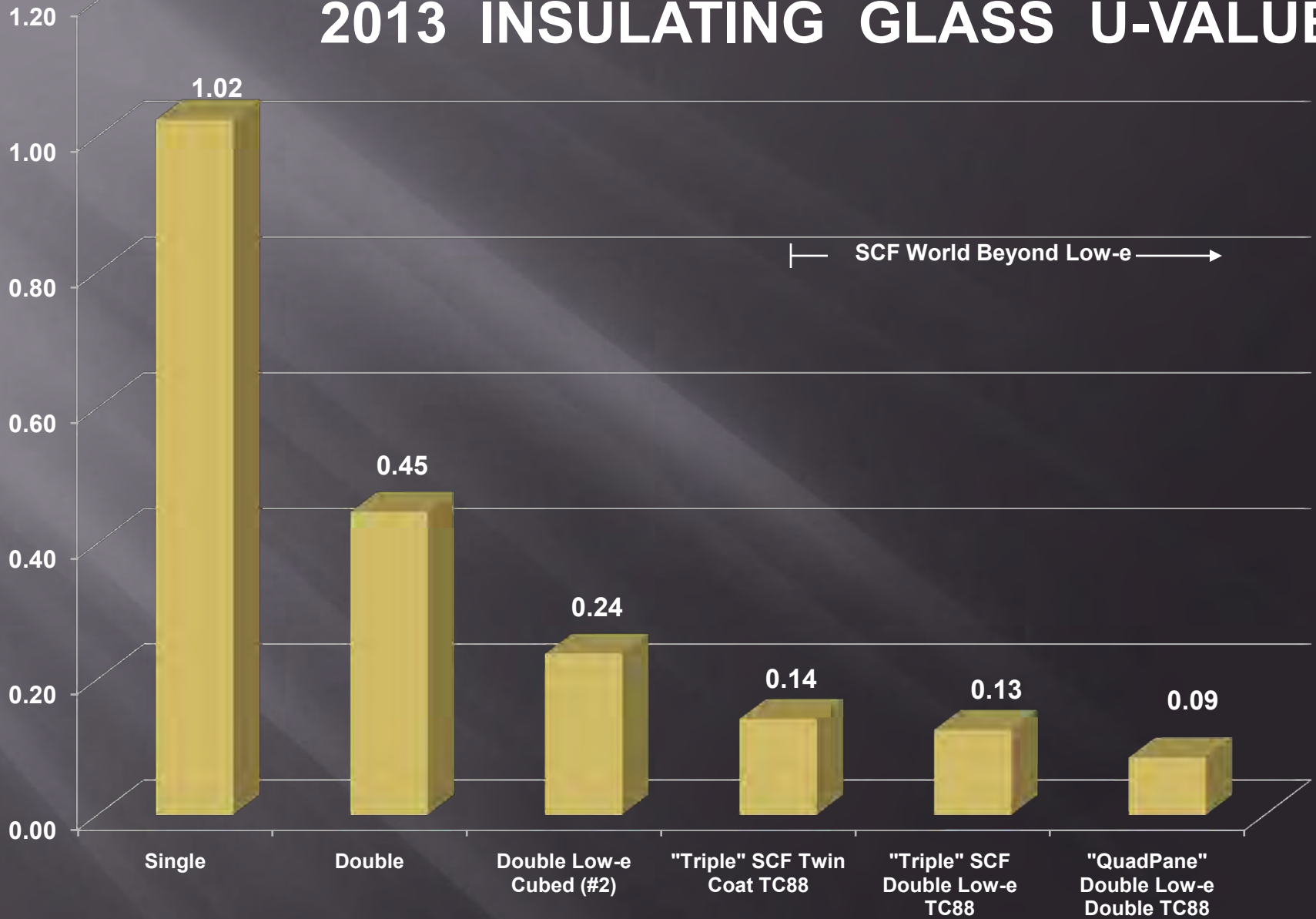
# SOUTHWALL INSULATING GLASS CHICAGO



- OEM Supplier To Passive House Window Manufacturers
- 80,000 SF Facility – Automated World Class SCF Production Line
- Single / Double / Triple Heat Mirror Options

See: [SouthwallGlass.com](http://SouthwallGlass.com)

# 2013 INSULATING GLASS U-VALUE

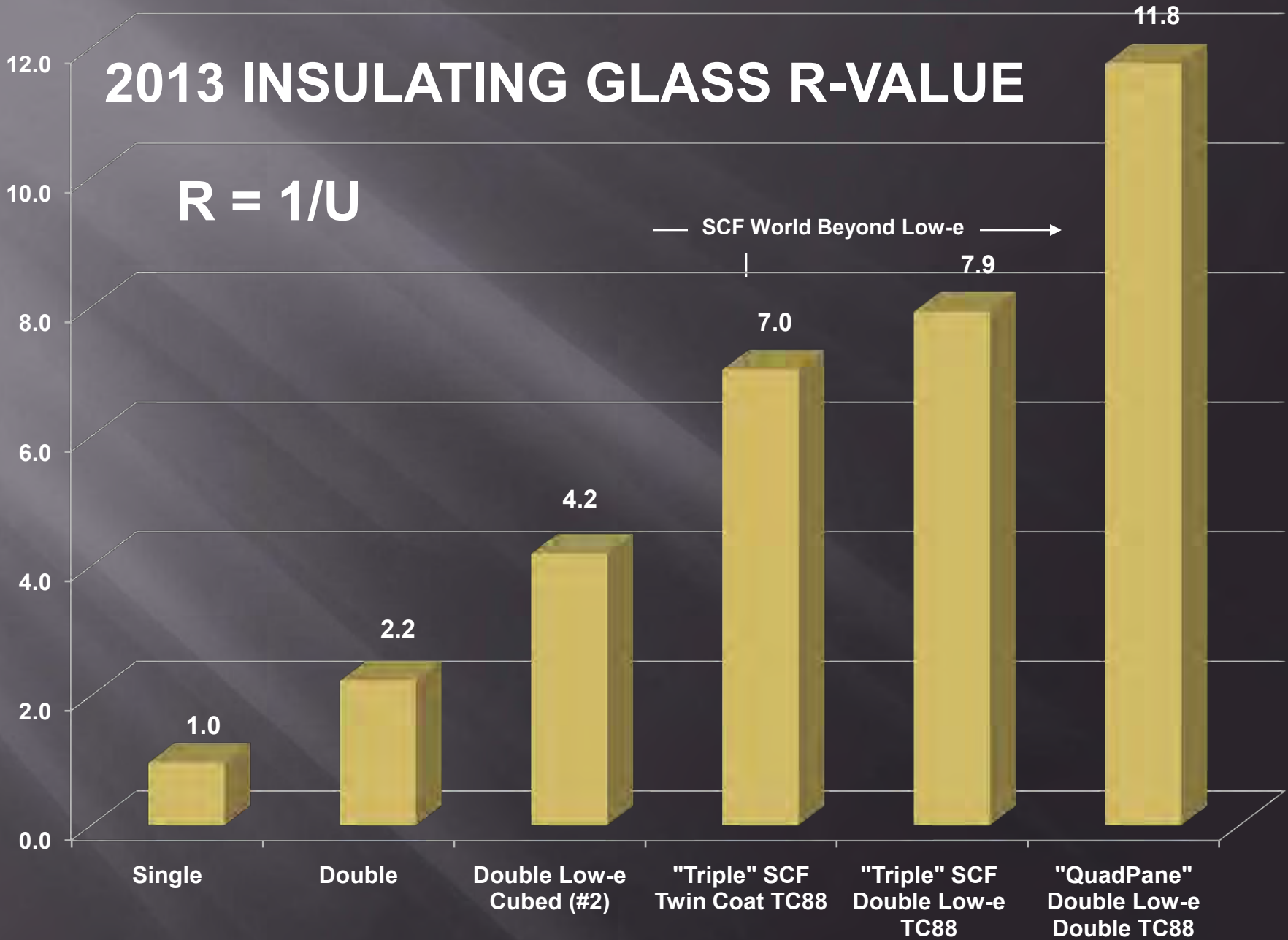




# 2013 INSULATING GLASS R-VALUE

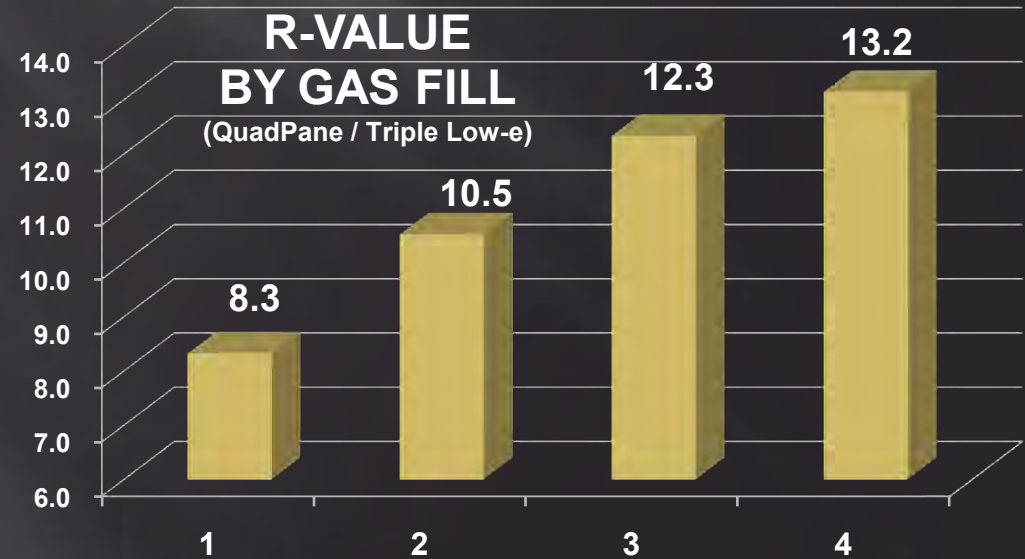
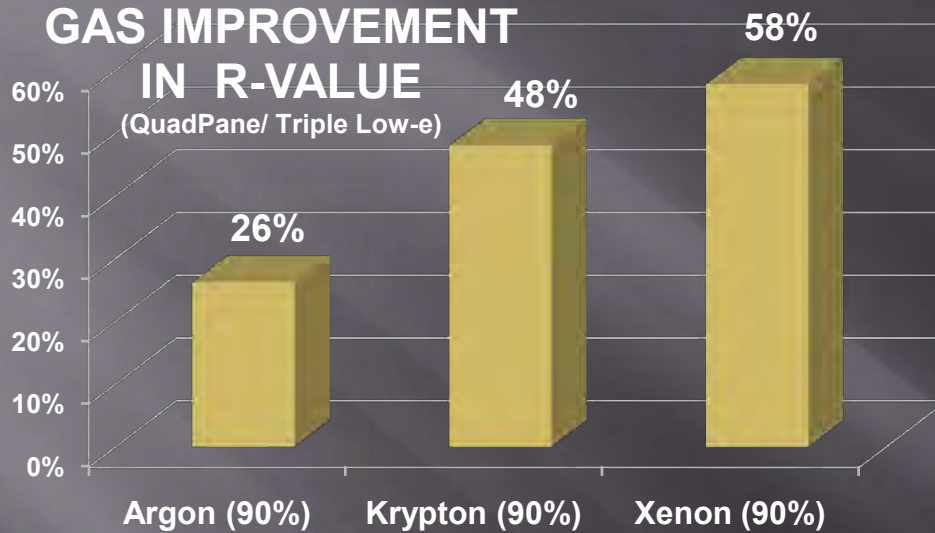
$$R = 1/U$$

— SCF World Beyond Low-e —>



# Performance Increase Due To Gas Filling

## Case #2: QuadPane



# Optimal (approximate) Interspaces

## Air, Argon, Krypton & Xenon

Air: 1/2"

Argon: 1/2"

Krypton: 3/8 "

Xenon: 1/4"

# ARGON CONTAINMENT MONITORING



**Argon Percentage  
Instantly Displayed**

**German Standard:  
Fill To 90+% -  
Maintain Gas Loss  
Below 1% Per Year**



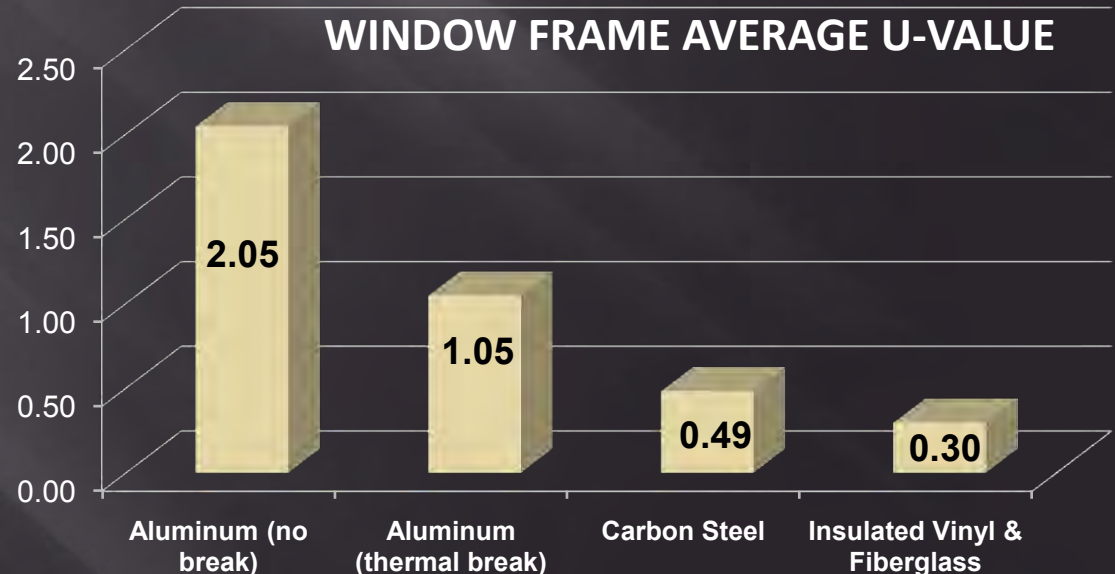
**FDR Design (Buffalo,  
MN) 12-Year Argon  
Containment < 1/2%  
Per Year**

**Contact: Randi Ernst:  
FdrDesign.com**



# Frame Only U-Values

Frame-Only U-Values			
From: "Residential Windows" (Carmody/Selkowitz/Arasteh/Heschong)			
	Low	High	Average
Aluminum (no break)	1.7	2.4	<b>2.05</b>
Aluminum (thermal break)	0.8	1.3	<b>1.05</b>
Carbon Steel	0.40	0.57	<b>0.49</b>
Insulated Vinyl & Fiberglass	0.2	0.4	<b>0.30</b>



# Zola Windows

## Passive House Windows

ZolaWindows.com



# Yaro Windows Passive House Windows



# Wooden Window Passive House Certified

WoodenWindow.com

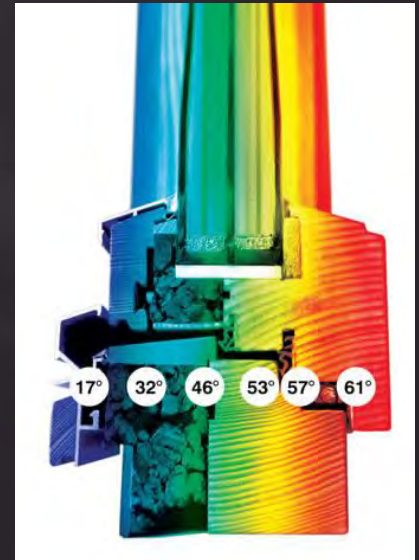
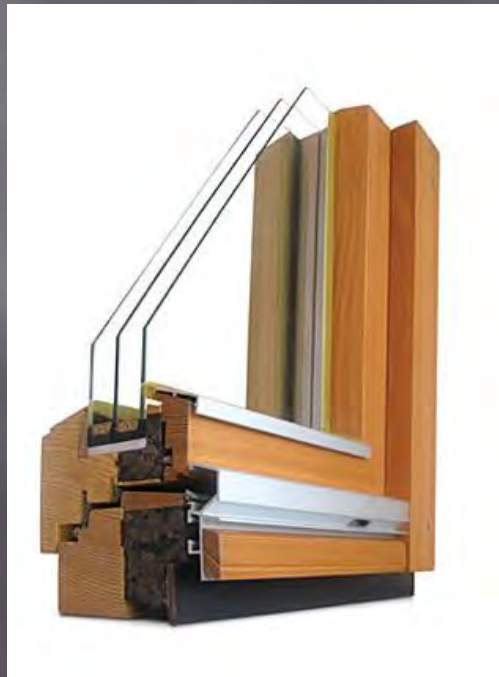




# OptiWin

## Passive House Windows

OptiWin-Usa.com



# NorthWin

## Passive House Windows

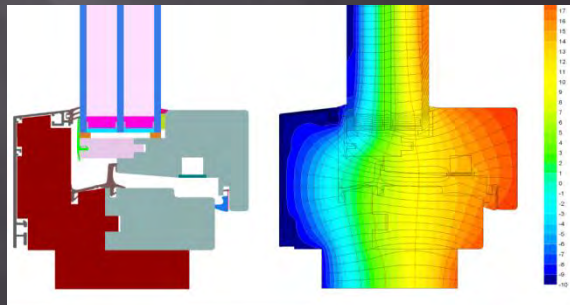
Northwin.com



### Certificate

**Certified Passive House Component**  
for cool, temperate climates; valid until 31.12.2013

Category: **Window Frame**  
Manufacturer: **Northwin windows and doors inc.**  
**V6P 6R9 Vancouver, CANADA**



# Marvin Ultimate Windows Passive House Certified

(Zone 3 & Marine South)



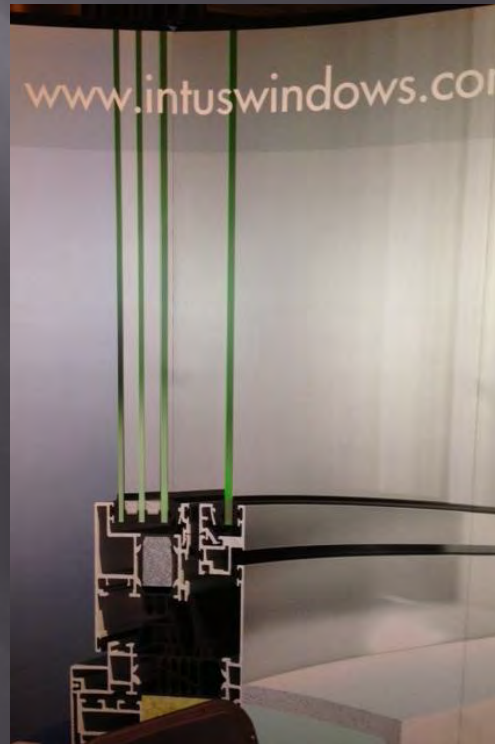
Glass Options: Tri-Pane & Quad Pane Heat Mirror®

# KlearWall / Munster Joinery (Ireland)



# Intus

IntusWindows.com



# Casa Grande Woodworks Passive House Certified

CasaGrandeWoodworks.com



# Alpen Windows

## Passive House Certified

AlpenHpp.com



525 Series



725 Series



925 Series

Glass Options: Alpenglass Heat Mirror Tri & Quad Pane

# HIGH-END GERMAIN WINDOWS



Optiwin



GlasTrosch

<b>Passive House Window: 4" Versus 2" Frame</b>			
<b>Reference: Standard NFRC Casement: 47.2 x 59.1</b>			
<b>Total Window (Frame) Area = 19.4 SF</b>			
	<b>4" Frame</b>	<b>2" Frame</b>	<b>Variance</b>
<b>Frame % Of Total Area</b>	<b>28.2%</b>	<b>14.5%</b>	<b>-49%</b>
<b>U-Value</b>	<b>0.18</b>	<b>0.16</b>	<b>-11%</b>
<b>SHGC</b>	<b>0.39</b>	<b>0.45</b>	<b>15%</b>
<b>VT</b>	<b>0.51</b>	<b>0.6</b>	<b>18%</b>
<b>Vision Area As % Of Total</b>	<b>71.8%</b>	<b>85.5%</b>	<b>19%</b>



# VISION AREA PERCENT



**Net Vision Versus Opaque (Sash + Frame) Areas For NFRC Sizes**

		<b>Casement</b>		<b>Fixed</b>
		6" Frame		6" Frame
	W/ H	Less 6"		Less 6"
W	23.6	11.6	47.2	35.2
H	59.1	47.1	59.1	47.1
Area	9.69	3.79	19.37	11.51
	% Glass	39%		59%
	<b>% Opaque Sash + Frame</b>	<b>61%</b>		<b>41%</b>

# PHIUS Certified Window Performance Program

## PHIUS Certified Data for Window Performance Program

At its September, 2012 national conference in Denver, PHIUS rolled out the first phase of the domestic (North American) passive house window certification program.

The initial goal is to calculate and make available valid thermal performance parameters for US windows so that designers will have more choices and can do building energy models with more confidence in their accuracy.

We encourage high-performance window manufacturers to participate in the Certified Data Program for Window Performance.

- Doing so **benefits manufacturers and their customers**, and can aid passive house adoption in the United States and Canada
- The program is intended to **simplify and grow the North American market for high-performance windows**, giving passive house designers, construction professionals, and their clients a wider range of confident choices of windows.

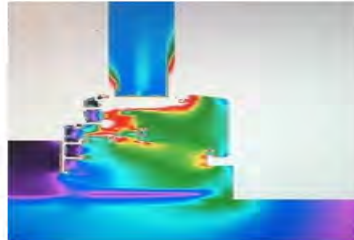
If you are a manufacturer who wishes to submit your product for the program, you can [download a full description of the program and application here](#).

If you have questions, please contact

**Graham Wright**, Senior Scientist and Chair of the PHIUS Technical Committee

[graham@passivehouse.us](mailto:graham@passivehouse.us)

**The Need for a North American Program**

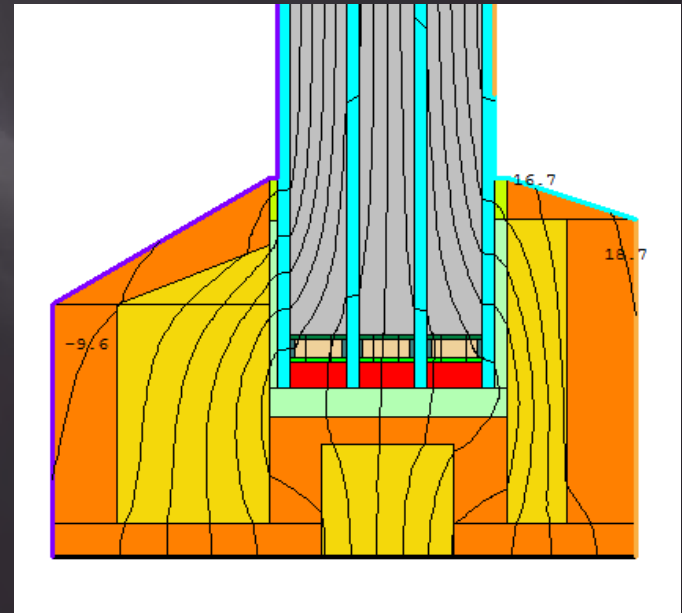


Graham Wright

Graham@PassiveHouse.us

# GRHAM WRIGHT R-9 Window Design

- ▣ Frame
  - Wood and spray foam
  - Width 90 mm
  - Depth 140 mm (5.5")
- ▣ Glazing
  - 4-pane, 90% Argon, 50 mm
  - Cardinal lo-e 180 and clear
- ▣ Spacers
  - Chromatech Ultra F



*“...I feel glazing is not the limiting factor for window performance at this time, but rather frame design.”*

# CONDENSATION & MOLD

From: <http://www.epa.gov/mold/>



The screenshot shows the EPA website's 'Mold and Moisture' section. At the top, the EPA logo and navigation links are visible. The main heading is 'A Brief Guide to Mold, Moisture, and Your Home'. Below this, there is a list of topics including Mold Basics, Mold Cleanup, and Moisture and Mold Prevention and Control Tips. A sidebar on the left contains a table of contents for the guide. A PDF icon and download information are also present.

**EPA** United States Environmental Protection Agency

Advanced Search A-Z Index

LEARN THE ISSUES SCIENCE & TECHNOLOGY LAWS & REGULATIONS ABOUT EPA

**Mold and Moisture**

**Mold & Moisture Home**

Basic Information

Where You Live

Frequent Questions

Publications

Glossary of Terms

Related Links

Flood Cleanup

Natural Emergencies

El medio ambiente y su salud: Moho

**You are here:** EPA Home » Air » Indoor Air » Mold and Moisture » A Brief Guide to Mold, Moisture, and Your Home

## A Brief Guide to Mold, Moisture, and Your Home

This Guide provides information and guidance for homeowners and renters on how to clean up residential mold problems and how to prevent mold growth.

- **Mold Basics**
  - Why is mold growing in my home?
  - Can mold cause health problems?
  - How do I get rid of mold?
- **Mold Cleanup**
  - Who should do the cleanup?
- **Mold Cleanup Guidelines**
  - Tips and techniques
  - Bathroom Tip
- **What to Wear When Cleaning Moldy Areas**
  - How Do I Know When the Remediation or Cleanup is Finished?
- **Moisture and Mold Prevention and Control Tips**
  - Actions that will help to reduce humidity
  - Actions that will help prevent condensation
    - Tips for Renters
  - Testing or sampling for mold
- **Hidden Mold**
- **Cleanup and Biocides**

We would like to thank Paul Ellringer, PE, CIH, for providing the photo of mold on the back of wallpaper in the Hidden Mold section. Should you like to use some of the photos used in this guide, higher quality print versions are available in the Mold Gallery. These photos may be used for presentations and educational purposes without contacting EPA.

Please note that this document presents recommendations. EPA does not regulate mold or mold spores in indoor air. Find [Frequently Asked Questions](#) about mold and moisture.

### Mold Basics

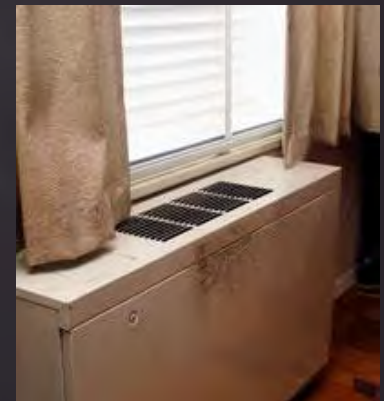
EPA 402-K-02-005, Reprinted September 2010

PDF, 22 pp., 1.4 M, About PDF

Una Breve Guía para el Moho, la Humedad y su Hogar (PDF) (1) pp., 1.28 M, Disponible en PDF. Documento de la agencia EPA número 402-K-03-008, reimprimido el 2010 de mayo.

"Mold Remediation in Schools and Commercial Buildings" (PDF) (1) pp., 1.8 M [EPA 402-K-01-001, reprinted September 2008]

Order publications from EPA's NSCEP. Use the EPA Document Number when ordering.



# FIBERGLASS CONDENSATION FREEDOM

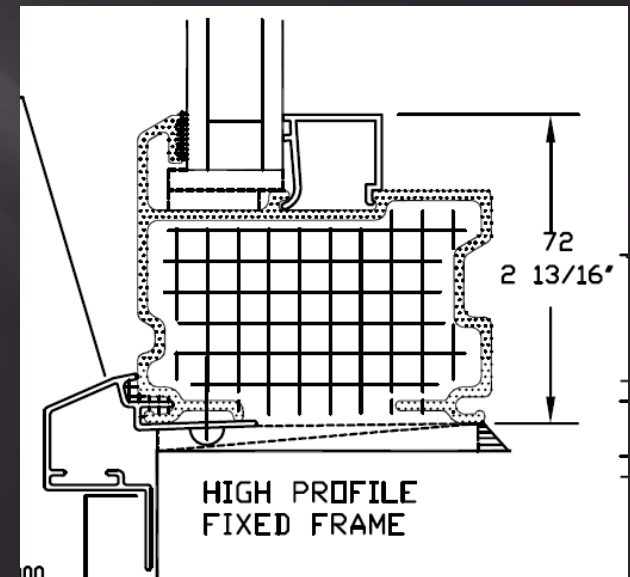


Lower Frame  
Corner: 54 °F(?)

ASHRAE  
"Winter" Glass  
Temp: 64 °F

# FIBERGLASS WINDOW SASH/FRAME CROSS SECTION

TectonProducts.com  
InlineFiberglass.com  
OmniGlass.com



# FIBERGLASS CROSS-SECTION



**Pultrusion Lineal  
Mechanical  
Corner Sash**



**Pultrusion "End"  
(Al Dueck – Duxton)**

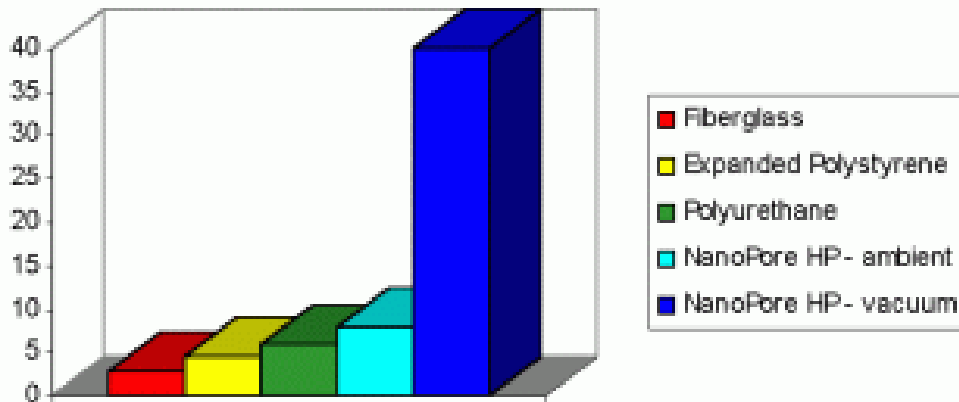
# VACUUM SILICA BASED SASH/FRAME R-36 INSULATION

KevoThermal.com - Albuquerque



Section through PU fridge wall with embedded Nanopore VIP.

R-Value (R/inch)





# Institutional/Commercial Passive House Presence



Morristown Maple  
Avenue City  
Building



NRDC  
Headquarters -  
NYC

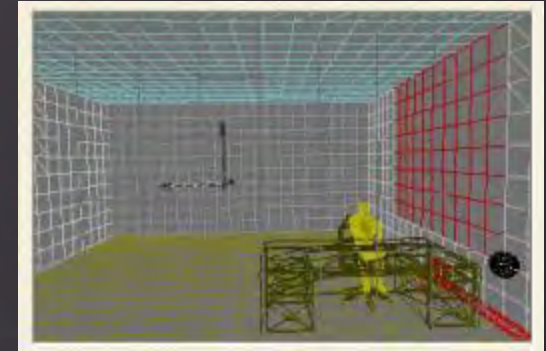


# Passive House Occupant Comfort



## Six Human Comfort Factors

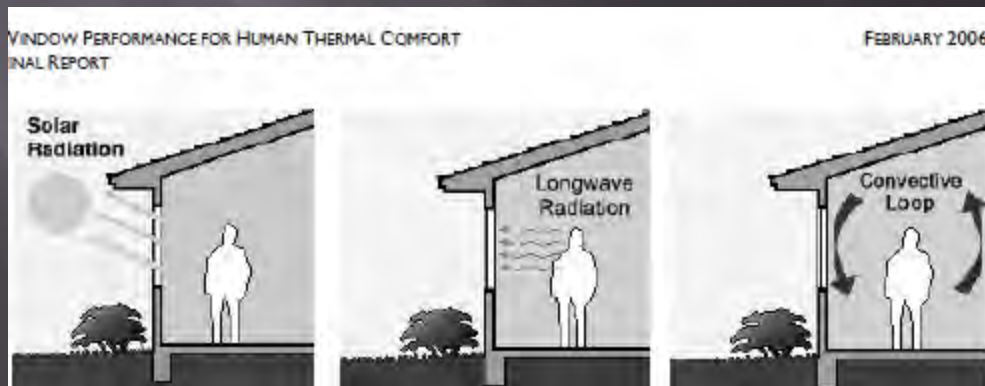
1. Air Temp
2. Mean Radiant Temp
3. Air Velocity
4. Relative Humidity
5. Activity Level
6. Clothing Factor



CFD Modeling



GOOGLE – New York City  
20-Degree Surface Temp Difference



# INSULATING GLASS ACOUSTICS 101




## REPRESENTATIVE STC RATINGS

GLAZING TYPE      SOUND TRANSMISSION CLASS (STC)

- |   |    |
|---|----|
| □ Conventional Double Pane (1/8") Glass | 29 |
| □ Solid 1/2" Gypsum Wall                | 36 |
| □ SCF: 1" Overall with 1/4" Glass       | 35 |
| □ SCF: 1 1/2" Overall with 1/4" Glass   | 38 |
| □ SCF: One Lite Laminated               | 40 |
| □ SCF: Two Lites Laminated              | 43 |
| □ SCF: Two Dissimilar Laminated Lites   | 49 |
| □ SCF: Two "Acoustic" Laminated Lites   | 52 |

# WINDOW ACOUSTICS

## National Research Council of Canada Inline Fiberglass Window Acoustic Report (STC = 35)


**National Research Council Canada** / **Conseil national de recherche Canada**  
 Institute for Research in Construction / Institut de recherche en construction

**CLIENT REPORT**

for

Inline Fiberglass Ltd.  
 141 Snydercroft Road,  
 Concord, Ontario  
 L4K 2J8

**Sound Transmission Loss Test of Window Unit**  
(6 mm glass, 19 mm air, 4 mm glass)

Author: R.E. Halliwell  
 Approved: J.D. Quirk, Section Head  
 Approved: W.A. Dalgleish, Head, Quality Assurance

Report No.: CR-5940.2  
 Report Date: 26 July 1989  
 Contract No.: CR-5940  
 Reference: Application for test dated 6 July 1989  
 Section: Acoustics

5 pages  
Copy 1 of 6 copies

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**Canada**

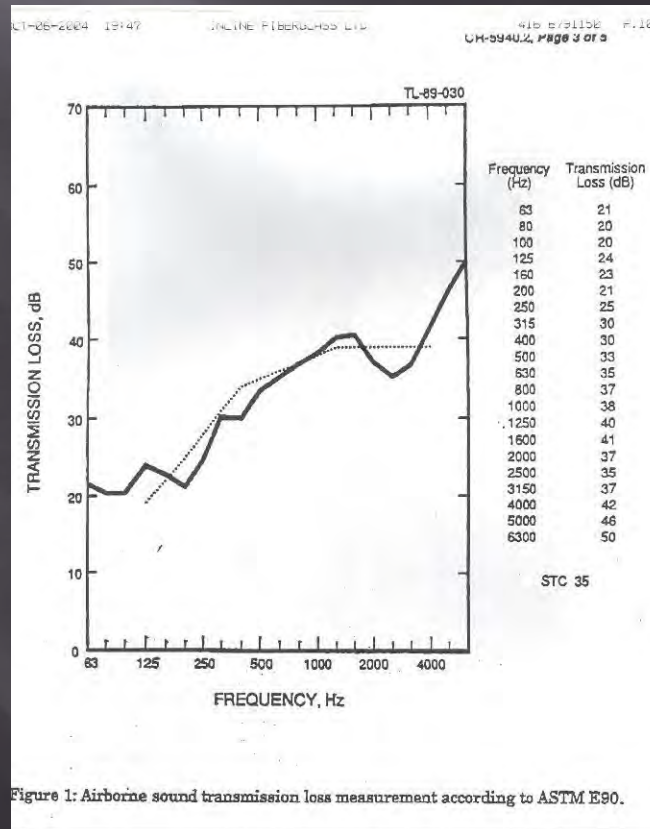


Figure 1: Airborne sound transmission loss measurement according to ASTM E90.

**TEST WINDOW:**

**87 Wide x 72" High**

**Two large upper fixed**

**One small fixed and  
one small awning  
below**

**Insulating Glass**

**Outer: 1/4"**

**Airgap: 3/4"**

**Inner: 3/16"**

# FIBERGLASS ENVIRONMENTAL FACTORS

Research By Enermodal Engineering – Canada



- Glass (silica sand): 65 – 85% Ample worldwide supply
- Resin: Thermoset Polyester “Relatively small” petroleum content
- Process resins: re-blended and reused
- Interior sash and frame insulation: polystyrene – petroleum base with some concern for pentane blowing-agent escape
- Both glass fiber and resin manufacturing are *closed processes* with “few emissions to the environment.”
- No ozone-depleting chemicals used in fiberglass window manufacturing
- Energy efficiency and long life significantly reduce energy consumption

## Enermodal Conclusion

Energy use was considered to be the most important environmental factor. From this analysis it was found that fiberglass windows have the lowest overall environmental impact.

# IG PERFORMANCE DATA SOURCE

- All Thermal, Optical and Ultraviolet IG data is generated by Lawrence Berkeley Laboratory's "WINDOW 6.3" software.

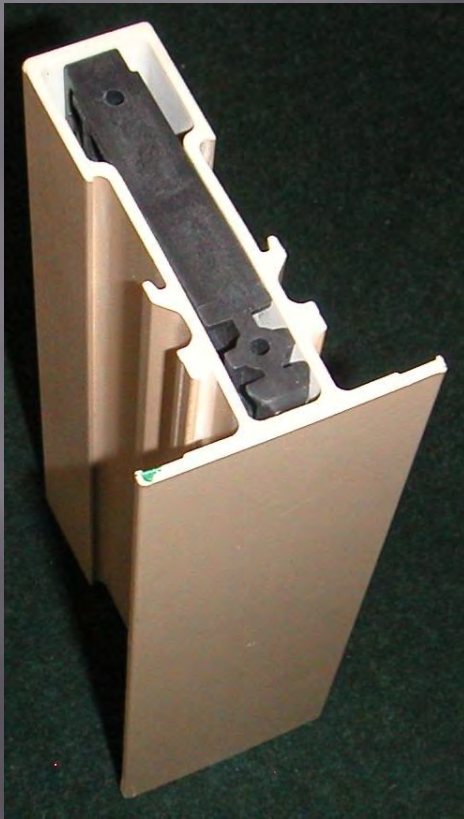
LBL WINDOWS & DAYLIGHTING GROUP

Berkeley, CA (510-486-6844)



- Windows 6.3 (free download)
- Website: <http://windows.lbl.gov>
- International IG Performance Standard
- 1000+ Glass Types As Of 2013

# COMMERCIAL FIBERGLASS FRAMES



**Internal Anchor  
Blocks**



**Winnipeg Church In Blizzard – Warm To  
The Touch Window Frames**

# DYNAMIC GLAZING

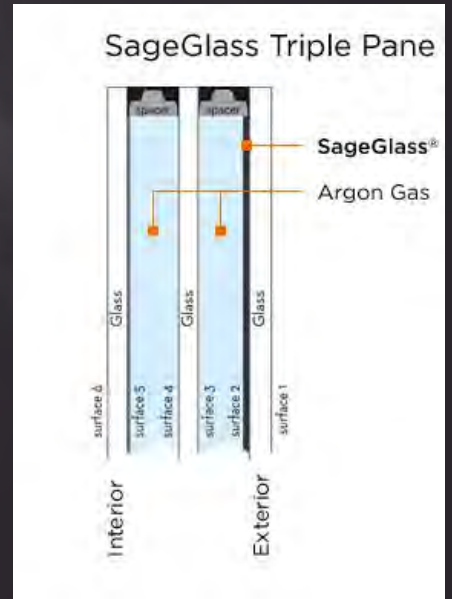
Electrochromic / Photochromic / Thermo-chromic



view Dynamic Glass

- Why Dynamic Glass?
- Benefits of View
- You in control
- Sustainability
- Product overview
- Specifying your Dynamic Glass
- Intelligent design
- Control your environment
- Energy efficiency
- Acoustic protection
- Control your privacy
- Control your glare
- Control your temperature

Like transition sunglasses for buildings



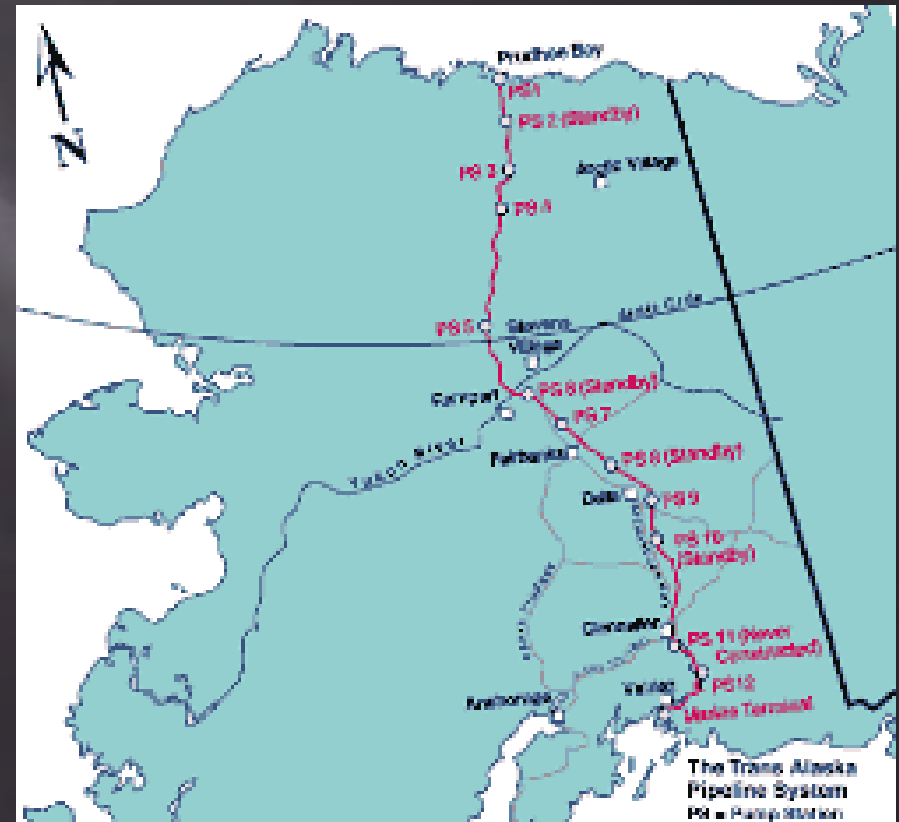


# BIPV GLAZING

## Integral PV Cells / Transparent PV



# ALASKA PIPELINE ENERGY GOES “OUT THE WINDOW”



**Amory Lovins:** *All of the energy pumped through the Alaska Pipeline each year goes literally “out America’s windows.”*