

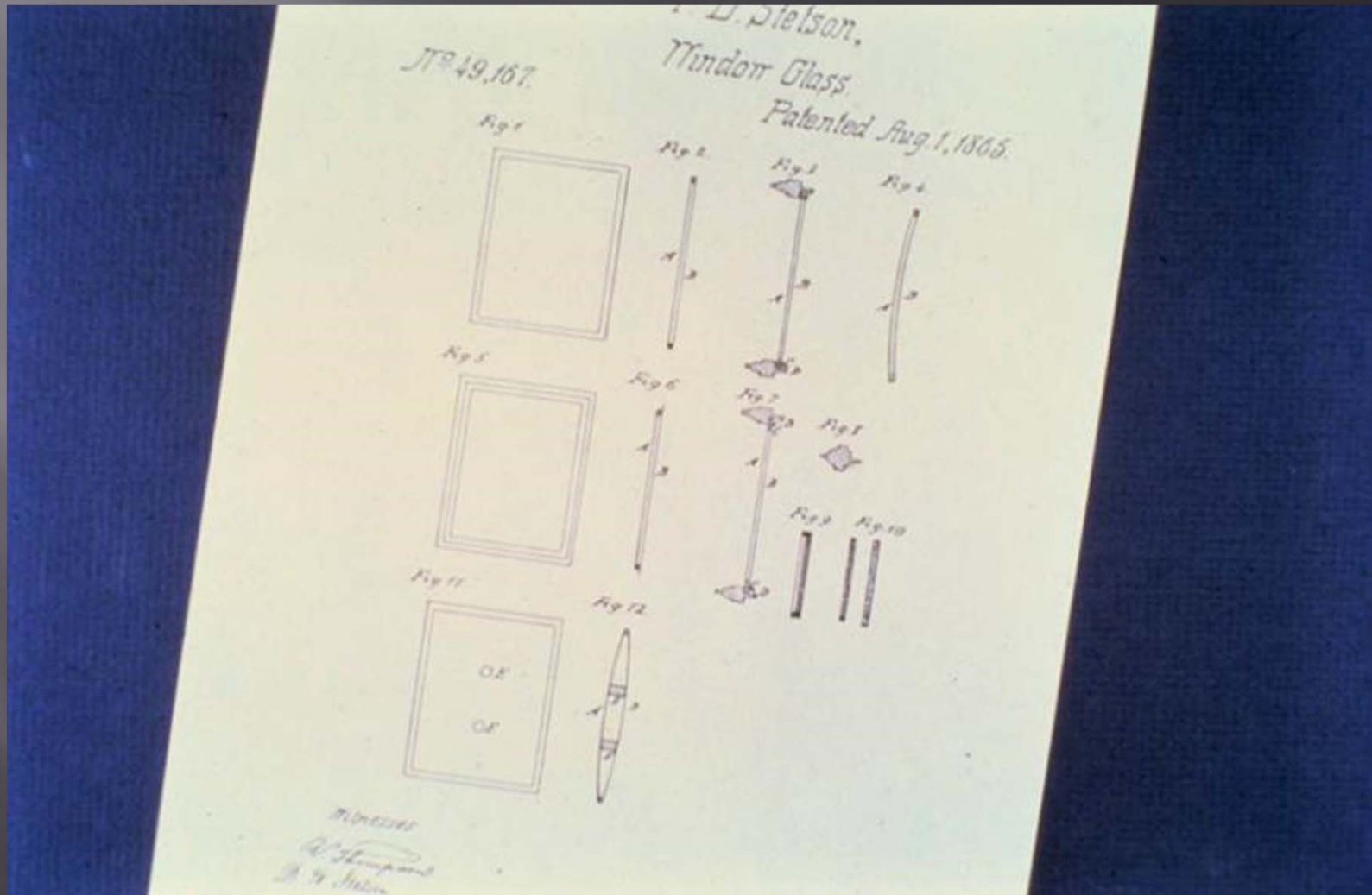
EFFICIENCY WORKS TRAINING

August 20, 2014

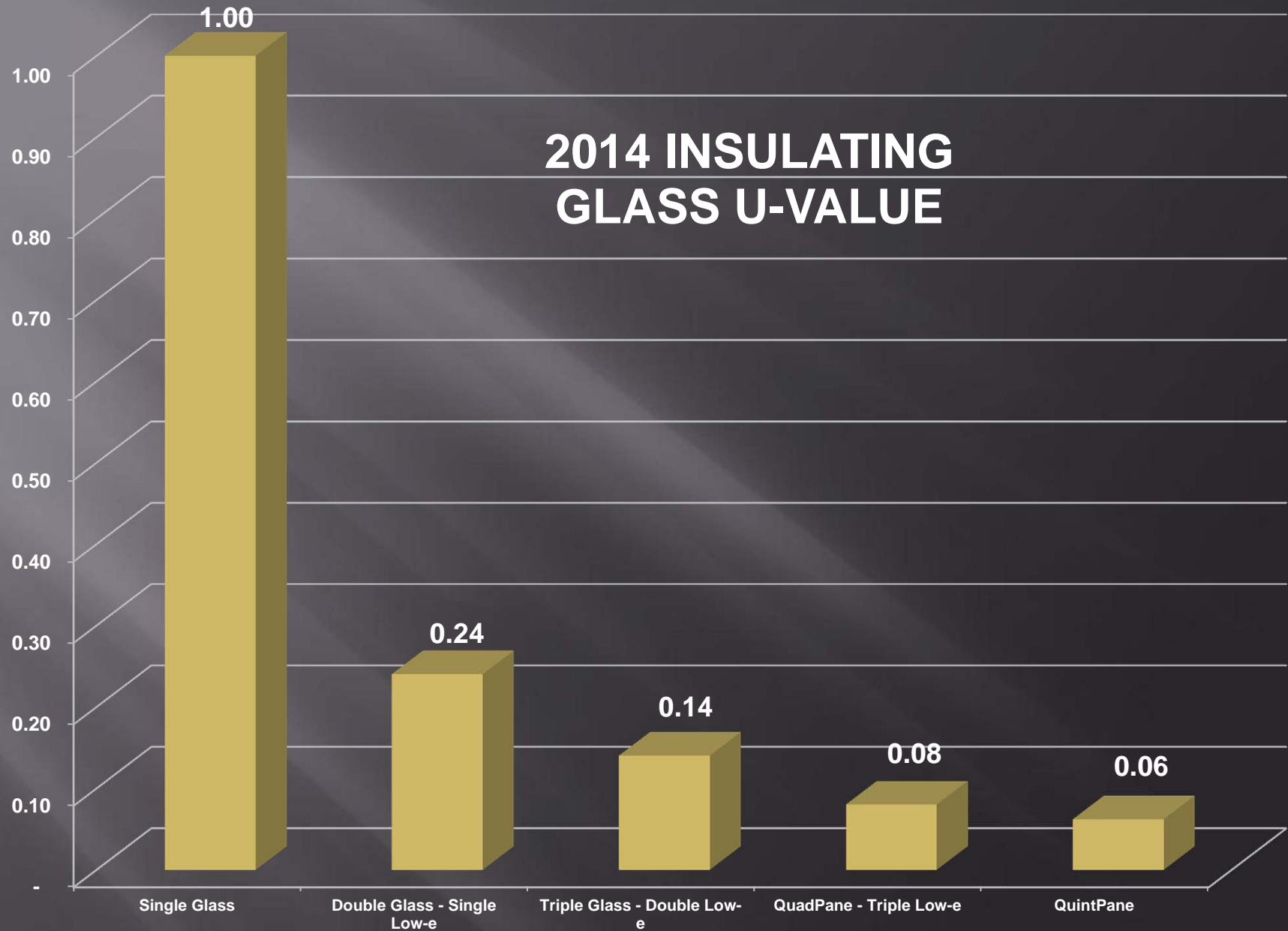


RobertClarkeAssociates.com
303-641-6476
Boulder, Colorado

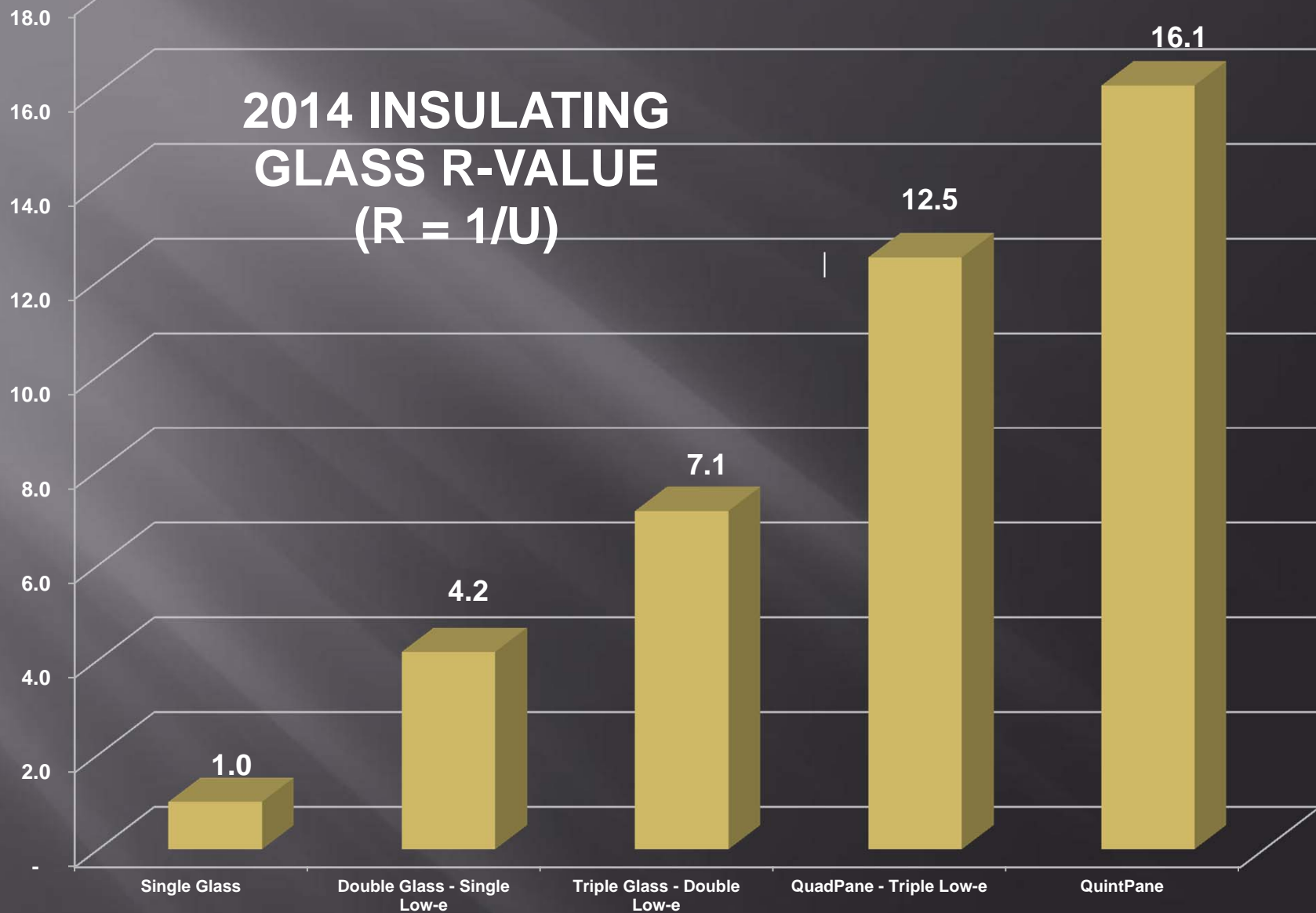
1865 DOUBLE GLAZING PATENT ("Lincoln" Movie Year)



2014 INSULATING GLASS U-VALUE



2014 INSULATING GLASS R-VALUE ($R = 1/U$)



Optimal Interspace

Air, Argon, Krypton & Xenon

Air: 1/2"

Argon: 1/2"

Krypton: 3/8 "

Xenon: 1/4"

ARGON/KRYPTON CONTAINMENT MONITORING



**Argon Percentage
Instantly Displayed**

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

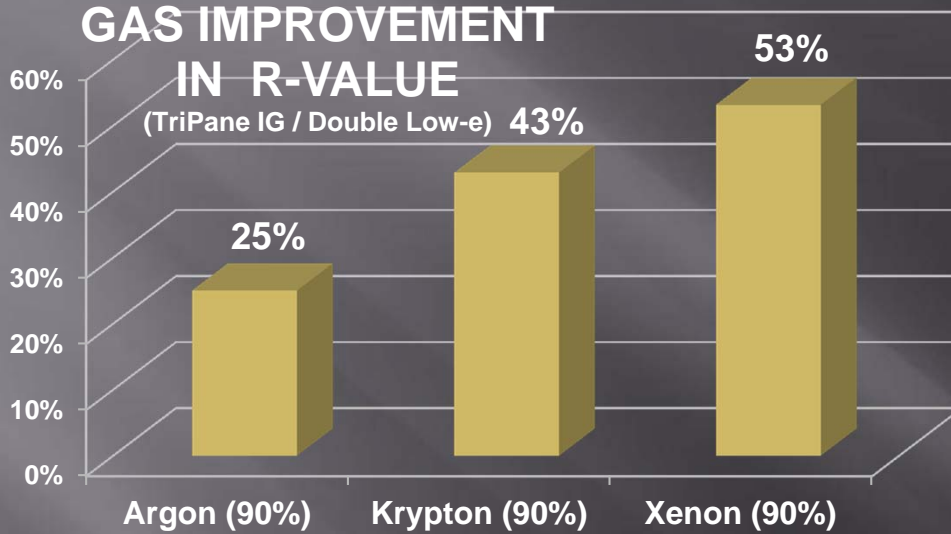


**FDR Design (Buffalo,
MN) 12-Year Argon
Containment < 1/2%
Per Year**

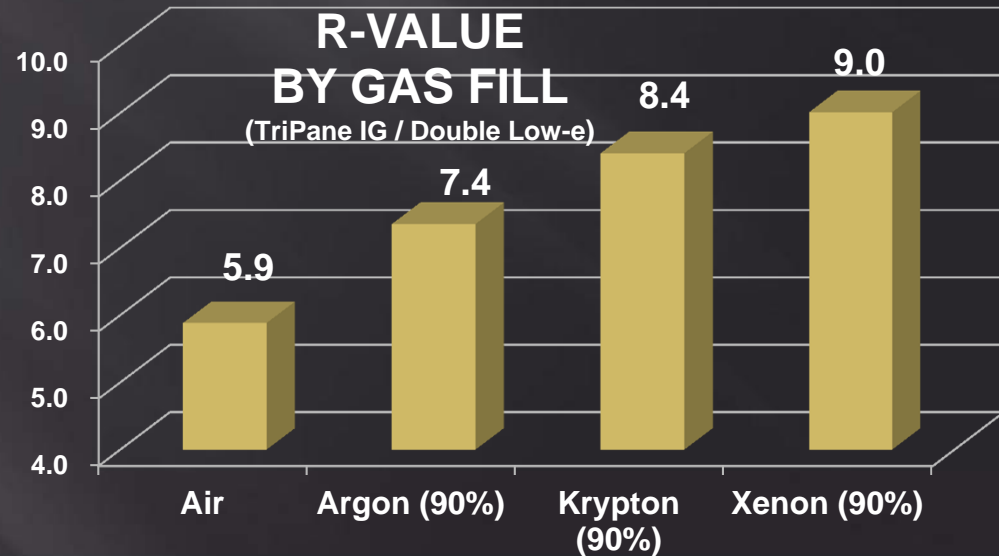
**Contact: Randi Ernst:
FdrDesign.com**



Performance Increase Due To Gas Filling (2014 Triple Insulating Glass)

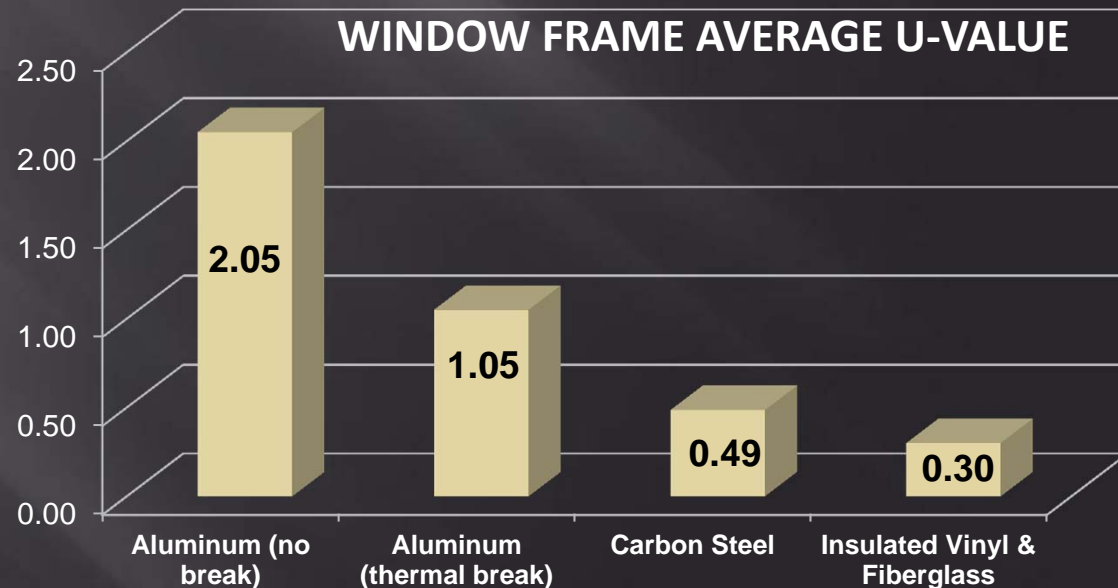


September 2014 Price Note:
Krypton Down 60% / Xenon
Up 10X



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	2.05
Aluminum (thermal break)	0.8	1.3	1.05
Carbon Steel	0.40	0.57	0.49
Insulated Vinyl & Fiberglass	0.2	0.4	0.30



SOLAR AGE Passive Solar Building Survey September, 1983

Fading

Overheating

Too cold on cloudy winter days

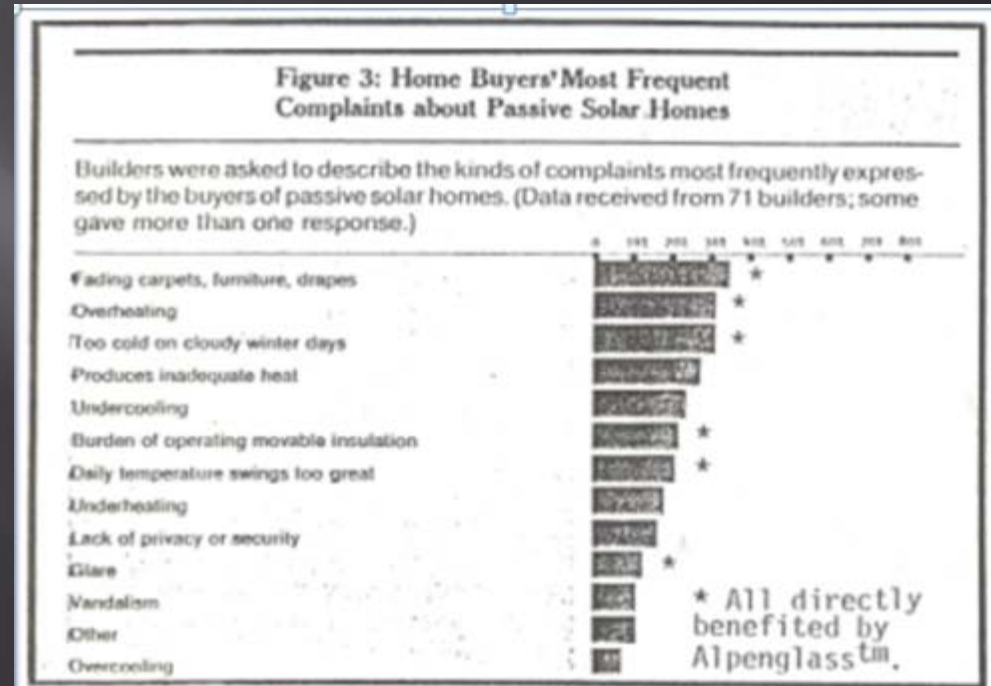
Undercooling

Moveable Insulation Burden

Daily temperature swings

Lack of privacy or security

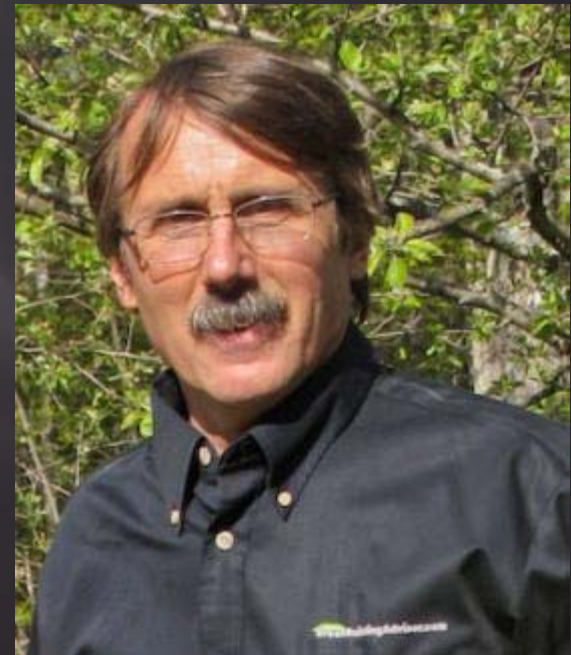
Glare




Directional Window “Tuning”

“Most designers feel safer specifying low-solar-gain glazing for the west elevation.”

*Martin Holladay
GreenBuildingAdvisor.com*



End Of Empirical Testing For Commercial Windows (?)



Component Modeling Approach FAQs

The National Fenestration Rating Council's (NFRC) new Component Modeling Approach (CMA) Product Certification Program enables whole product energy performance ratings for commercial (non-residential) fenestration. CMA uses online performance data for the three primary components of a fenestration product – glazing, frame, and spacer – to generate overall product performance ratings for U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT). This information is incorporated into a CMA Label Certificate for code compliance.

Does the Component Modeling Approach (CMA) really 'eliminate' the need for lab testing?
Lab testing (otherwise known as a validation test) of the framing product line is still conducted by accredited labs in order to validate the framing product lines placed in the CMA Software Tool (CMAST). Once validated, frame members associated with this framing product line can be NFRC-approved and entered into the CMAST library for unlimited use.



CMAST = Component Modeling Approach Software Tool

ACE = Approved Calculation Entity

UNIVERSITY OF COLORADO

Accepting Passive House Principles

University Of Colorado - \$63 Visual Arts Center

Super IG + 131" Pultrusion FG Frames

Architects: KMW-Boston & OZ-Colorado



**Woodbury Hall – 1890 – Original
Steel – to Interim Aluminum – to
Serious Fiberglass**

Alex Wilson – Building Green



BuildingGreen.com

NEWS LEARN CSI DIVISIONS LEED CREDITS GREEN PRODUCTS CASE STUDIES

Environmental Building News

WHAT REALLY MATTERS IN SUSTAINABLE DESIGN & CONSTRUCTION

CURRENT ISSUE
Vol. 21 No. 5

Search *EBN* Issues by Date

Features

- What's Happening
- Product News & Reviews
- BackPage Primers

Product Review from *Environmental Building News*

European Windows for Passive House Buildings

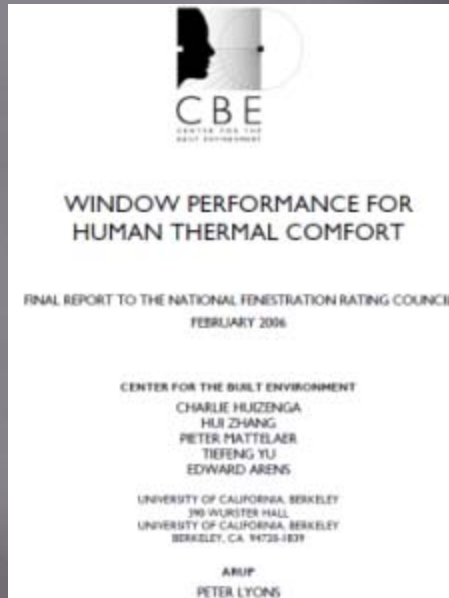
The National Fenestration Rating Council (NFRC) was established in the U.S. in 1989 to standardize the testing and reporting of window energy performance. Prior to the formation of NFRC, window manufacturers used different methods to report their performance. Consumers and specifiers couldn't compare apples to apples. Among the most important performance metrics to be addressed by NFRC was the U-factor, the amount of heat flow through a whole window unit under certain testing conditions. U-factor is the inverse of R-value, and until NFRC came along, manufacturers most commonly reported energy performance as the center-of-glass R-value.



**2007 Top-10
Green Building Product**
GreenSpec
www.BuildingGreen.com

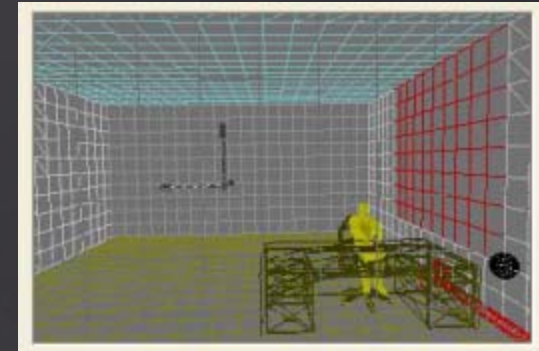


Passive House Occupant Comfort



Six Human Comfort Factors

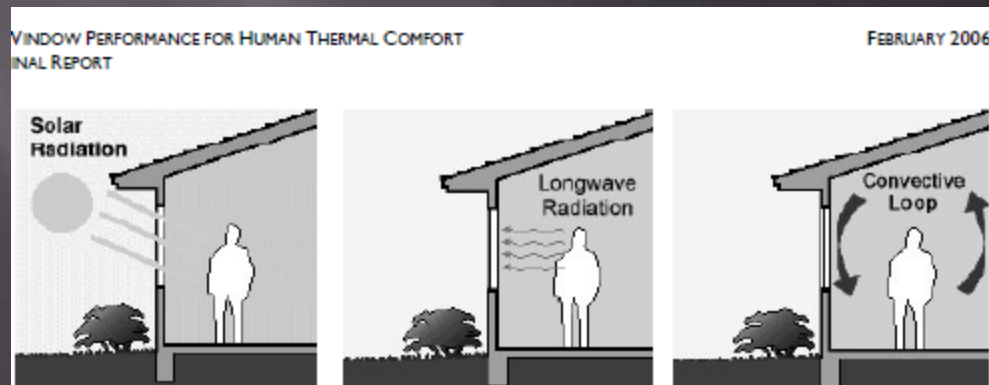
1. Air Temp
2. Mean Radiant Temp
3. Air Velocity
4. Relative Humidity
5. Activity Level
6. Clothing Factor



CFD Modeling



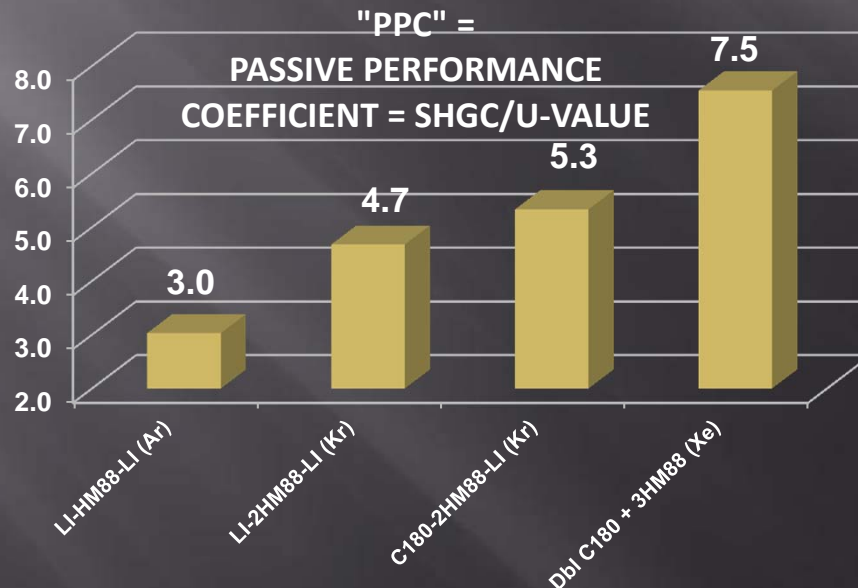
GOOGLE – New York City
20-Degree Surface Temp Difference



"PASSIVE PERFORMANCE COEFFICIENT" = SHGC / U-VALUE

Insulating Glass "Passive Performance Coefficient"				
CONFIGURATION				
Label	LI-HM88-LI (Ar)	LI-2HM88-LI (Kr)	C180-2HM88-LI (Kr)	DbI C180 + 3HM88 (Xe)
Outer Light	1/8" Low Iron	1/8" Low Iron	1/8" Low Iron	1/8" C180 (#2)
Triple Versus QuadPane	Triple	Quad	Quad	Quint
Interspaces	2 @ 1/2" Argon	3 @ 3/8" Krypton	3 @ 3/8" Krypton	4 @ 1/4" Xenon
(SFC) Suspended Coated Film	HM88	Double HM88	Double HM88	Triple HM88 (#4,6,8)
Inner Light	1/8" Low Iron	1/8" Low Iron	1/8" Low Iron	1/8" C180(#9)
PERFORMANCE				
U-Value (Winter)	0.20	0.11	0.08	0.050
R-Value	5.0	9.3	12.2	20.0
Solar Heat Gain Coefficient	0.60	0.51	0.44	0.38
"PPC" Passive Performance Coefficient	3.0	4.7	5.3	7.5
Tvis	74%	66%	63%	53%
UV Blockage (to 380 nm)	99.3%	100.0%	100.0%	100.0%
ASHRAE/NFRC "Winter" Glass Temp (°F)	59 Deg F	63 Deg F	65 Deg F	67 Deg F
ASHRAE/NFRC "Summer" Glass Temp (°F)	91 Deg F	94 Deg F	90 Deg F	96 Deg F

All values are Center Of Glass - as calculated by LBNL Window 6 Software



Low Iron Glass
(no green)

Institutional/Commercial Passive House Presence



Morristown Maple
Avenue City
Building

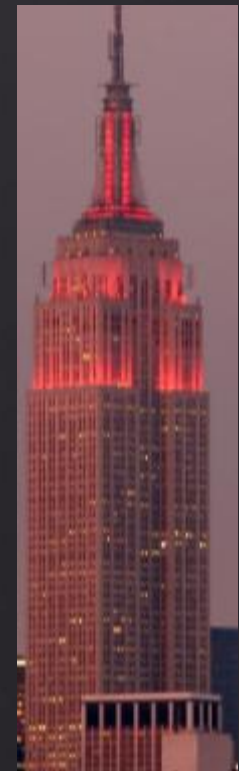


NRDC
Headquarters -
NYC



PASSIVE HOUSE COMMERCIAL RETROFIT? EMPIRE STATE BUILDING

Empire State Building <i>Before And After</i> Glass Performance			
North Elevation (Fifth Avenue Orientation: 29 1/2 Degrees East Of North)			
	Before	After	
	Clear Uncoated Double Pane (1992)	"Triple" SCF Glass Suspended Coated TC88	
Outer Light	3/16" Clear	3/16" Clear	
Interspaces And Thickness	1 @ 5/8"	2 @ 5/16"	
Suspended Coated Film(s)	None	TC-88 (Double Low-e)	
Gas Fill	Air	90% Krypton/10% Oxygen	
Inner Light	3/16" Clear	3/16" Clear	
Performance			
	Before	After	Difference
U-Value	0.48	0.13	-72%
R-value	2.1	7.6	+261%
SHGC	0.72	0.49	+32%
Tvis	80%	64%	-20%
Winter NFRC (70 in/0 out/15 mph) Glass Temp	44 Deg F	62 Deg F	+ 18 Degrees F
Summer NFRC (75 in/90 out)	95 Deg F	76 Deg F (LBNL)	- 19 Degrees F
Overall Thickness	1"	1"	No Change
UltraViolet Blockage	46.8%	98.6%	-111%



EMPIRE STATE BUILDING SCF GLAZING RENOVATION



Windows: 6,514
 IG Units: 13,028
 Glazing: ~160,000 ft²
 Start: March, 2010
 End: November 2010

ESB Renovation Measure Contributions		
1) DDC (Direct Digital Control)	603	36.8%
2) Demand Controlled Ventilation	5	0.3%
3) Tenant Lighting & Plug Load Reduction	424	25.9%
4) Windows	440	26.9%
5) Tenant Energy Management	166	10.1%
Total Tonnage Reduction	1,638	100.0%
Total Avoided HVAC (Chiller) Expenditure	\$ 17,400,000	
Windows Share Of Chiller Savings	\$ 4,673,993	
So, by <i>GSB Valedictorian</i> Mel Hodge Logic, payback is:	"Immediate"	
\$/Ton Savings	10,623	(High?)

Manufacturing Innovation Reuse Of Existing Glass



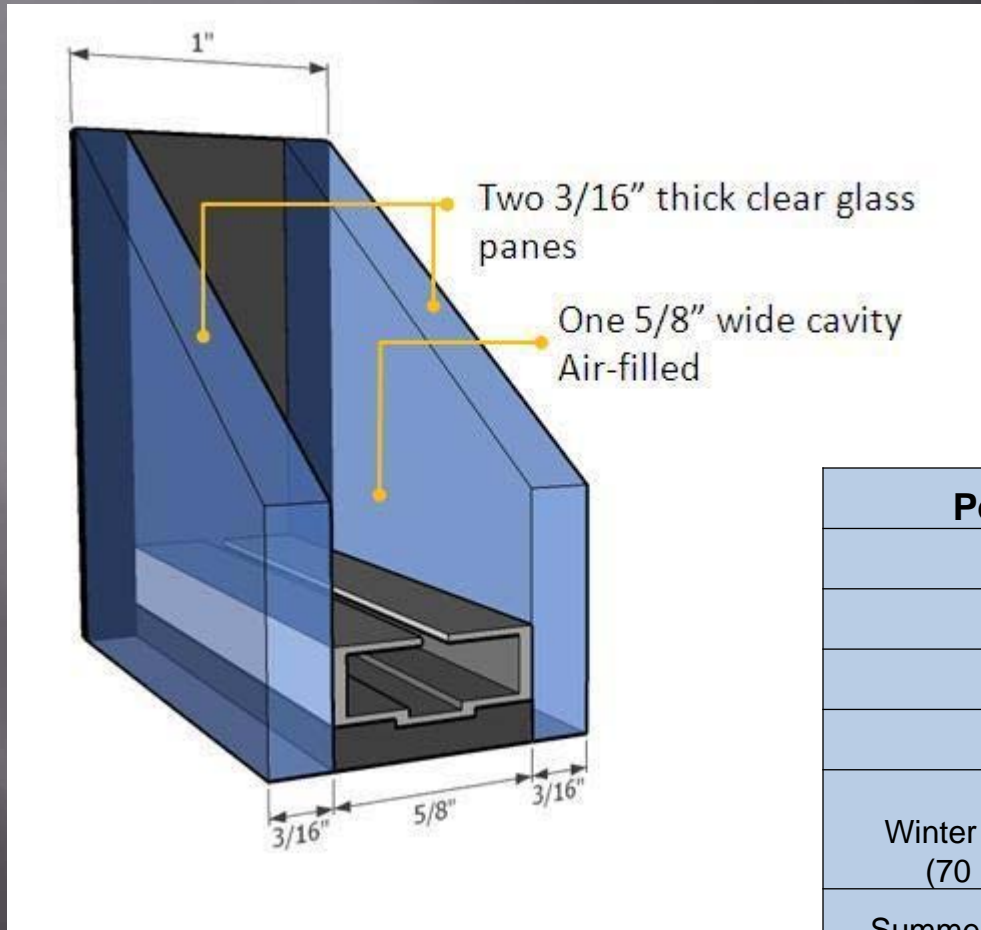
Production/Installation Capacity:
35-50 Windows/Night



Traco 9000 Windows Identical To Those Of
111 8th Avenue

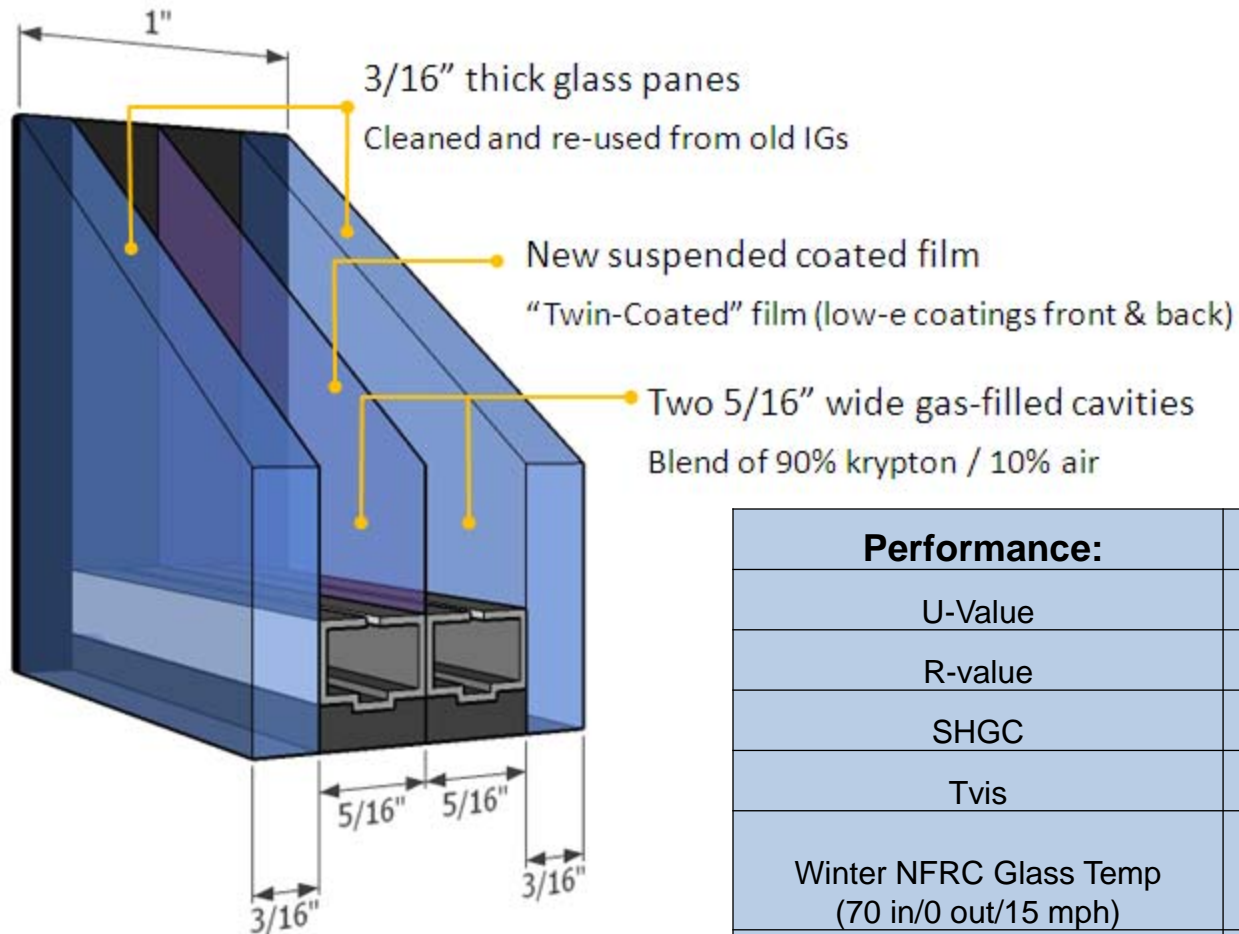


EMPIRE STATE: *Before*



Performance:	<i>Before</i>
U-Value	0.48
R-value	2.1
SHGC	0.72
Tvis	80%
Winter NFRC Glass Temp (70 in/0 out/15 mph)	44 °F
Summer NFRC Glass Temp (75 in/90 out)	95 °F
Overall Thickness	1"
UltraViolet Blockage	46.8%

EMPIRE STATE: *After*



NORTH

Performance:	After Retrofit	Difference
U-Value	0.13	-72%
R-value	7.6	261%
SHGC	0.49	32%
Tvis	64%	-20%
Winter NFRC Glass Temp (70 in/0 out/15 mph)	62 °F	+ 18 °F
Summer NFRC Glass Temp (75 in/90 out)	76 °F (LBNL)	- 19 °F
Overall Thickness	1"	No Change
UltraViolet Blockage	98.6%	-111%

\$63M UNIVERSITY OF COLORADO VISUAL ARTS CENTER



- SCF North-South-East-West “Tuned” Glazing
- Fiberglass Storefront In High Humidity Galleries
 - 99.9% UV Blockage
 - 62 Degree “Winter” Glass Temp
- Perimeter Baseboard Heating Removal
- Payback Under One Year

LEED PLATINUM FIBERGLASS WINDOWS & SCF GLASS



- Pultrusion Fiberglass Casement Frames
- 1 3/8" SCT Glazing Pocket For Thermal & Acoustic Performance
- R-8 SCF Glass
- Warm Winter / Cool Summer



- Directionally "Tuned" SCF Glass
 - 99.5% UV Blockage
 - Inside/Outside Color Freedom
- 1/500th Aluminum Frame Conductivity
- High Volume Pricing

FIBERGLASS CROSS-SECTION



**Pultrusion Lineal
Mechanical
Corner Sash**



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

COMMERCIAL FIBERGLASS FRAMES

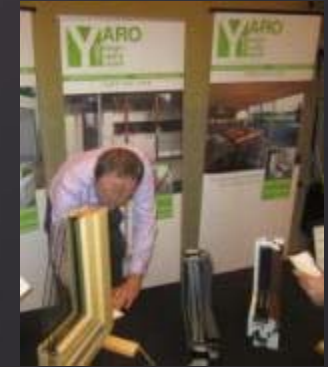


**Internal Anchor
Blocks**

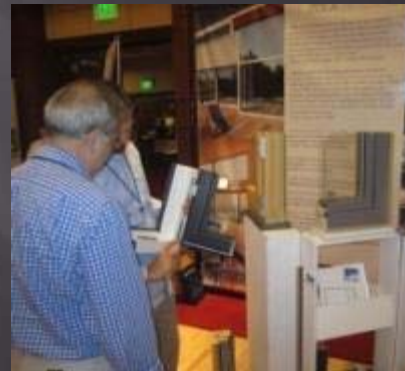


**Winnipeg Church In Blizzard – Warm To
The Touch Window Frames**

“European” High End Windows – (Denver Passive House)



Average Frame + Sash Width: 4.9”



Marvin Ultimate Windows Passive House Certified

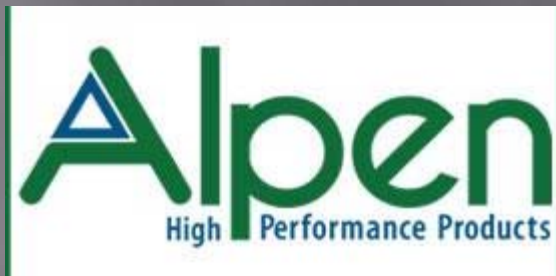
(Zone 3 & Marine South)



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

Alpen Windows Passive House Certified

AlpenHpp.com



525 Series



725 Series

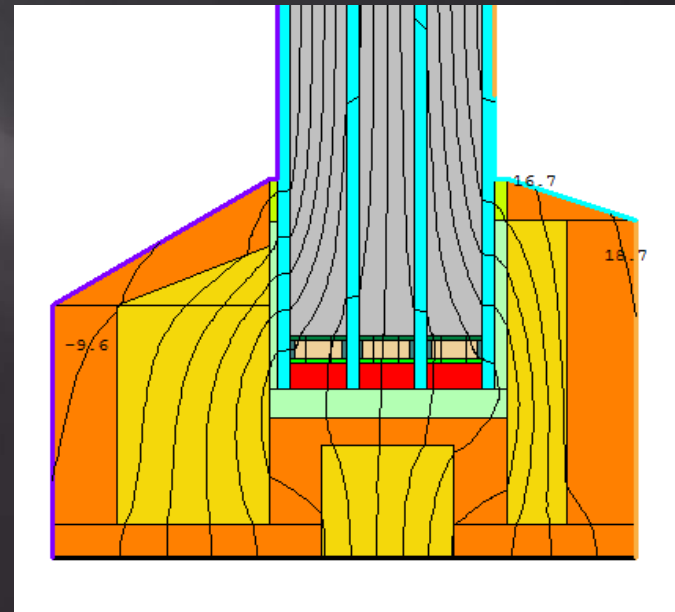


925 Series

Glass Options: Alpenglass Heat Mirror Tri & Quad Pane

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

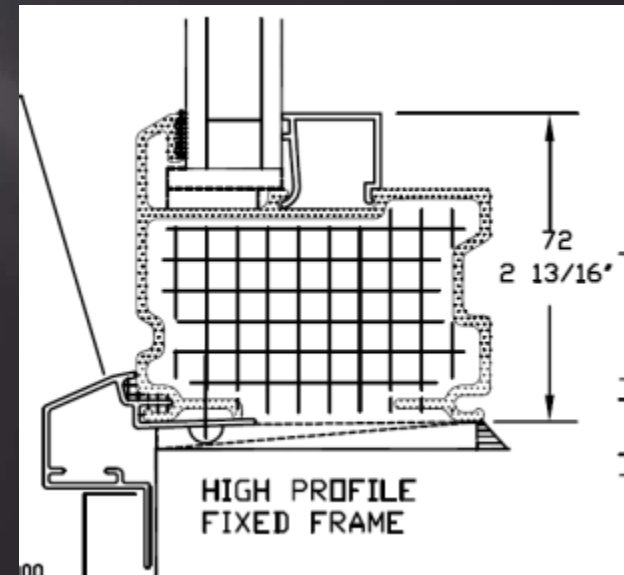
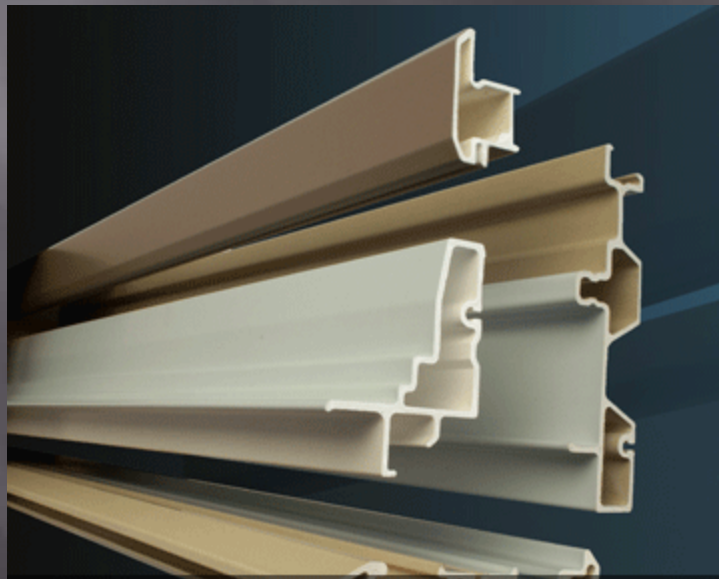


“...I feel glazing is not the limiting factor for window performance at this time, but rather frame design.”

FIBERGLASS WINDOW SASH/FRAME CROSS SECTION



TectonProducts.com
InlineFiberglass.com
OmniGlass.com

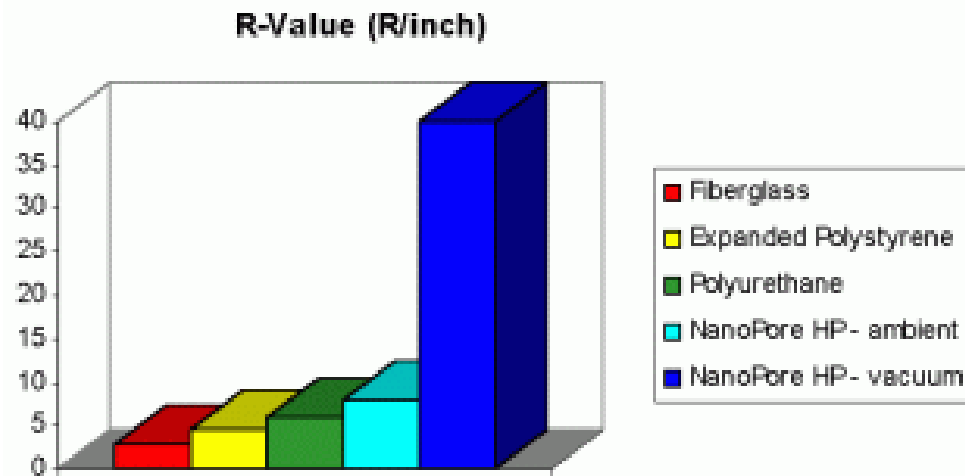


VACUUM SILICA BASED SASH/FRAME R-40 INSULATION



Section through PU fridge wall with embedded Nanopore VIP.

KevoThermal.com – Albuquerque (9/14/14 Update)
2014 Passive House Window “Core” Insulation
Pricing: \$7-\$10/SF = \$2.13/Lineal 3” x 3/9” Strip
Effective R-Value: 13.5



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)

INTERNATIONAL REPORT NO. 12-87

National Research Council of Canada
Institut National de Recherche en Acoustique

CLIENT REPORT

for
Inline Fiberglass Ltd.
141 Sandhurst Road,
Cambridge, Ontario
N4K 2Z8

Sound Transmission Loss Test of Window Unit
8 mm glass, 19 mm air, 4 mm glass

Author: *[Signature]*
S.E. HARRISON

Approved: *[Signature]*
Section Head

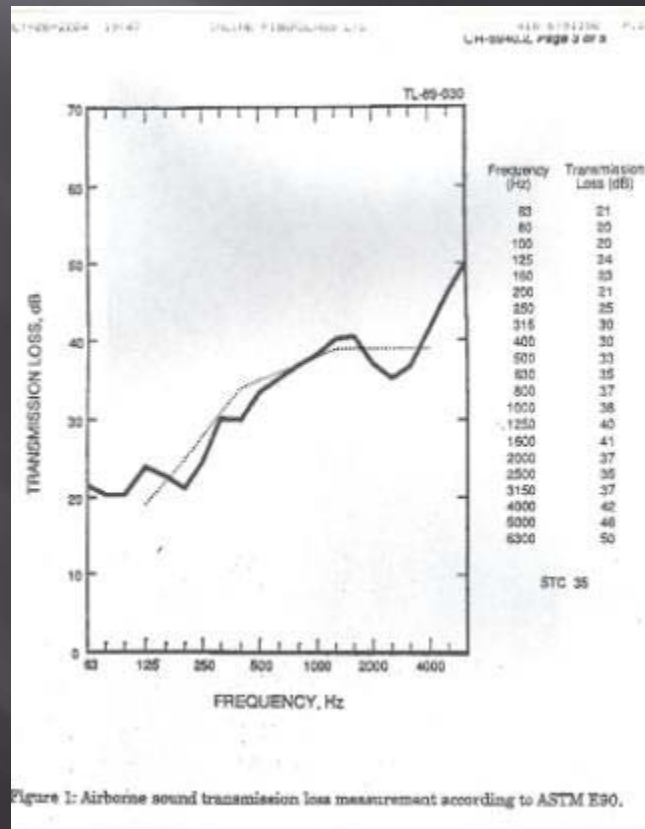
Approved: *[Signature]*
N.C.A. Division
Head, Quality Assurance

Report No.: C-20002
Report Date: 20 July 1989
Contract No.: C-2000
Subject: Application for use as a July 1989
Series: Acoustic

Copy 1 of 1/1

Report may not be reproduced in whole or in part without the written consent of both the client and National Research Council Canada.

Canada



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"

COMMERCIAL FIBERGLASS CURTAINWALL

100% Fiberglass Framing (22' Height)



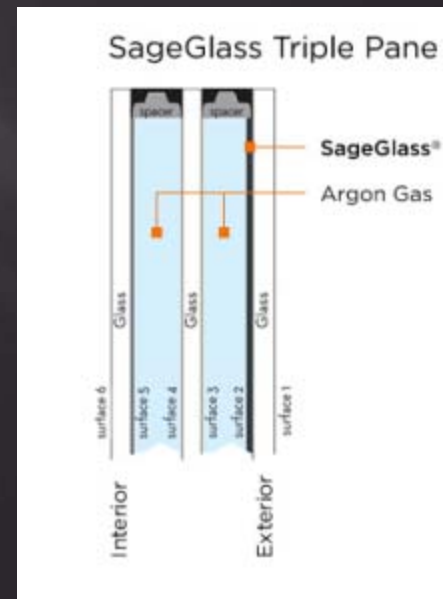
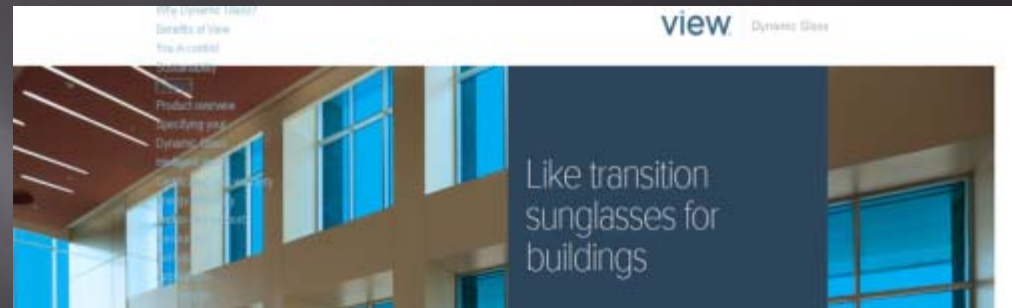
Colorado State
University *Power Center*

Infra Red (Interior) With
New Aluminum
Insulated Door



DYNAMIC GLAZING

Electrochromic / Photochromic / Thermochemical



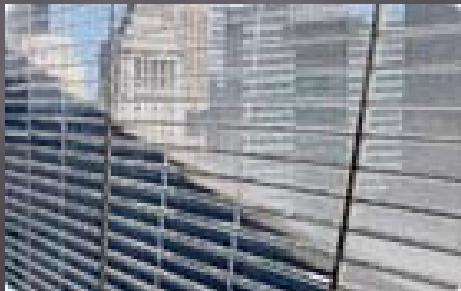
BIPV GLAZING

Integral PV Cells / Transparent PV

Onyx Solar - (Spain)



Pythagoras Solar



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.”*

