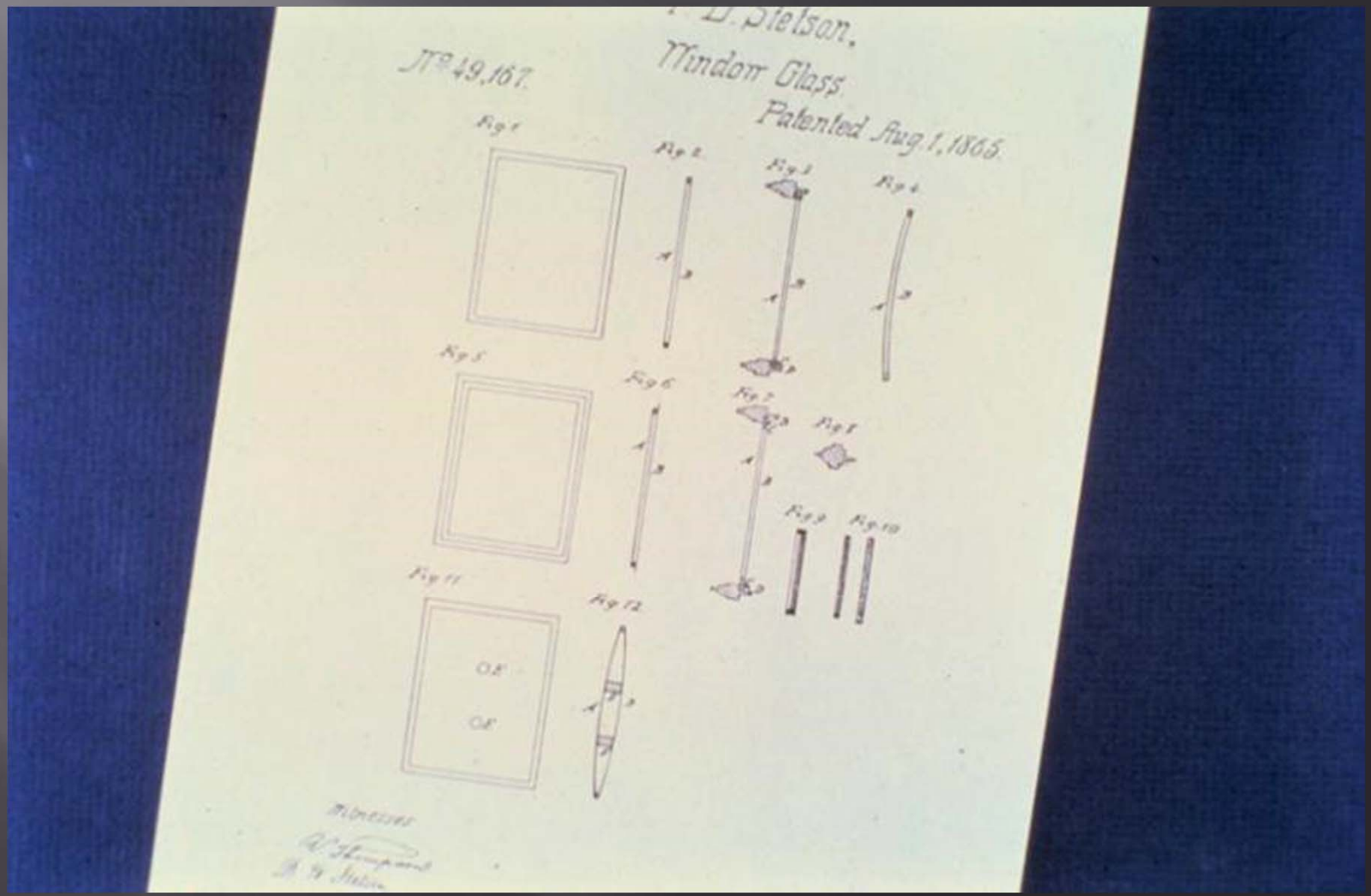
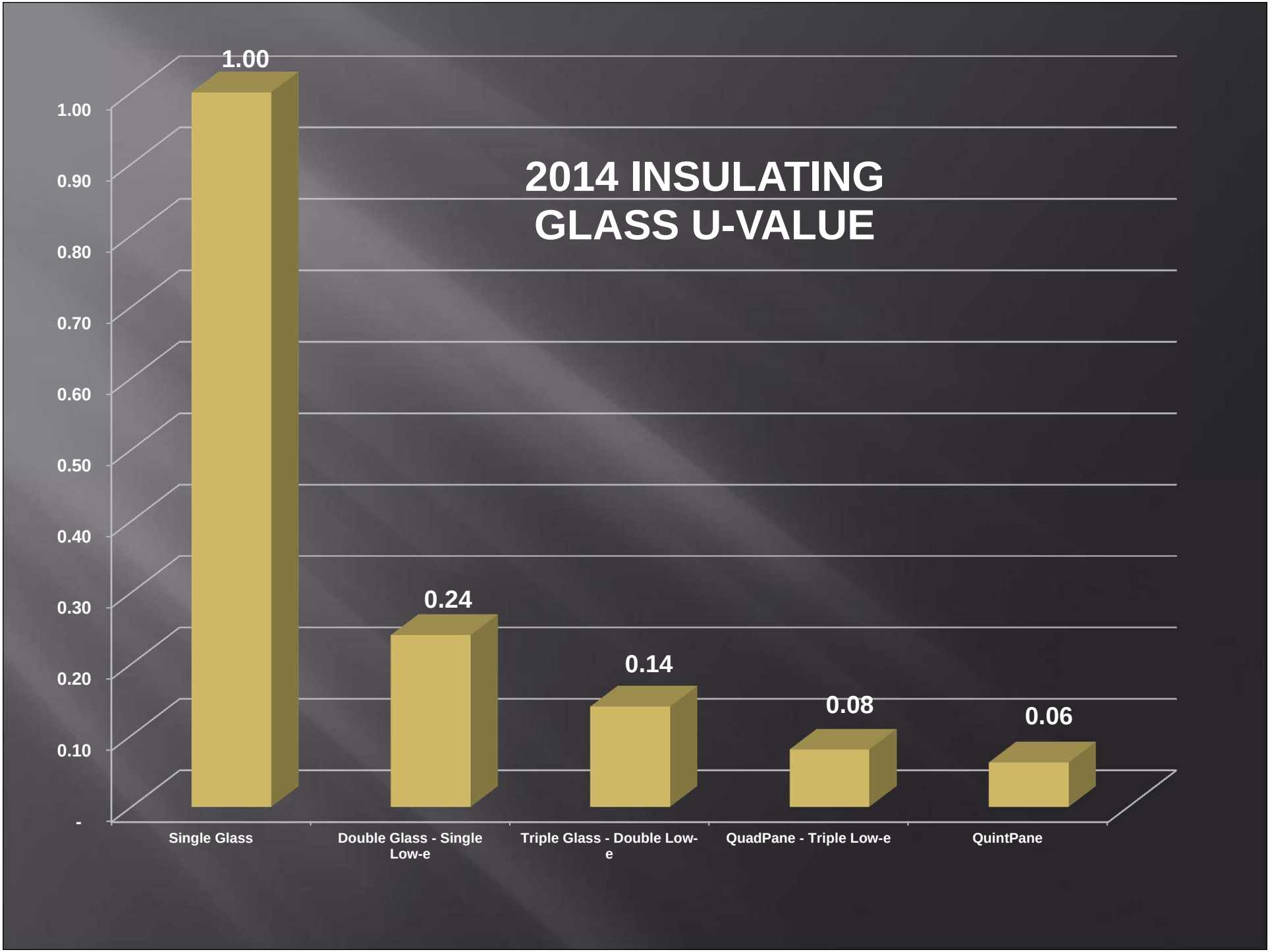
EFFICIENCY WORKS TRAINING

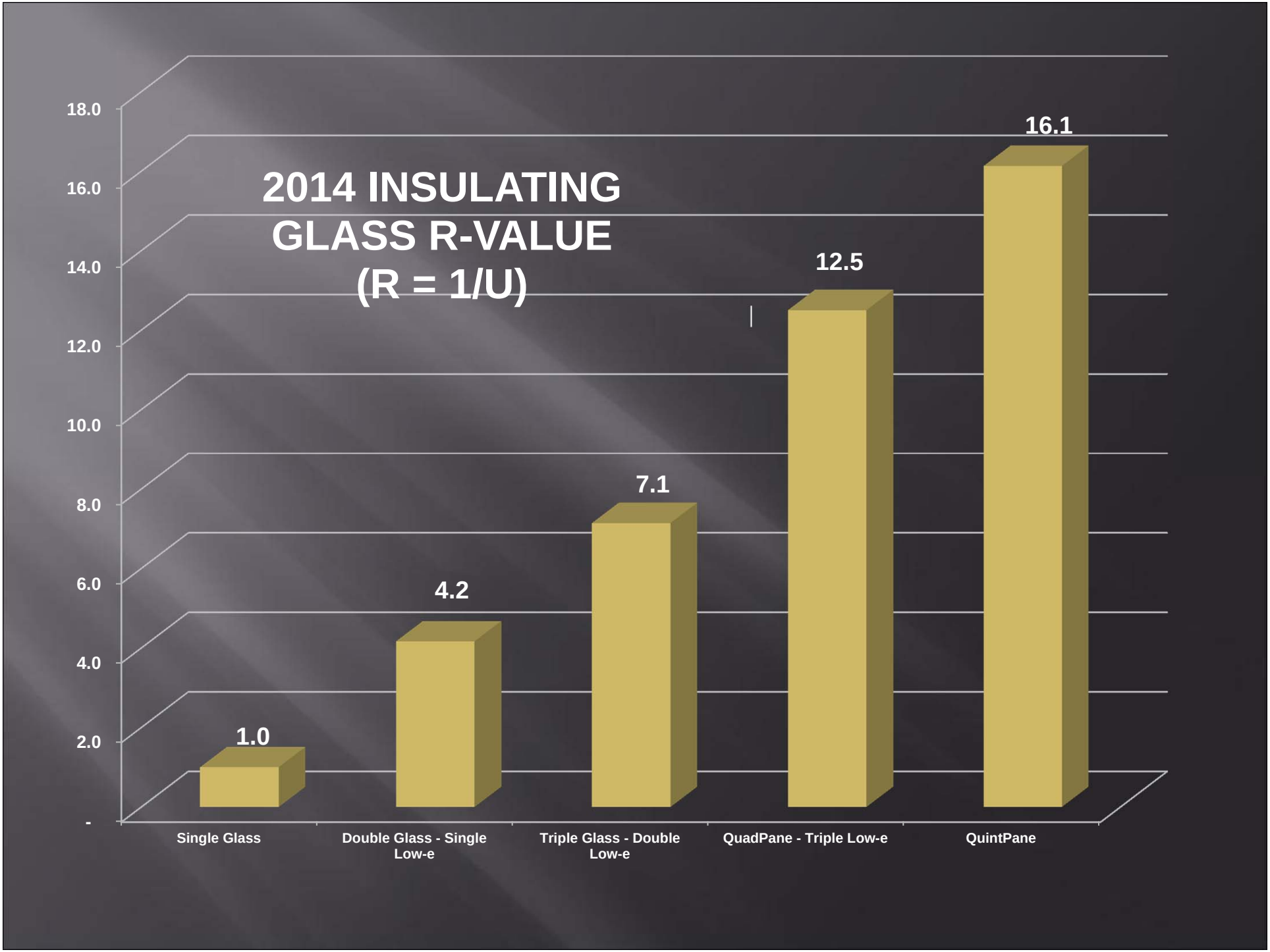
August 20, 2014

RobertClarkeAssociates.com
303-641-6476
Boulder, Colorado

1865 DOUBLE GLAZING PATENT
("Lincoln" Movie Year)




2014 INSULATING GLASS U-VALUE
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1.00
0.24
0.14
0.08
0.06
Single Glass
Double Glass - Single Low-e
Triple Glass - Double Low-e
QuadPane - Triple Low-e
QuintPane


2014 INSULATING GLASS R-VALUE (R = 1/U)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
-
1.0
4.2
7.1
12.5
16.1
Single Glass
Double Glass - Single Low-e
Triple Glass - Double Low-e
QuadPane - Triple Low-e
QuintPane

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

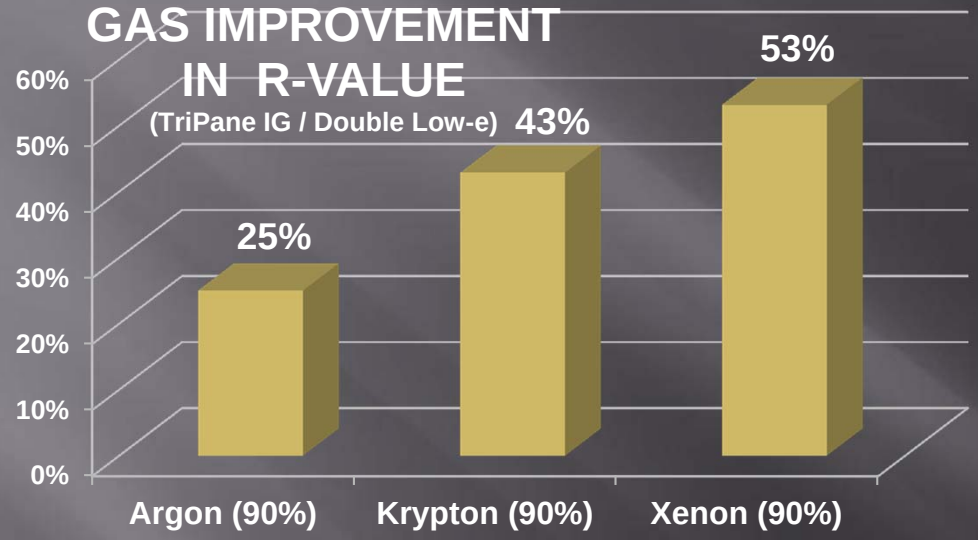
German Standard: Fill To 90+% - Maintain Gas Loss Below 1% Per Year

FDR Design (Buffalo, MN) 12-Year Argon Containment < ½% Per Year

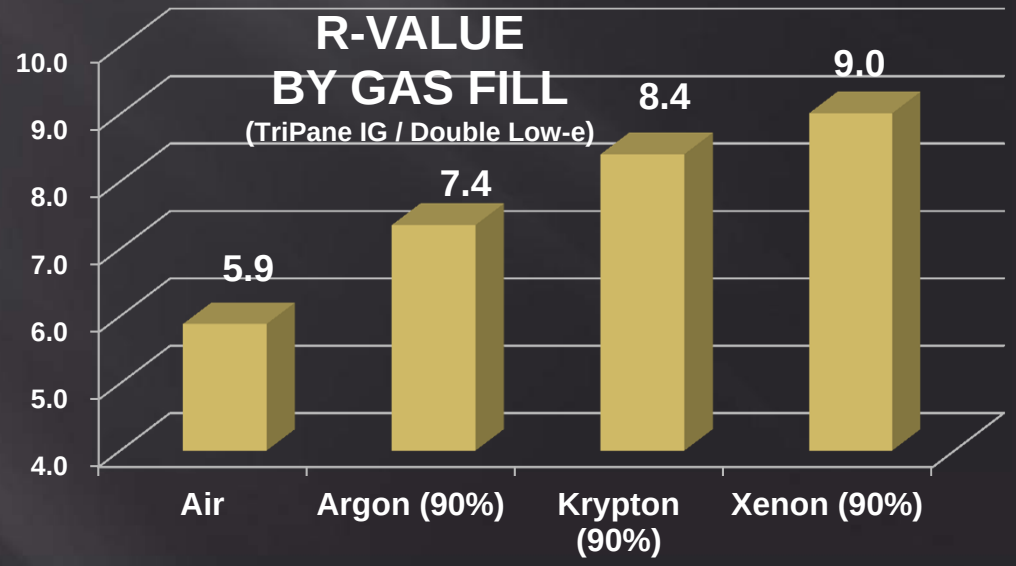
Contact: Randi Ernst: FdrDesign.com

Performance Increase Due To Gas Filling

(2014 Triple Insulating Glass)

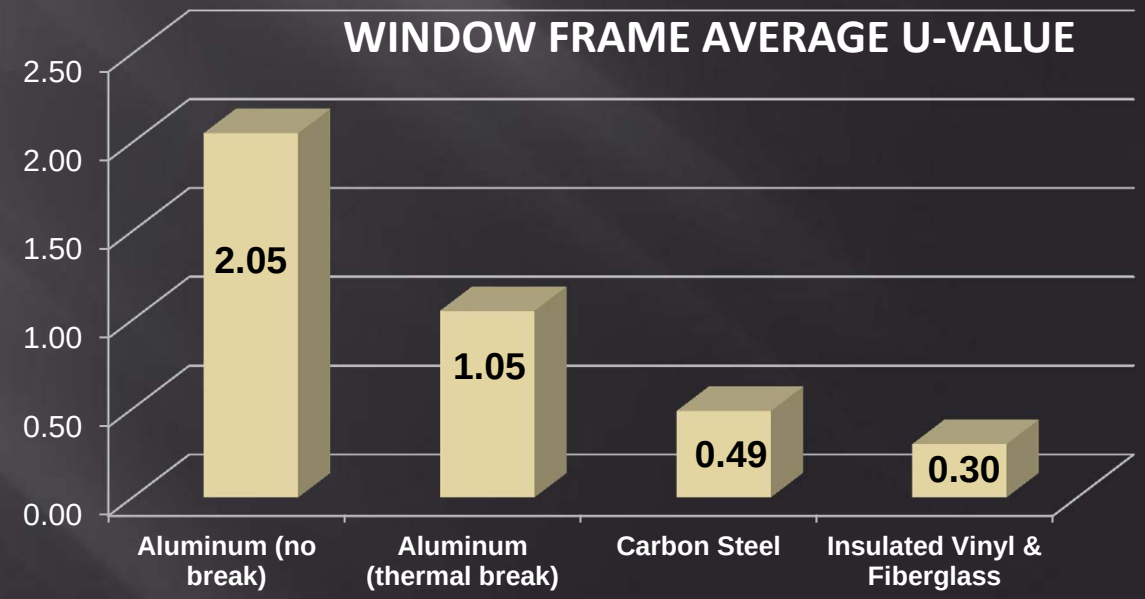


September 2014 Price Note: Krypton Down 60% / Xenon Up 10X



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

Undercooking

Moveable Insulation Burden

Daily temperature swings

Lack of privacy or security

Glare

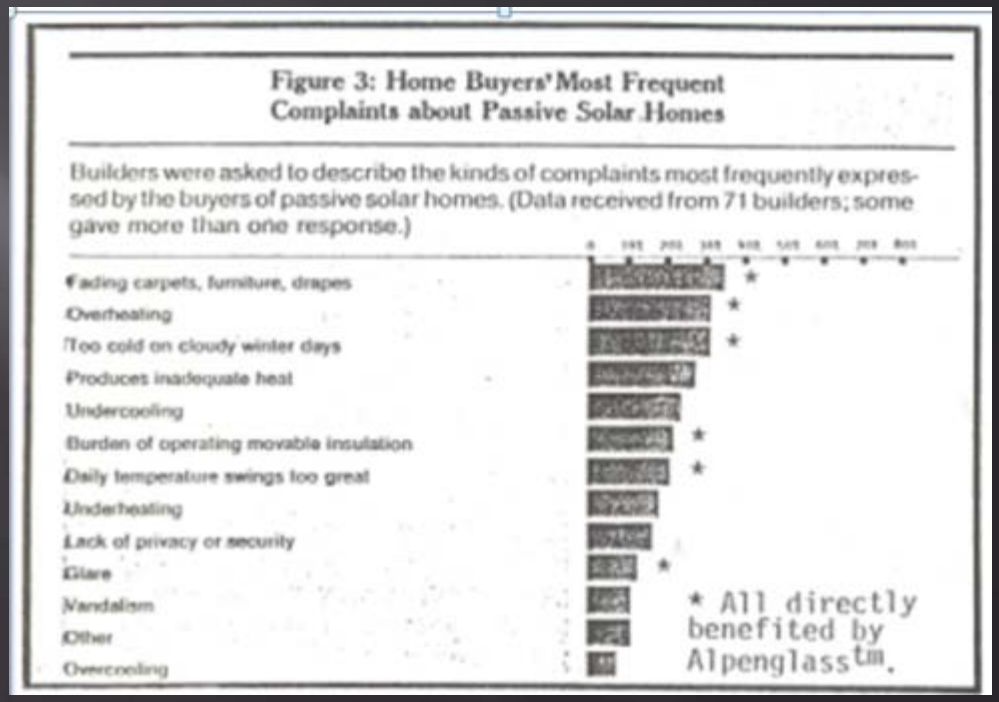


Figure 3: Home Buyers' Most Frequent Complaints about Passive Solar Homes

Builders were asked to describe the kinds of complaints most frequently expressed by the buyers of passive solar homes. (Data received from 71 builders; some gave more than one response.)

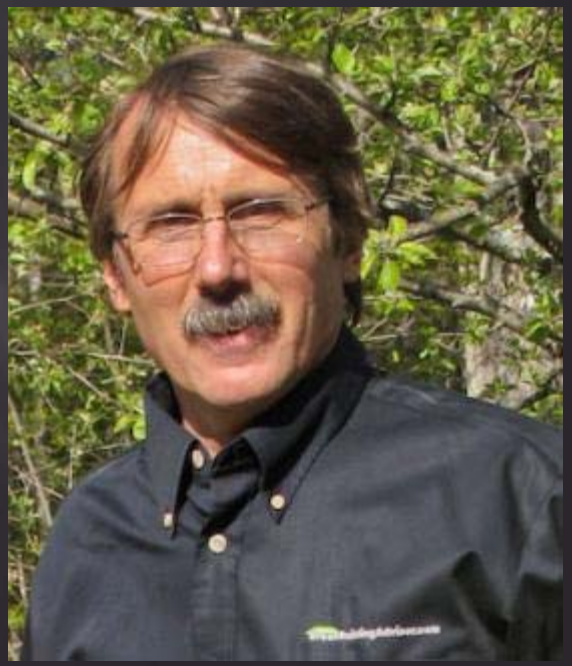
Fading carpets, furniture, drapes *
Overheating *
Too cold on cloudy winter days *
Produces inadequate heat
Undercooling
Burden of operating movable insulation *
Daily temperature swings too great *
Underheating
Lack of privacy or security
Glare *
Vandalism
Other
Overcooling

* All directly benefited by Alpenglass^{tm}.

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

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

Passive House Occupant Comfort


CBE

WINDOW PERFORMANCE FOR HUMAN THERMAL COMFORT

FINAL REPORT TO THE NATIONAL FENESTRATION RATING COUNCIL
FEBRUARY 2006

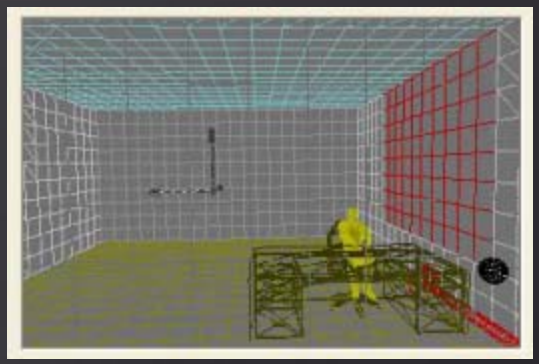
CENTER FOR THE BUILT ENVIRONMENT
CHARLIE HUIZENGA
HUI ZHANG
PIETER MATTELAER
TIEFENG YU
EDWARD ARENS

UNIVERSITY OF CALIFORNIA, BERKELEY
390 WURSTER HALL
UNIVERSITY OF CALIFORNIA, BERKELEY
BERKELEY, CA 94720-1839

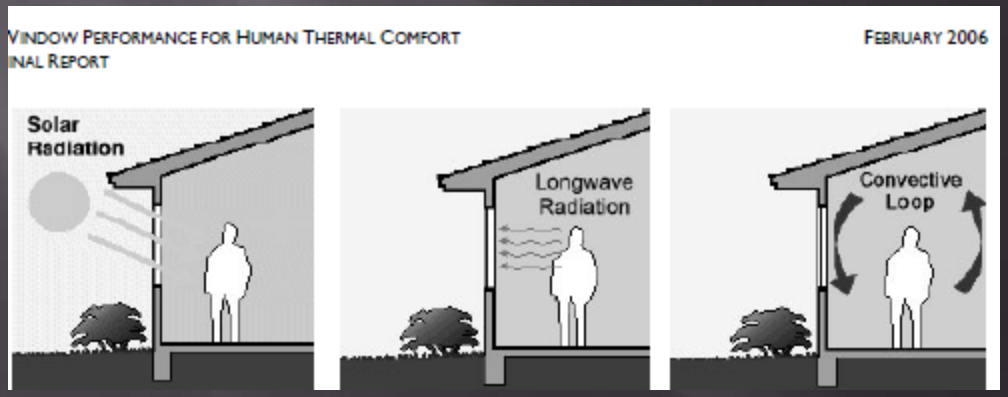
ARUP
PETER LYONS

Six Human Comfort Factors

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

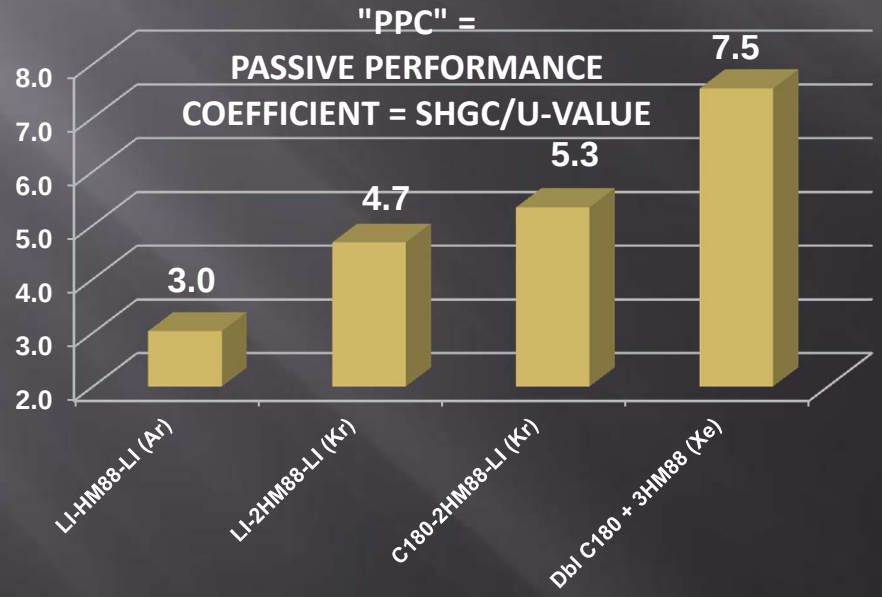

CFD Modeling


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)	Dbl 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 *Before* And *After* 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 *GSB Valedictorian* Mel Hodge Logic, payback is:		*"Immediate"*	
$/Ton Savings		*10,623*	(High?)

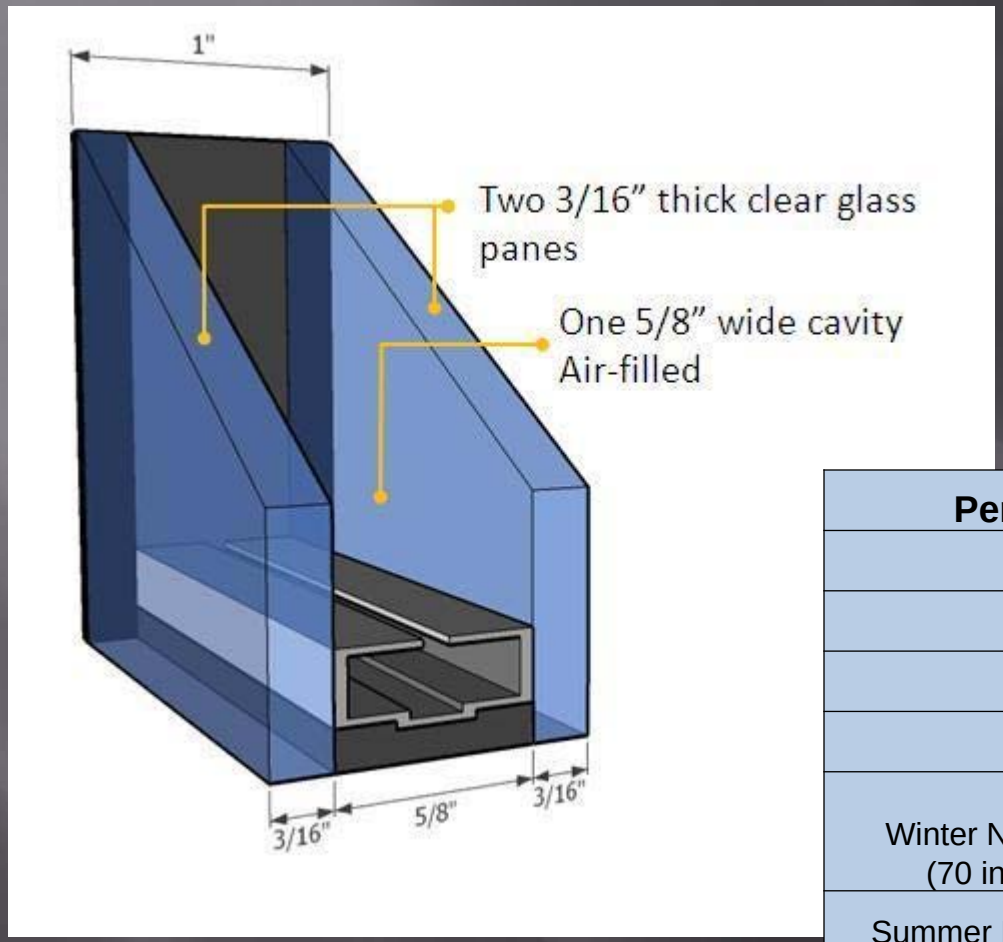
Manufacturing Innovation
Reuse Of Existing Glass

Traco 9000 Windows Identical To Those Of 111 8th Avenue

Production/Installation Capacity:

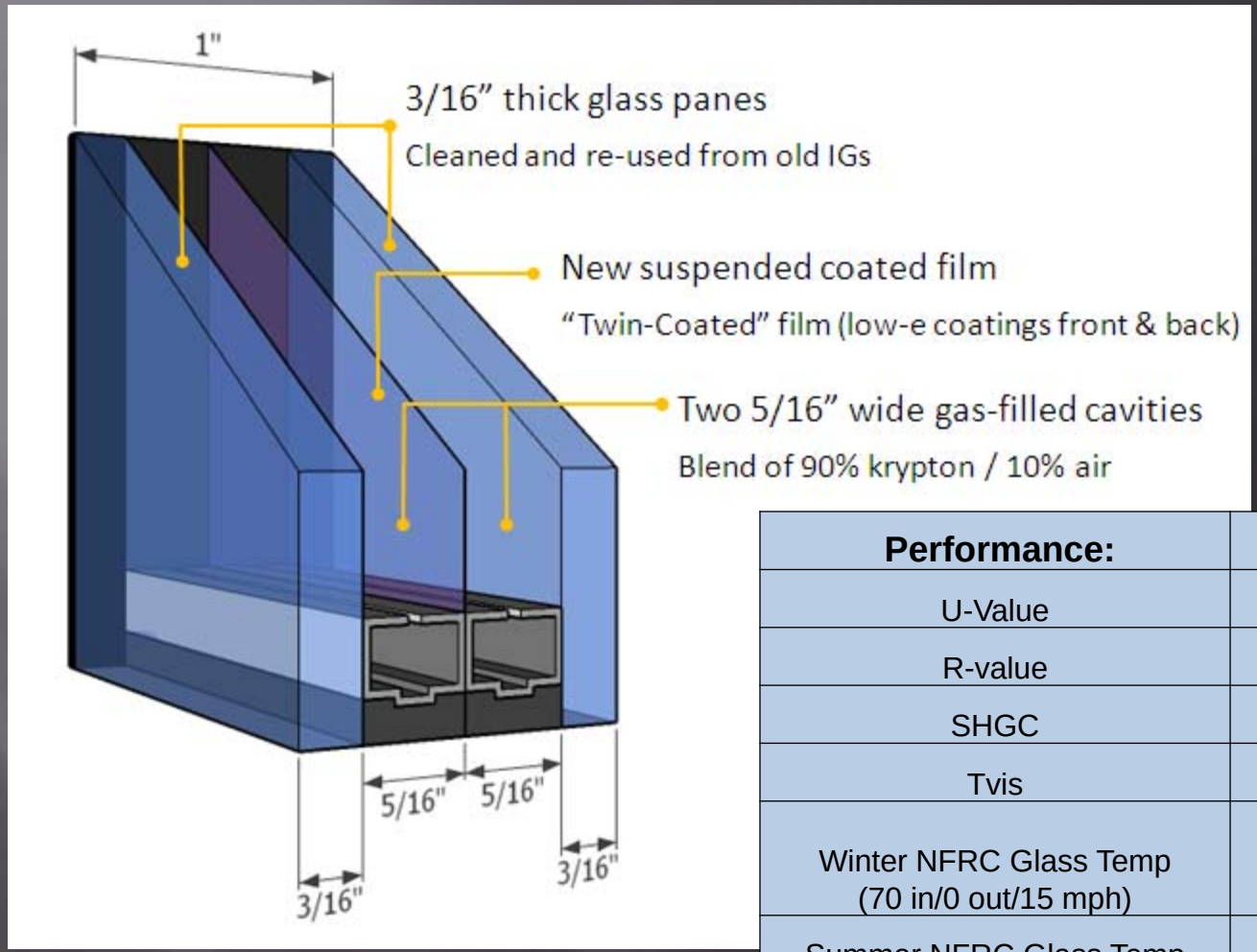
35-50 Windows/Night

EMPIRE STATE: *Before*



Performance:	***Before***
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)

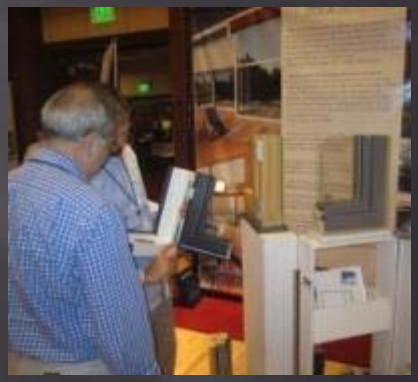
COMMERCIAL FIBERGLASS FRAMES

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

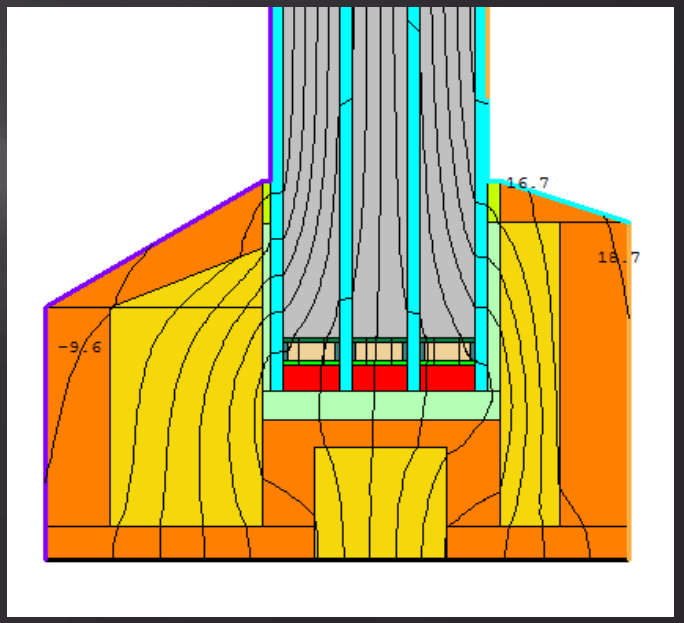
AlpenHpp.com

Alpen
High Performance Products

Glass Options: Alpenglass Heat Mirror Tri & Quad Pane

GRHAM WRIGHT R-9 Window Design

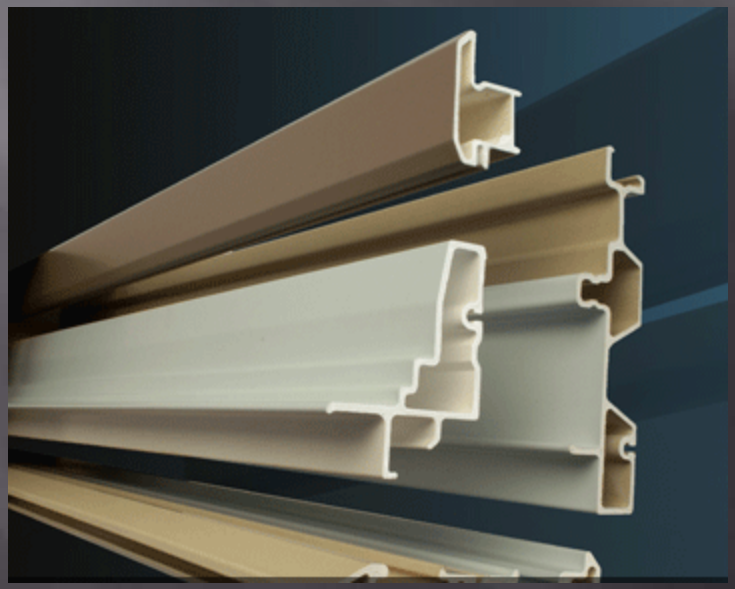
- Frame
  - Wood and spray foam
  - Width 90 mm
  - Depth 140 mm (5.5”)
- Glazing
  - 4-pane, 90% Argon, 50 mm
  - Cardinal lo-e 180 and clear
- Spacers
  - Chromatech Ultra F

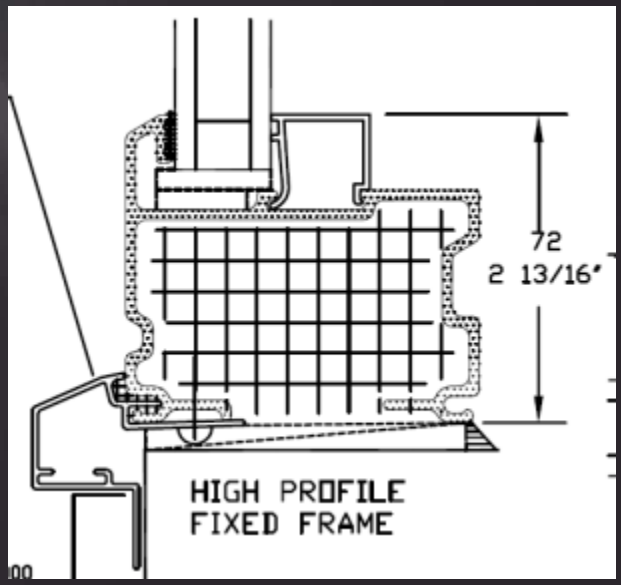


“…I feel glazing is not the limiting factor for window performance at this time, but rather frame design.”

FIBERGLASS WINDOW SASH/FRAME CROSS SECTION

TectonProducts.com
InlineFiberglass.com
OmniGlass.com

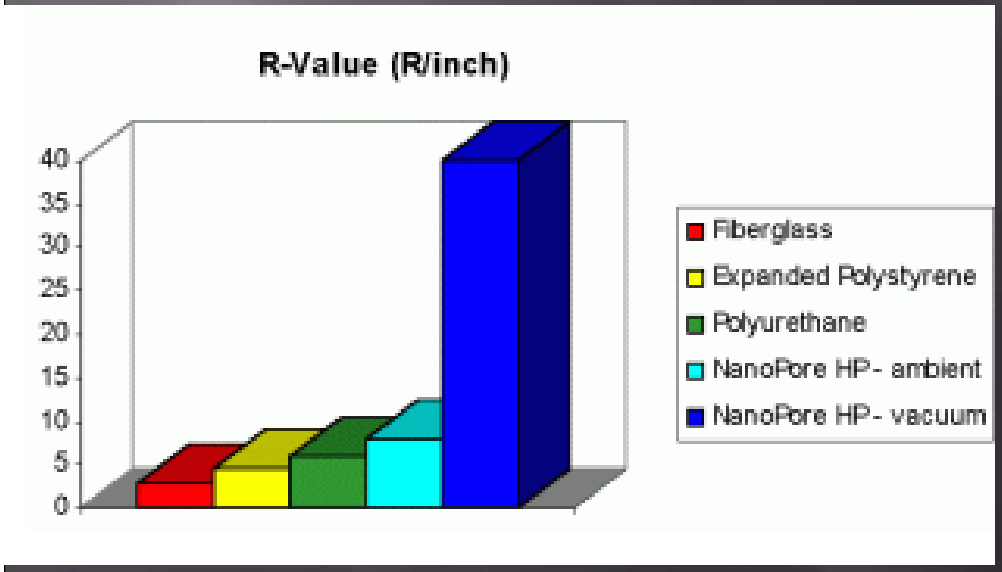




Section through PU fridge wall with embedded Nanopore VIP

VACUUM SILICA BASED SASH/FRAME R-40 INSULATION

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

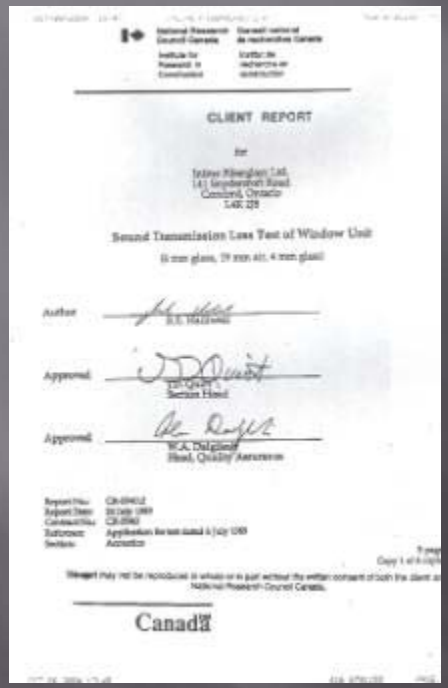


INSULATING GLASS ACOUSTICS 101

REPRESENTATIVE STC RATINGS

GLAZING TYPE	SOUND TRANSMISSION CLASS (STC)
Conventional Double Pane (1/8”) Glass	29
Solid ½” Gypsum Wall	36
SCF: 1” Overall with ¼” Glass	35
SCF: 1 ½” Overall with ¼” 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



CLIENT REPORT

for

Sound Transmission Loss Test of Window Unit

Author

Approved

Approved

Canada

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

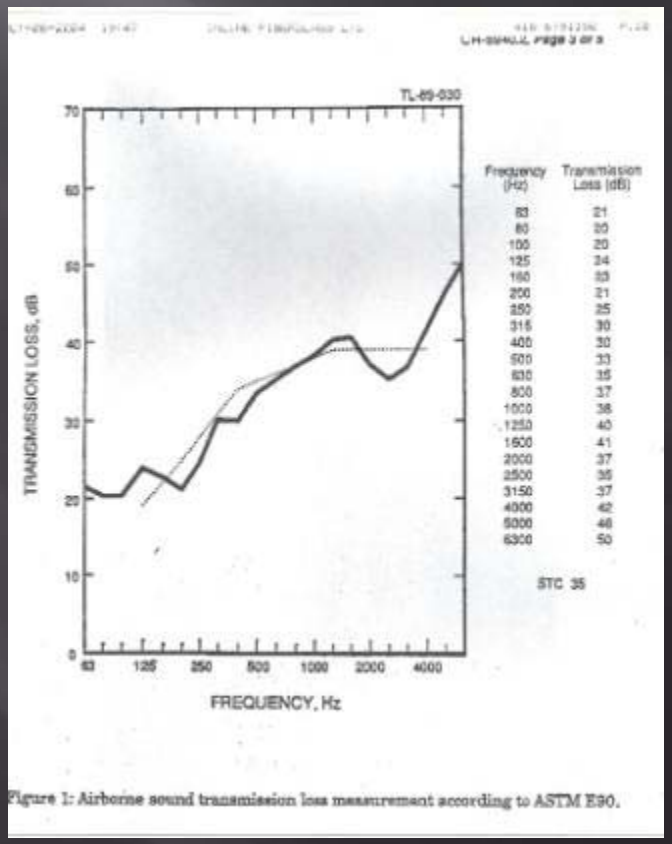


Figure 1: Airborne sound transmission loss measurement according to ASTM E90.

TEST WINDOW:

87 Wide x 72” High

Two large upper fixed

One small fixed and one small awning below

Insulating Glass

Outer: ¼”

Airgap: ¾”

Inner: 3/16”

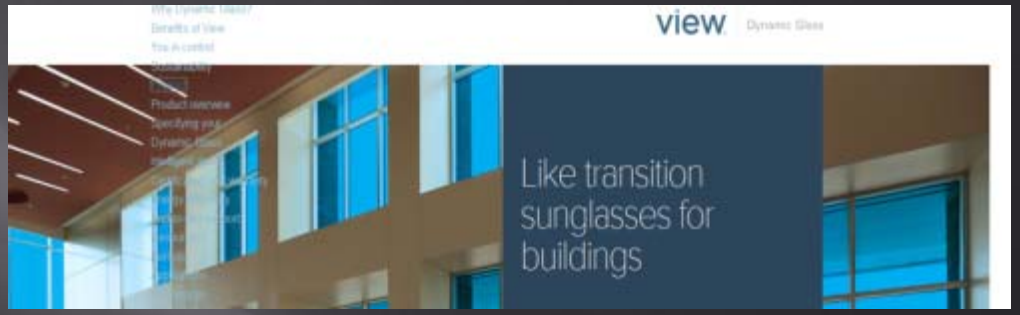
COMMERCIAL FIBERGLASS CURTAINWALL
100% Fiberglass Framing (22’ Height)

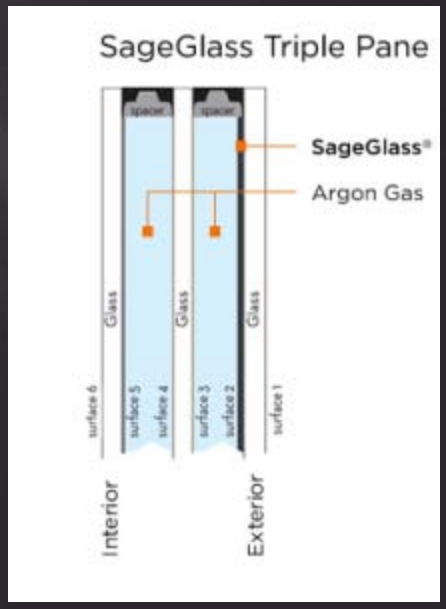
Colorado State University *Power Center*

Infra Red (Interior) With New Aluminum Insulated Door

DYNAMIC GLAZING

Electrochromic / Photochromic / Thermochromic

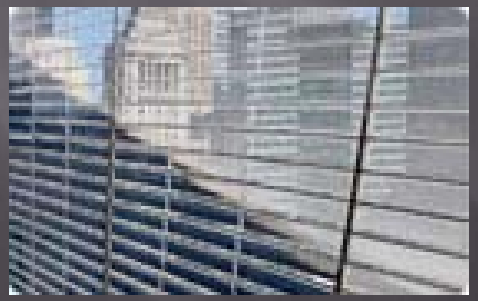




BIPV GLAZING
Integral PV Cells / Transparent PV

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."***