



Skylight solar shade screen study at John Brooks, Inc.

An Interior Design Showroom in Scottsdale
Arizona.

Curtis Fawley, Arizona Sky Shades

7/25/2014

www.arizonaskyshades.com



In cooperation with Efficiency First Arizona

www.encyfirstaz.org

Solar shade screens installed over skylights provide significant energy and cost savings for business owners and a more comfortable interior climate without compromising transmitted visible light.

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Background:

John Brooks, Incorporated operates a high end 37,000 square foot showroom open to the Interior Design Trade and is located within the Scottsdale Design District at 2712 North 68th Street, Scottsdale, Arizona. This showroom represents leading artisans of furniture, fabric, and lighting in the design industry.

For John Brooks, Inc. a comfortable showroom climate is critical along with a natural light source at a reasonable display and working level. The showroom has a total of 39 skylights installed throughout the roof system.

Showroom Skylight & Square Footage

	Sq. Ft. Area	Int. Ceiling Height	4'x8' Skylight	4'x4' Skylight
	32,000	17'-6"	11	21
	5,000	11'-7"	4	3
Totals	37,000	-	15	24

Summertime solar heat gain and the intense glare allowed by these skylights resulted in a very uncomfortable work and display environment. The heat and light became so uncomfortable, that over the past five years, John Brooks attempted to mitigate this solar gain issue by covering the skylights with 6 mil black plastic sheeting. The plastic covers did significantly reduce the heat gain, but in turn blocked all natural light. As an unforeseen consequence the black plastic also resulted in cracked lenses at a number of the skylights due to the increased temperatures under the plastic at the acrylic skylight dome, requiring their replacement.



(above) 2010 aerial photo of the John Brooks Showroom, showing many of the skylights covered with black plastic.



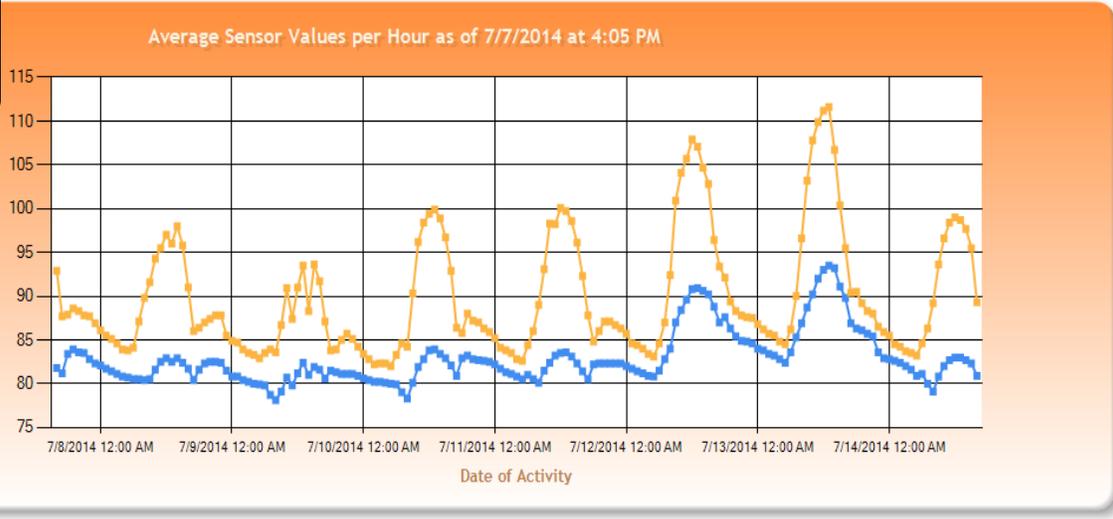
Lens temperatures on plastic covered skylights reached over 175 degrees!

(above) Plastic covered 4'x4' skylight

Arizona Sky Shades became aware of the situation at the John Brooks Showroom in March of 2014 and after brief discussion it was determined that four of the Sky Shades would be installed on skylights at random locations over the showroom. Wireless temperature sensorsⁱ were also installed at various locations allowing the continuous charting of temperatures. Temperatures were recorded at Sky Shade locations (both interior and exterior), at no shade locations, under black plastic, and internally for ambient room temperatures. Temperature logging began on 4/29/2014.

Over the course of May and June 2014, the resulting data collection along with positive employee and customer feedback on room temperature and light levels, convinced John Brooks to approve the complete installation of Sky Shades on all 39 skylights.

Skylights with Sky Shades installed ran over 18 degrees cooler!



(above) Typical week long chart (7/7/14 – 7/15/14) at John Brooks showing interior air temperature 28" below lens of skylight at a location with no solar shade installed (orange line) and at location with Sky Shade installed (blue line), averaging 18.1 degree differential at max. daily temp.

Sky Shade Design:

Arizona Sky Shades began developing and testing skylight shade screen prototypes in the Spring of 2011. Preliminary versions have been installed and tested over the past three summers at the Southwest Building Science Training Facilityⁱⁱ located in Phoenix, Arizona.

Design standards throughout the testing phases have always maintained these key elements:

- Effective in reducing solar heat gain.
- Allow for functional and desirable visible light transmission (VTL).
- Lightweight and simple construction.
- Strong and durable, easy to remove for maintenance.
- Maintain ventilating air space between shade screen material and skylight lens.
- Architecturally pleasing.
- No mechanical or penetrating attachments to either skylight frame or roofing materials.

Current market version of the Sky Shade meets all these standards far beyond any other commercially available solar shade for skylights.

Sky Shades block the sun's UV rays while cooling skylight lens temperatures by over 20 degrees.



(above) Typical Arizona Sky Shade installed on 4'x4' residential skylight application, allowing for positive ventilation at skylight lens and light transmission while still blocking solar heat gain.



This other shade increases the lens temperatures as much as 10 degrees due to the lack of air flow.

(above) Other commercially available skylight shade with direct contact to skylight lens and occluded light transmission, resulting in dramatically increased skylight lens temperatures and restricted VLT.

John Brooks Showroom Analysis:

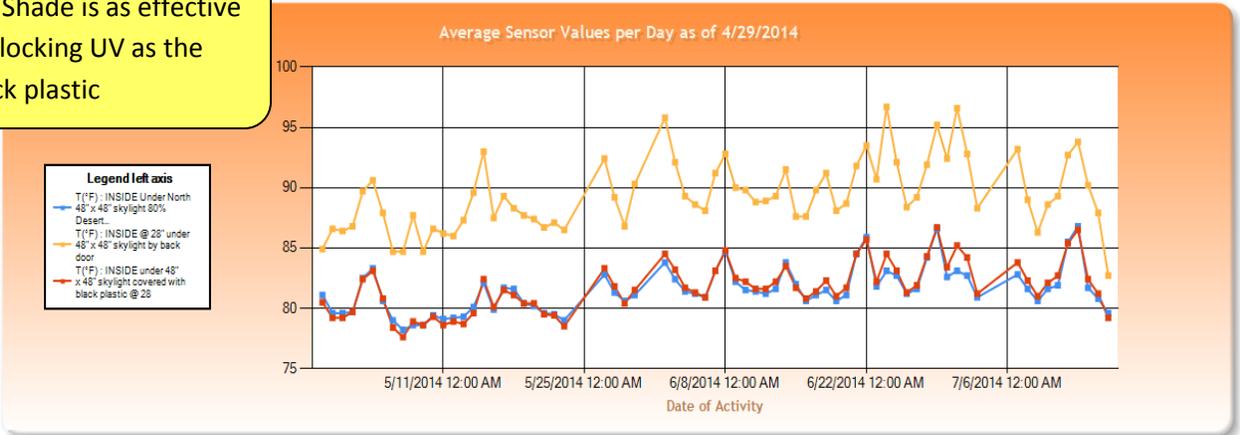


(above) Showroom interior light levels before shades (left) and with Sky Shades installed (right), showing reduced glare.

In late April of 2014, thirteen data logging temperature sensors were installed at a variety of locations throughout the interior and exterior of the John Brooks showroom. These sensors wirelessly transmitted data via a network hub allowing for real time, web based remote monitoring of temperatures. These monitors have been logging continuously since installation with notable results.

Analyzing three of the primary sensors demonstrated very positive results in regard to the effectiveness of the Sky Shade's solar heat gain blocking. On each of these three locations the sensor was suspended 28" below on the interior of a 4'x4' skylight. One sensor at a skylight with no solar shade installed, one sensor at a skylight covered with 6mil black plastic sheeting, and one sensor installed at a skylight with a Sky Shade installed above. The Sky Shade utilized Twitchell Corporation's "Textilene 80" solar screen fabric in a Desert Sand color. This fabric has an effective shading coefficient of .0985.

Sky Shade is as effective in blocking UV as the black plastic



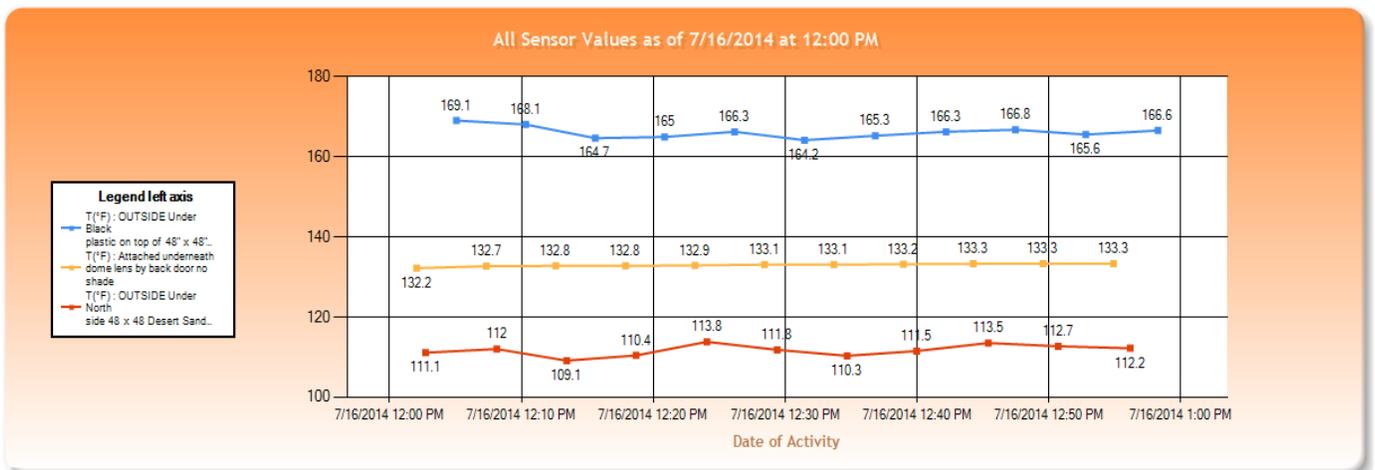
Analysis (cont.)

	T(°F) : INSIDE Under North 48" x 48" skylight 80% Desert Sand @ 28"	T(°F) : INSIDE @ 28" under 48" x 48" skylight by back door	T(°F) : INSIDE under 48" x 48" skylight covered with black plastic @ 28
min	78.2	82.7	77.6
max	86.8	96.7	86.7

(above) chart of 78 day total min/max avg. at the three primary sensor locations.

Average maximum temperatures logged for the 78 day period show a temperature differential of only .1 degree Fahrenheit between the 6mil black plastic (86.7) and the Sky Shade (86.8), and each of these two ran cooler than the skylight with no shading by 10 degrees. This simply shows that the Sky Shade is as effective in blocking solar heat gain as a completely occluded skylight, and the Sky Shade significantly lowers interior temperatures.

Continuing the analysis and comparing external lens temperatures between the same skylight locations, a dramatic disparity is immediately noticed. Maximum skylight lens temperatures for a typical Scottsdale midsummer day on July 16th with clear skies, calm wind, and an air temperature 102 degrees show:



(above) Temperature chart for July 16, 2014 @ 12:00 – 1:00 pm

Immediately noticeable in this temperature chart is the extremely high temperature at the skylight’s acrylic lens, covered by the black plastic -maximum for the hour period @ 169.1 degrees.

Lens temperature without any coverings peaked at 133.3, and with a Sky Shade installed the maximum temperature for the same period reached a relatively cool 113.8 degrees.

Analysis (cont.)

Over a period of time, and as a result of the dramatically increased lens temperatures, many of the skylights covered with the black plastic experienced failure and significant cracking of the acrylic skylight lens.



(above) Resulting lens damage from the heat generated under the black plastic covered skylights.

Payback and energy savings modeling (appendix a) shows a payback of under 2 yrs. for the complete installation of Sky Shades on all the skylights at the John Brooks showroom.

Using utility bills provided to Arizona Sky Shades by John Brooks, fabric shading coefficients provided by Twitchell Corporation (appendix b), and solar radiation values from the National Renewable Energy Labⁱⁱⁱ in Golden, CO, an energy model was constructed to estimate the potential cost savings by installing Sky Shades on all of the showroom skylights.

Through this modeling program and an input of 9.85 cents/kWh, Arizona Sky Shades conservatively estimates that with the installation of Sky Shades on all of the showroom's skylights, John Brooks, Inc. will save over 40% in utility expenses for the 5 month cooling season in Scottsdale, yielding a return on investment in less than two years. Additionally, and more immediately tangible for their day to day business, the Showroom will operate at more comfortable temperature and the natural light levels will be moderated and diffuse.

Conclusions:

Immediately after completion of the Sky Shade installation on all 39 of the John Brooks Showroom skylights, employee feedback has been extremely positive. The intense mid-day heat that was previously obvious and uncomfortable under the un-shaded skylights is now noticeably cooler with the installed Sky Shades above. Glare from the un-shaded skylight is now reduced to an acceptable working level and allows for a better presentation of the furniture, art and lighting on display in the Showroom. Typical lumen light readings were reduced by an average of 50% by the addition of Sky Shades. Prior to the Sky Shade installation the showroom lumen readings ran as high as 1500 which would be more typical of businesses working in detailed drafting or very detailed mechanical works. After the Sky Shade installation lumen values dropped to the 600 – 700 range which optimal for showroom displays. Energy savings should be easy to recognize with approximately three months remaining in the cooling season for Scottsdale and will be followed up closely by both John Brooks, Inc. and Arizona Sky Shades.

To further encourage customers to refit their skylights with solar shade screens, Arizona Public Service has recently included the Sky Shade into their *Solutions for Business Program*, which will allow for a rebate of over \$2 per square foot of shade screen. Salt River Project is also reviewing the Sky Shade for inclusion into their rebate program. By doing so, the whole building approach to energy performance becomes even more complete. As shown in appendix b, using aforementioned John Brooks modeling program with the additional input of a potential Salt River Project rebate of only 80 cents per square foot, the return on investment becomes a little over 1.5 years, at which point adding skylight shade screens becomes an easy decision for most business owners.

In Alliance With:



Installation Photos:



(above) Cleaning and preparation of the skylight frame



(above) Application of the adhesive tape and Sky Shade side rails



(above) Final installed 4'x8' Sky Shade (total install time for one unit, approx. 20 min.)

Appendix (a): Cost savings analysis without rebates applied

Estimated Cost vs Savings for John Brooks Inc.

	Shade Quantity	Price Installed			
48" x 48" in 80% Desert Sand	21	\$ 157.95	\$	3,316.87	
48" x 98" in 80% Desert Sand	13	\$ 285.95	\$	3,717.35	
SRP Rebate	\$ -	469.4444 sqft	\$	-	
SRP Rebate	\$ -	394.33333 sqft	\$	-	
Total Client Costs			\$	7,034.22	

Cost analysis study on a 48" x 48" skylight unshaded and with "Skyshade" applied

Total square foot surface	Btu' per Sqft average corrected	Btu's Generated total surface area	of Heat per day	Total Btu's generated Day		kWh used per day	kWh rate Avg. Billed	Utility cost per day	Utility cost per month	Total utility costs per 5 month period	
469.4444	173.85	81612.917	Btu's	7.5	612096.88	3.41	180	0.1200 \$	21.54	30 \$ 646.20	5 \$ 3,231.01
		With 80% Shade Fabric Installed→			80% 122419.38	3.41	35.9	0.1200 \$	4.31	30 \$ 129.24	5 \$ 646.20
										80%	\$ 2,584.81
		Cost of the 21- 48" x 48" "Skyshade" units installed	→	\$ 3,316.87							
				\$ 2,584.81	←						Estimated savings over a five month period
				1.28	←						Estimated payback in years

Cost analysis study on a 48" x 98" skylight unshaded and with "Skyshade" applied

Total square foot surface	Btu' per Sqft average corrected	Btu's Generated total surface area	of Heat per day	Total Btu's generated Day		kWh used per day	kWh rate Avg. Billed	Utility cost per day	Utility cost per month	Total utility costs per 5 month period	
394.3333	173.85	68554.85	Btu's	7.5	514161.38	3.41	151	0.1200 \$	18.09	30 \$ 542.81	5 \$ 2,714.05
		With 80% Shade Fabric Installed→			80% 102832.28	3.41	30.2	0.1200 \$	3.62	30 \$ 108.56	5 \$ 542.81
										80%	\$ 2,171.24
		Cost of the 13- 48" x 98" "Skyshade" units installed	→	\$ 3,717.35							
				\$ 2,171.24	←						Estimated savings over a five month period
				1.71	←						Estimated payback in years

Appendix (b):

Leading Brands
Responsive Solutions.

TEXTILENE⁸⁰
BRAND FABRIC
Solar Screen Fabric

Technical Data

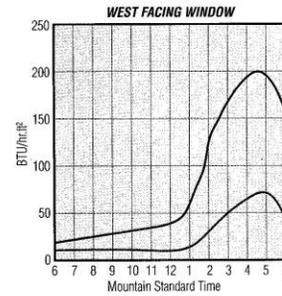
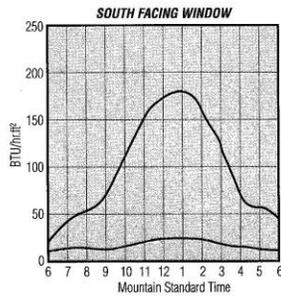
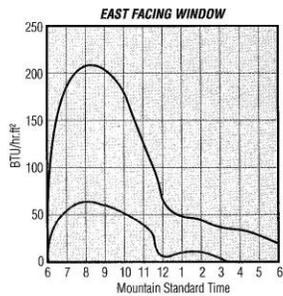
Item Number: T18DE

Product Description: Solar screen fabric in a plain weave using .025" diameter vinyl-coated 1000 denier polyester core yarns in the warp and fill. 80%

Attribute	ASTM	Warp	Fill	Typical
Construction, end/inch	D3775-96	16.0 .5	14.5 .5	
Weight, oz/yd ²	D3776-96	—	—	13.0
Tensile Strength (Grab), lbf	D5034-95	304.7	290.9	
Tensile Strength (Strip), lbf	D5035-95	230.7	193.7	
Tear Strength (Trapezoidal), lbf	D1117-97	76.8	58.8	
Elongation, %	D5035-95	13.8	13.0	
Abrasion Resistance (H18/500 cycles/ with no added weight)	D3884-92	No exposure of core yarn		
Flammability Rating	CS-191.53 & CA 117 E			
Weatherability, 1200 hours	G53-96	Trace discoloration		
Mildew Resistance	G21-96	No growth		

The above results are representative of real data from single test samples. Presently no specification is incorporated.

Twitchell Exterior Window Shade Solar Screen											
Profile	Total Solar			Visible			Shading Coefficient				
							1/8" Clr.	1/4" Clr.	1/4" HA	Clr. Dbl.	HA Clr.
Angle	Trans.	Ref.	Abs.	Trans.	Ref.	Abs.	Clr.	Clr.	HA	Dbl.	Clr.
30	0.24	0.03	0.73	0.21	0.04	0.75	0.33	0.33	0.31	0.28	0.26
45	0.20	0.03	0.77	0.18	0.04	0.78	0.29	0.29	0.27	0.25	0.22
75	0.04	0.04	0.92	0.03	0.08	0.89	0.14	0.14	0.13	0.11	0.10



Legend	
1/8" Clear Glass	_____
No Protection	_____
With TEXTILENE ⁸⁰	_____
Solar Screen	_____

Suggested Applications Include:

- Marine Screen
- Window Screens
- Folding Screens
- Room Dividers
- Umbrellas
- Awnings

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Twitchell CORPORATION 4031 Ross Clark Circle NW · Dothan, Alabama 36303 · 1-800-633-7550 · Fax: 334-673-4126
Visit us on the web at www.twitchellcorp.com

Appendix (c):

Cost savings analysis with potential rebates applied

**Estimated Cost vs Savings
for John Brooks Inc.**

	Shade Quantity	Price Installed			
48"x 48" in 80% Desert Sand	21	\$ 157.95	\$	3,316.87	
48"x 98" in 80% Desert Sand	13	\$ 285.95	\$	3,717.35	
SRP Rebate	\$ 0.80	469.44444 sqft	\$	(375.56)	
SRP Rebate	\$ 0.80	394.33333 sqft	\$	(315.47)	
Total Client Costs			\$	6,343.20	

**Cost analysis study on a
48" x 48" skylight
unshaded and with
"Skyshade" applied**

Total square foot surface	Btu' per Sqft corrected	Btu's of Generated total surface area	Heat of the Hours per day	Total Btu's generated Day	kWh used per kWh conV day	kWh rate Avg. Billed	Utility cost avg. per day	Utility cost per month	Total utility costs avg. per 5 month period
469.4444	173.85	81612.917 Btu's	7.5	612096.88	3.41	180	0.1200 \$	21.54 30	\$ 646.20 5 \$ 3,231.01
With 80% Shade Fabric Installed→				80%	122419.38	3.41	35.9	0.1200 \$	4.31 30 \$ 129.24 5 \$ 646.20
									80% \$ 2,584.81
Cost of the 21- 48" x 48" "Skyshade" units installed				→	\$ 2,941.32				
				←	\$ 2,584.81	Estimated savings over a five month period			
				←	1.14	Estimated payback in years with REBATE APPLIED			

**Cost analysis study on a
48" x 98" skylight
unshaded and with
"Skyshade" applied**

Total square foot surface	Btu' per Sqft corrected	Btu's of Generated total surface area	Heat of the Hours per day	Total Btu's generated Day	kWh used per kWh conV day	kWh rate Avg. Billed	Utility cost avg. per day	Utility cost per month	Total utility costs avg. per 5 month period
394.3333	173.85	68554.85 Btu's	7.5	514161.38	3.41	151	0.1200 \$	18.09 30	\$ 542.81 5 \$ 2,714.05
With 80% Shade Fabric Installed→				80%	102832.28	3.41	30.2	0.1200 \$	3.62 30 \$ 108.56 5 \$ 542.81
									80% \$ 2,171.24
Cost of the 13- 48" x 98" "Skyshade" units installed				→	\$ 3,401.88				
				←	\$ 2,171.24	Estimated savings over a five month period			
				←	1.57	Estimated payback in years with REBATE APPLIED			

References:

ⁱ Omni Sense Remote Monitoring
<https://www.omnisense.com/default.asp>

ⁱⁱ Southwest Building Science Training Center
<http://www.swbstc.org/building-science-super-lab/>

ⁱⁱⁱ National Renewable Energy Laboratory
<http://pwwatts.nrel.gov/pwwatts.php>

Testimonial:

JOHN BROOKS
I N C O R P O R A T E D

John Brooks Inc. worked with Arizona Sky Shades recently to install nearly 40 shade structures over our skylights, and I can say that we are elated at the results! The showroom is noticeably cooler, and the diffused light passing through the shades is extremely comfortable on the eyes. We enjoy our skylights of "free" and natural lighting, as it showcases our custom furniture, our fabrics, and wallcoverings in their truest colors, and now we can couple that with lower electric bills and cooler temperatures in our warehouse! They were very easy to work with, and the shades they created for us are visually attractive as well as incredibly functional -as we can definitely see (and feel) after the install.

We will absolutely, recommend Arizona Sky Shades without reservation, to any company or person who is thinking about using their services.

Shane Henson
Background Operations
John Brooks Incorporated



4423 N. 86th St. Scottsdale, AZ 85251 (928)978-0915