Appendix 6

Selecting the Right Glazing Material *

The most important things to consider in choosing a glazing material are appearance, durability, performance, and cost. Since the glazing is visible, whether it is clear or cloudy, shiny or dull, or flat or bowed, it dramatically affects the appearance of the system. Durability is critical since the glazing provides the outer barrier to water, cold air, ultraviolet radiation, and weather. High transmittance of light and low transmittance of heat affect the efficiency of the system. The glazing should be inexpensive and easy to handle. The table summarizes important properties of various glazings.

Glass

Glass is usually a more expensive choice but a very popular one. Although common glass is less expensive, tempered glass is stronger and safer. "Water-white" glass (fully tempered) has a very low iron-oxide content (0.01 percent) and thus the highest transmittance 0.91). Tempered float glass is less expensive but has a high iron oxide content and a transmittance of (0.91. However, use it only vertically and when safety is a small factor.

Glass is rigid, it looks good, it's durable, and it resists weathering and chemical and light deterioration. Unfortunately, it is heavy and difficult to handle. It also breaks .

• Based on an article by Peter Temple and Joe Kohler entitled "Glazing Choices" in *Solar Age* magazine, April1979, Harrisville, NH 03450.

Glass prices vary significantly depending on how much you buy and where you buy it. Tempered low-iron glass ("water-white") usually has the same retail price as float glass, roughly $2 to $2.50 per square foot. But you can buy water-white glass for as little as $1.00 per square foot if you shop hard enough.

Fiberglass-reinforced Polyester

Fiberglass-reinforced polyester (FRP) glazing materials appear cloudy, but their solar transmittance (0.84-0.90) is only slightly less than low-iron glass. Kalwall's Sun-lite™ and Vistron's Filon™ are two commercially available FRP glazings.

FRPs are available in 4- and 5-foot-wide rolls in thicknesses of 0.025, 0.040 and 0.060 inches. It is a popular material since it is easy to cut, drill, and install. Some people do not like its appearance it does not lie flat and often looks wrinkled. Kalwall has double-glazed panels onto which the FRP is stretched taut over an aluminum frame. The panels are less wrinkled but are not entirely smooth.

FRPs degrade somewhat at high temperatures. Kalwall notes that their Sun-lite loses 1 %, 3%, and 11 % of its transmittance when exposed to temperatures of 150°F, 200°F, and 300°F, respectively, for 300 hours. Most passive applications do not reach 200°. Tilted convective loop collectors are the main exception.

Filon is an acrylic-fortified polyester, reinforced with fiberglass. A thin layer of Tedlar™ polyvinylfluoride provides protection from ultraviolet degradation and weathering. Filon is available in flat or corrugated sheets. The corrugations reduce the wavy appearance problem. Filon, like Sun-lite, may require venting in higher temperature applications to protect it from thermal degradation.

Films

Plastic films are very transparent and are relatively inexpensive. Two of the best materials are Dupont's Teflon™ and Tedlar™. Teflon stands up well in high

temperatures except that it expands and sags. It is difficult to handle, bowing between supports and sticking to surfaces like Saran Wrap™.

Tedlar is also difficult to handle and install. Dupont recommends that it be used only at low temperatures. Direct exposure to ultraviolet radiation causes embitterment, and this effect is tremendously accelerated at higher temperatures. Used at low temperatures, Tedlar has an expected lifetime of 4 to 5 years until embitterment. If there are any hotspots (e.g., near a hot metal support), these places will embrittle earlier. A new version of Tedlar, 400xRB160SE, has recently been developed, and it is expected that this product will be less susceptible to UV degradation.

A new product by 3M Company, Flexiguard™ 7410, may avoid one of the problems of most films. The manufacturer claims that it does not sag at high temperatures. It remains rigid, but not brittle, at temperatures from -30°F to 3000°F.

A common disadvantage of thin plastic films is their transparency to long-wave radiation (heat). The resulting higher heat loss reduces efficiency. Glass has a transmittance of heat of less than 1 %, but the transmittance for films ranges from 17% for 5 mil polyester to 30% for 4 mil Teflon REP and 57% for 1 mil Tedlar. Long-wave transmittance data for Flexiguard 7410 is not presently available.

Rigid Plastics

Rigid plastic glazings are strong, easy to handle, and generally attractive. Most of them are either acrylics or polycarbonates. Acrylics are slightly more transparent than tempered water-white glass and resist ultraviolet light and weathering. They are usually clear and are as attractive as glass if they are not scratched. They tend to soften and bow at higher temperatures, but this is not a concern for most passive applications.

Polycarbonates are stronger than acrylics, but they have a lower transmittance and suffer from ultraviolet degradation. Like acrylics, polycarbonates have a high coefficient of thermal expansion and bow inward when the passive system gets too hot.

Insulating Panels

Some glazing materials are manufactured as "insulating" panels, which form a rigid sandwich: an air space between two glazing layers. Their higher initial cost may be offset by the lower installation cost compared with two individually installed layers.

Comparing Glazings

	Thickness (in.)	Cost ($/ft.^{2})	Transmittance	Weight/Area (lb/ft.^{2})	Thermal Expansion (°F^{-1}x10^{-6})	Ease in Handling	Strength	Sheet Size (ft.)	Remarks
Water white glass "Solatex" (ASG)	0.125	0.99	0.90	1.60	0.47	Poor	Good (tempered)	2, 3, or 4x8	Very durable—no degradation
Float glass	0.125	2.35	0.84	1.60	0.47	Poor	Good (tempered)	4x8	Very durable—no degradation
Window glass (ASG SS Lustra-glass)	0.090	1.80	0.91	1.20	0.47	Poor	Poor (non-tempered)	4x7	Fragile
Sunlite Premium II (Kalwall)	0.040	0.60	0.88	0.29	2.00	Excellent	Very good	4 or 5 width rolls	Maximum temperature 300°F
Filon w/Tedlar (Vistron Corp.)	--	1.00	0.86	0.25	2.30	Very good	Very good	4.25x16	Maximum temperature 300°F
Flexiguard 7410 (3M)	7 mil	0.38	0.89	0.053	--	Fair	Good	4x150 roll	Maximum temperature 275°F
Tedlar (Dupont)	4 mil	0.05	0.95	0.029	2.80	Fair	Good, some embrittlement	up to 5.33 width roll (64 in.)	4-5 yr. lifetime at 150°F
Teflon FEP 100A (Dupont)	1 mil	0.58	0.96	0.02	5.85	Poor	Fair, not for exterior glazing	4.83 width roll (58 in.)	Maximum temperature 300°F
Swedcast 300 Acrylic (Swedlow Inc.)	0.125	0.81	0.93	0.77	4	Excellent	Very good	9 wide	Maximum service temperature 200°F
Lucite Acrylic (Dupont)	0.125	1.14	0.92	0.73	4	Very good	Very good	4x8	Maximum temperature 200°F
Tuffak-Twinwall (Rhom & Haas)	--	1.25 (2 layers)	Equiv. to 0.89 for 1 layer	0.25	3.3	Very good	High impact strength fatigue cracking	4x8	5% reduction in transmittance over 5 years
Acrylite SDP (Cyro)	--	2.15 (2 layers)	Equiv. to 0.93 for 1 layer	1.00	4	Very good	Good	6x8	Maximum temperature 230°F
Sun-lite Insulated Panels (Kalwall)	--	2.50 (2 layers)	Equiv. to 0.88 for 1 layer	0.7	--	Good	Good	4x8 4x10 4x12 4x14	Maximum temperature 300°F
Solar Glass Panels (ASG)	--	2.99 (2 layers)	Equiv. to 0.90 for 1 layer	4.5	0.47	Poor	Good	3 or 4x6 3 or 4x8	Very durable

• Courtesy *Solar Age* magazine, Harrisville, NH.

Tuffak-Twinwall™ is a sandwich of polycarbonate material. Although it is relatively inexpensive, it has the same serious disadvantages of any polycarbonate: ultraviolet degradation, low transmittance, and a large coefficient of expansion. Likewise, the Cyro-Acrylic SDP™ panels have the disadvantages associated generally with acrylics: a low melting point and a large coefficient of thermal expansion.

ASG sells double solar glass panels using either their Solatex™ or Sunadex™ glazing. These panels are designed specifically for solar applications. The two layers of glass are hermetically sealed.