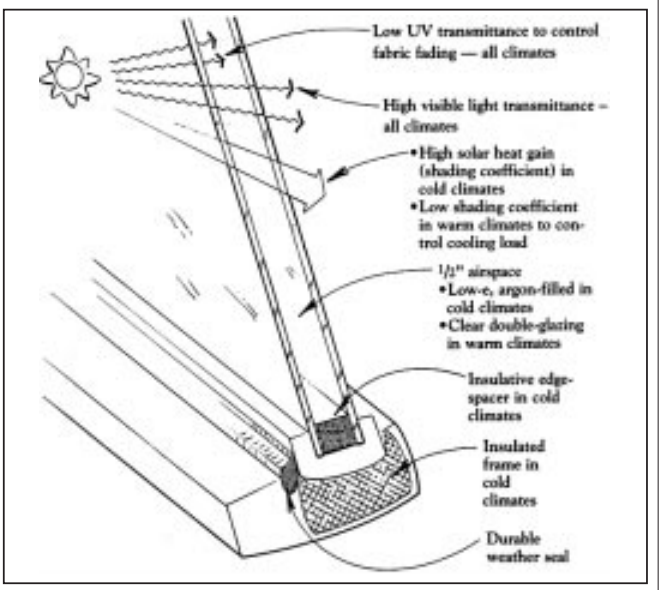
High-Performance Window Shopping

by J.D. Ned Nisson

As windows get more energy efficient, window selection gets more complex. Gone are the days when R-value and air leakage were the only important window specifications. Open almost any building magazine, and you will probably see ads promoting the reduction of fabric fading with *Heat Mirror* windows, the increased solar heating of LOF *Energy Advantage* glass, and reduced condensation with Hurd *Insol-8* windows. These are a few examples of the latest performance features that window manufacturers are promoting. More are sure to follow.

The following suggestions should help a builder or designer intelligently navigate this technological maze.



Look at more than simple R-value when selecting windows. Other features such as UV light transmission, shading coefficient, visible light transmission, and edge spacer design all affect overall window performance and customer satisfaction.

R-value — A Moving Target

When low-e windows were first introduced ten years ago, they carried a hefty cost premium over conventional windows with clear glazing. That price difference has rapidly narrowed. And so it should since the manufacturers' extra cost for some low-e coatings is less than $1 per square foot. Argon gas filling costs only a few pennies more. Some of the new coatings with enhanced solar control are still expensive, but their costs will likely also drop as production volume increases.

These price trends make it difficult to pin down the single most cost-effective R-value for any particular climate. In cold climates, it is always cost effective to move up to low-e, gas-filled glazing (with some manufacturers, it is now standard). Look for R-values between R-3.0 and R-3.5. In warm climates, low-e windows are still somewhat rare and quite expensive. Clear double-glazing is, in many cases, still the most cost-effective choice south of the Mason-Dixon line, but look for units with wide (½ inch) air spaces which typically have R-values between R-2.0 and R-2.5.

To find accurate window R-values, you'll need a 1990 catalog. Beginning this year, most reputable manufacturers switched to a new calculation method which takes into account the effect of edge spacers and frame. The difference can be significant. The pre-1990 calculation technique overstated the R-value of high-performance windows by as much as 25%.

When examining manufacturers' listed R-values, look for a statement indicating that all values are based on *Windows 3.1*, a computer program developed by Lawrence Berkeley Laboratory, and that the calculations are consistent with the 1989 issue of the ASHRAE Handbook of Fundamentals.

Most catalogs list two R-values (or U-values) — one for the center-of-glass and one for the whole window. The overall window R-value is the important number for energy calculations.

Air Leakage — The Common Sense Approach

There are three ways to evaluate the air leakage of a window: by type, by the manufacturer's listed rating, and by visual inspection.

Casements, awnings, and any other windows with compression seals will generally allow about half as much air leakage as windows with sliding seals, such as double hungs and horizontal sliders. Fixed windows are naturally tightest.

Window catalogs will almost always list measured air infiltration rates in units of cubic feet per minute per lineal foot of crack length (cfm/ft). Typical reported rates are from 0.01 to 0.04 cfm/ft for casements and 0.08 to 0.17 cfm/ft for double hungs.

Those values, however, should be taken with a grain of salt. They may be based upon a *single* measurement on a *single* window furnished by the manufacturer and may not be representative of average production. A notable exception is Andersen Corp. whose reported infiltration values are based on randomly selected and tested windows.

Also, the infiltration rate of a window that was hand carried to a testing lab may be very different from that of a window that has suffered typical shipping and on-site handling. However, even if the specific values listed are not totally accurate, they should be useful for comparing the air leakage of different types of windows within a single brand.

Perhaps the best way to evaluate the tightness of a window is a common sense visual inspection. Are the weather seals sturdy? Will they maintain shape after a few thousand openings? How about the hardware? Does it create a tight, strong closure?

Condensation Resistance — Looking at The Edge

The number one reason for callbacks regarding windows is moisture condensation. This is another area where manufacturers' listed specifications are of little practical value. Window catalogs often list an indoor humidity at which condensation begins to form on the inner glass surface. For high-performance glazing, the listed humidity is typically between 60% and 65%. That figure is simply a calculation based on *center-of-glass* surface temperature when the outdoor temperature is 0°F. It is nothing more than a function of center-of-glass R-value.

A more important concern is the ability of a window to resist condensation at the glass edge. Condensation always starts at the edge because of the aluminum spacer between the layers. The best windows for resisting edge

condensation are those with some type of insulated edge spacer.

Currently, there are only two nationally available brands that fit the bill. One is the Hurd Insol-8 which has a nonmetallic edge spacer; the other is the Pella which has a removable inner pane and no edge spacer. (Watch for other manufacturers to introduce insulating edge spacers. Marvin is now testing a nonmetallic edge spacer in Alaska, and Cardinal is reportedly developing a nonmetallic edge spacer for Andersen Windows.)

The other approach to reducing edge condensation is to recess the glass deep into the window frame, allowing the frame to serve as insulation on each side of the glazing. The only window I know of with that feature is the Alaska Window, produced in Fairbanks, Alaska. One reason most manufacturers shy away from this approach is that it reduces the window view area.

Speaking of frames, the only window with a thermally improved frame is the new Owens Corning fiberglass window, which has high-density fiberglass insulation inside a hollow fiberglass frame. However, given the new emphasis on frame and edge losses, I'd watch for foam-filled vinyl window frames in the next year or so.

UV Light and Fabric Fading

Ultraviolet (UV) light comprises only about 2% to 4% of the total energy in sunlight but is believed to cause more fabric fading than the visible portion of the solar spectrum. By filtering out UV light, windows can reduce the rate of fabric fading.

All glass filters out some UV light. Low-e glass filters out more than clear glazing, and specialty glazings, such as Heat Mirror film, take out even more. Some, but not all, window manufacturers provide UV transmission values in their catalogs.

Unfortunately, selecting windows on the basis of UV light transmission is not very easy. First of all, not all manufacturers measure UV transmission the same way, so it is often hard to compare apples with apples. But more important is the fact that we don't really know how to quantify the benefits of reduced UV. It's important to understand that removing UV light should slow down fabric fading but cannot completely eliminate it. Visible light also causes fading along with other factors such as heat and humidity. In other words, a couch next to a Hurd Heat Mirror window may fade more slowly than one next to a Marvin window, but it will still fade.

We may get better information on this topic soon, but for now my only recommendation is that in sunny climates, it may be worthwhile to spend extra money on UV protection for expensive or delicate fabrics. In other situations, UV protection would still be an advantage, but probably not worth significantly higher cost.

Optical properties of low-e glass.

Manufacturer and Type	Shading Coefficient	Visible Transmittance	Luminous Efficacy
LOF Energy Advantage	.87	75%	.86
PPG Sungate 300	.86	78%	.91
Pella Low-E DGP	.83	66%	.80
Andersen H.P.	.79	79%	1.00
Marvin Double Glazing	.73	74%	1.01
Heat Mirror 88	.70	71%	1.01
Heat Mirror 66	.50	55%	1.10
Heat Mirror 55	.41	47%	1.15
Cardinal Low-E Squared	.49	69%	1.41

Solar Heat Gain Versus "Luminous Efficacy"

Some of the most notable recent developments in glazing technology have to do with solar heat transmission and rejection. For northern climates, we are seeing new glazing products such as LOF's Energy Advantage glass, which are designed to allow maximum solar gain. For southern climates, there is a new breed of "selective" glazings which reduce solar gain without significantly lowering visible light transmittance.

Most window catalogs list the shading coefficient (SC), which describes the ability of a glazing system to transmit solar heat. The higher the SC, the more solar heat is transmitted through the glazing. For passive solar heating benefits, look for a SC of at least 0.80. (The new LOF glass has an SC of 0.87.) For southern applications where cooling is more important than heating, look for a low SC, preferably below 0.60.

There is one catch to shopping for windows in southern climates. It's easy to find tinted windows with very low SCs. For example, Andersen *H.P. Sun Glass* has an SC of 0.44, and reflective glazings used in commercial buildings have SCs as low as 0.14. But those windows also have markedly reduced visible light transmittance.

What we really want in warm climates is a glazing that transmits the most light with the least solar heat. Window catalogs usually list both visible transmittance and the SC. The ratio of those two quantities — visible transmittance divided by the shading coefficient — is what researchers at Lawrence Berkeley Laboratory are now calling the "luminous efficacy constant."

For southern houses, the most desirable window is the one with the highest luminous efficacy. In fact, Southern California Edison now offers rebates to customers who install glass with a luminous efficacy greater than 1.0. The table at left lists optical properties for several popular glazing products. Those at the top of the list, with the highest shading coefficient, are best for passive solar heating. Those at the bottom are best for reducing solar gain in warm climates. Notice that Cardinal "Low-E Squared" glass has a low shading coefficient and high visible light transmittance. This and similar glazings, now being used in residential skylights, are examples of the new high performance products just now entering the market. ■

J.D. Ned Nisson is president of Energy Design Associates Inc., a New York City-based building consulting firm, and editor of Energy Design Update*, a monthly technical newsletter on energy-efficient building design and construction, published in Arlington, Mass.*