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ENERGY SMARTS: ENERGY EFFICIENT WINDOWS

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Windows bring light, warmth, and beauty into buildings and can give a feeling of openness and space to living areas. They can also be major sources of heat loss in the winter and heat gain in the summer. An average home may lose 30 percent of its heat or air conditioning energy through its windows. Employing energy conservation techniques can decrease heat loss or gain. When choosing windows for a building, the usual decision criteria tend to be appearance and initial cost. But energy efficiency is also very important.

FACTORS TO CONSIDER

The type of window is always selected according to the region of the U.S. in terms of Heating Degree Days, Cooling Degree Days, and whether the breeze or wind is coming from the North, South, West or East side of the building (see Table 1). Selecting the correct window for the particular location can save on heating and cooling costs.

Window selection should include a number of factors, such as the different types of glazing, low-emissivity (Low-E), U-factor (U-value), R-value, Solar Heat Gain Coefficient (SHGC), Visible Light Transmission, air leakage rating, energy efficient ratings and labels, and double or triple glazing.

TYPES OF GLAZING

Spectrally selective glass has special coatings or tint glazing with optical properties that are transparent to some wavelengths and reflective to others. Typically spectrally selective coatings are designed to allow high levels of visible light into a building and reflect other heat generating wavelengths.

The visible transmittance (VT) is an optical property that indicates the amount of visible light transmitted. While VT varies between 0 and 1, most values are between 0.3 and 0.8. The higher the VT, the more light is transmitted. A high VT is desirable to maximize daylight.

LOW-EMISSIVITY (LOW-E)

In recent years, advances have been made in coatings that are deposited onto a window surface to reduce heat loss in the winter, but also reduce heat gain in the summer. Low-E coatings are microscopically thin, invisible metal or metallic oxide layers applied to a window surface (Efficient Windows Collaborative, 1998-2004). Low-E glazing allows light through, but reduces ultraviolet light (see Figure 1). Low-E blocks about two times more ultraviolet light than clear, single-pane glass windows (Pilkington, 2004). Ultraviolet light transmitted through windows fades interior furnishings such as carpets,

Table 1. Salt Lake City and Cedar City Areas: Recommended Window Properties

U Factor	Solar Heat Gain Coefficient (SHGC)	Visible Transmittance (VT)	Air Leakage (AL)
Salt Lake City and Northern Utah Areas			
Windows: U=0.35 or less	Select the highest SHGC for passive heat gain in winter. Select lowest SHGC if overheating house in summer is a concern.	Select higher VT to maximize daylight and views.	AL of ⁻0.30 or less.
Cedar City and Southern Utah Areas			
Windows: U=0.40 or less	With moderate air conditioning requirements, select windows with SHGC of 0.55 or less (lower SHGC values reduce summer overheating, but also reduce free winter solar heat gain).	Select higher VT to maximize daylight and views.	AL of ⁻0.30 or less.

(Adapted from: Energy Efficient Windows Collaborative, 1998-2004)

curtains, and furniture. The Low-E coating also acts as a mirror to keep the heat inside the house.

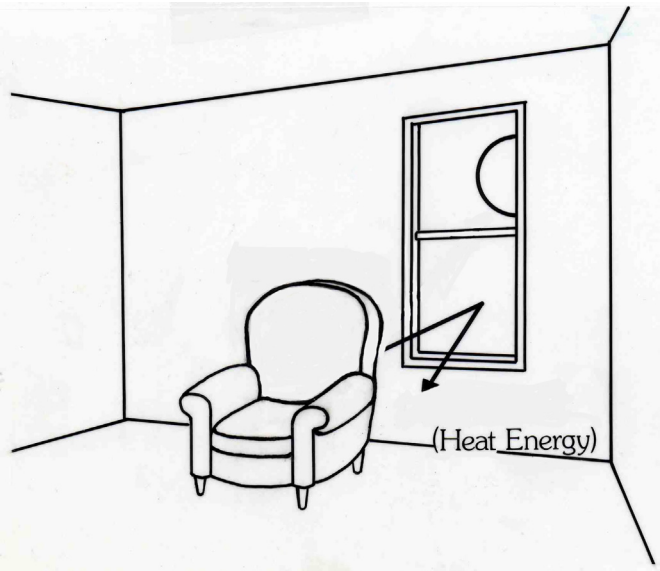
Low-E glazing has benefits from both sides of the window. Compared to most reflective and tinted window coatings, Low-E glass provides a higher level of visible light transmission for a given amount of solar heat reduction. The coatings are transparent to visible light and, depending on the coating, will allow for high, moderate or low solar gain (BFRC, 2002). When the long-wave heat energy inside the house hits the glass, the coating on the glass acts as a mirror to keep the heat inside the house. This assists in keeping the house warmer in the winter (see Figure 2).

U-VALUES AND R-VALUES

The energy efficiency of windows is often represented by its U-factor (sometimes called U-value), or its R-value, which is the inverse of the U-value. The U-values and R-values are measures of a window's rate of heat loss. The insulative value is indicated by the R-value. If a window's U-value is low, it will lose less heat than one with a high U-value. Conversely, if a window's R-value is high, it will lose less heat than one with a lower R-value. Most window manufacturers use U-factors in rating their windows' performance. The following factors affect the U-factor: the type of glazing material (e.g., glass, plastic, treated glass), the number of layers of glass, the size of the air space between the layers of glass, the thermal resistance or conductance of the frame and spacer materials, and the air leakage, and tightness of the installation (Nemmur,

1990-2005). When shopping for windows, look for those with a U-value of .35 or lower.

Figure 1. Low-E Allows Light Through Windows but Reduces Ultraviolet Light



SOLAR HEAT GAIN COEFFICIENT (SHGC)

Solar Heat Gain Coefficient (SHGC) is a measurement of the amount of direct solar radiation that enters the home through the glass as heat. The SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits, and the greater its shading ability. Stated another way, the smaller the number, the better the glazing is at preventing solar heat gain. The larger the number, the better the glazing is at letting in solar heat during the winter. The value can be an indication of the window only or the entire window assembly (Healthgoods, 1998-2004).

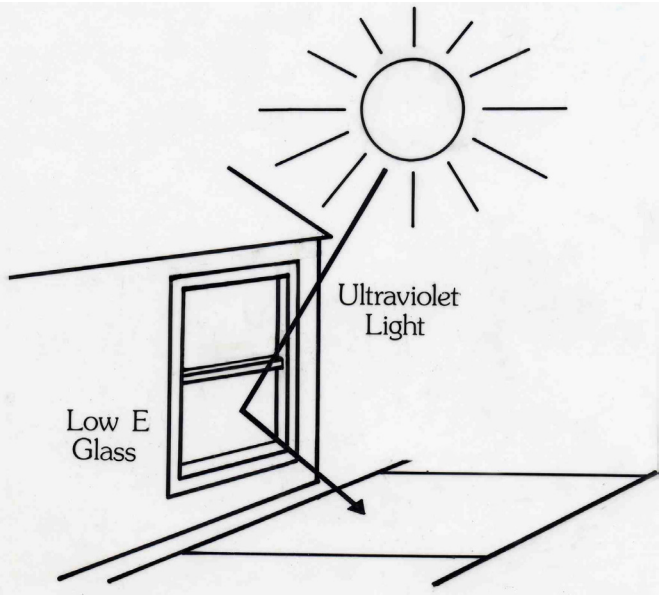
AIR LEAKAGE/ INFILTRATION

Air leakage or air infiltration is the amount of air passing in and out of a building through cracks in walls, windows, and doors. Air leakage (AL) is an energy performance rating that measures the rate at which air moves through the window frame as the result of the pressure difference on either side of the window. The rating is expressed in cubic feet of air passing through a square foot of window area. Any window purchased should be 0.30 cfm/ft^2 or lower (lowest values are best). The lower the AL, the less air leakage though cracks around the window frame. Sliding windows generally have a higher rate of AL than casement or awning type windows with compression seals. AL generally has a smaller impact than U-factor and SHGC values, but houses in windy or harsh climate conditions may benefit from windows with low AL values (NFRC, 2005).

Infiltration is a term used to describe air leakage through cracks between the glass assembly and the window frame, resulting in heat loss. Well-designed windows have durable weather-stripping and high-quality closing devices that can effectively block air leakage, heat loss and gain through the windows (see Figure 3).

Weather-stripping is a narrow piece of metal, vinyl, rubber, felt or foam that seals the contact area between the fixed and movable section of a window joint and the frame. Weather-stripping is applied between the sash and the frame, but should not interfere with the operation of the window. Weather-stripping is a cost-effective way of solving AL problems. Hinged windows such as casements and awnings clamp more tightly against weather-stripping than do double-hung windows (Fisette, 2003).

Figure 2. Low-E Reflects Heat

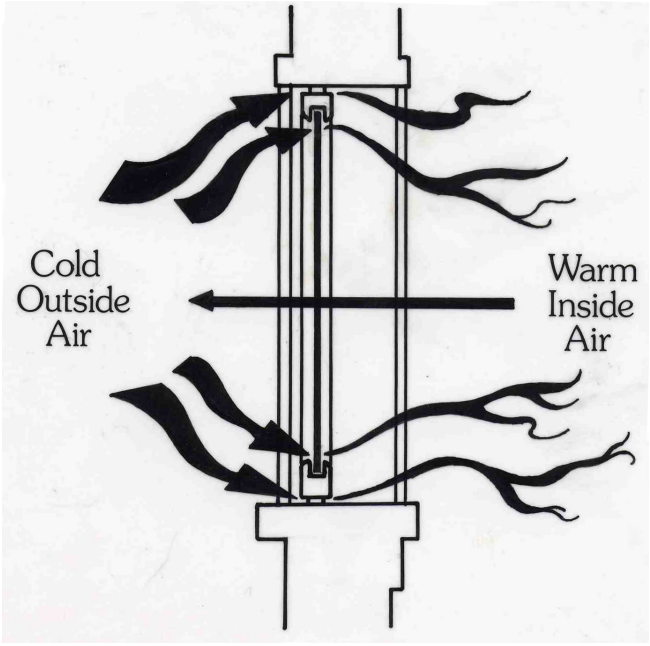


ENERGY EFFICIENT LABELS AND RATINGS

The **National Fenestration Rating Council** (NFRC) is a voluntary, third-party organization that provides ratings of windows' performance. This sticker is found on some windows and provides the window's U-factor, solar heat

gain, visible transmittance, air leakage, and condensation resistance (see Figure 4). The NFRC energy performance label can help you determine how well a window will perform. By using the label to compare windows, homeowners can determine which window will provide the best performance. The label lists the manufacturer, describes the product, provides a source for additional information, and includes ratings for one or more energy performance characteristic. In addition to windows, the NFRC label can be found on skylights and doors. The NFRC sticker does not mean that a window is energy-efficient. It merely reports the different energy ratings of that particular window (NFRC, 1990-2005).

Figure 3. Conduction Through Windows



The **ENERGY STAR®** rating, however, does certify that a window is energy efficient (see Figure 5). Direct benefits of choosing ENERGY STAR® products include lower energy bills without sacrificing style or comfort. Expanded benefits include fewer green-house gas emissions, a cleaner environment, and less dependence on foreign energy sources. To qualify for the ENERGY STAR® label, windows, doors, and skylights must meet certain rating criteria, as measured by the National Fenestration Rating Council. For Northern climates such as Utah, windows should have a U-factor of less than 0.35, and a SHGC of less than 0.55.

Figure 4. National Fenestration Rating Council Label

(Printed with permission from National Fenestration Council)

BENEFITS OF DOUBLE/TRIPLE GLAZED WINDOWS

Double-glazed windows are also called double-pane indicating that window is made up of two layers of glass with an insulating space in between. Triple-glazed windows are made up of three layers of glass. Because these windows trap air between the layers of glass they provide more insulation than single pane windows (see Table 2).

Figure 5. EnergyStar® Label

(Printed with permission from EnergyStar ®)

CONCLUSION

Windows are a major source of heat loss in the winter and heat gain in the summer. Many factors go into choosing

Table 2. Single, Double, and Triple Glazed Windows

	R-Values	U-Values
Single Glazing	.98	1.02
Double Glazing (½" air space)	2.04	.49
Triple Glazing (1/2" air space)	2.92	.39

a window, including cost and appearance. However, one of the most important factors in selecting a window is its energy efficiency. Energy efficient windows can reduce energy costs, provide comfort, and pay for themselves in reduced energy costs when compared to an energy inefficient windows. When shopping for energy efficient windows look for the following characteristics: Low-E glazing; U-factor for Salt Lake City area of 0.35 or less and for the Cedar City area a U-factor of 0.40 or less; double or triple pane windows; insulating thermal breaks inside window frames; higher visible transmittance (VT) to maximize daylight and views; air leakage (AL) of .30 or less, and the ENERGY STAR® logo.

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