

White Paper

# **Evaluating Residential Window Components & Performance**

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# Evaluating Residential Window Components & Performance

## Helpful information for homeowners in making an informed decision about replacement or remodeling windows

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### Introduction

There is a lot of information, often conflicting, for a homeowner to sort through when making an informed decision about replacement or remodeling windows. Besides the myriad of types and styles of windows, there are vast differences in framing materials, window components and construction that greatly affect long-term window performance and thermal efficiency, especially for a “green” minded consumer.

These differences are often reflected in “good, better, and best” window quality ratings and pricing. The primary selling point is usually thermal efficiency, but all too often this point is centered on just the Insulating Glass (IG) unit.

While the IG unit is a critical component and the most visible part of a window, it is just one unit within the overall window system. Evaluating overall window system performance involves more than just a look at the IG unit and its thermal efficiency. In fact, poor window performance is most often due to faulty installation.

To help evaluate overall window system performance, this paper takes a brief look at window system design and performance criteria. A separate white paper includes a critical review of the main IG systems window manufacturers use today and how they affect the durability and thermal efficiency of the overall window system.

### **Window System Components**

#### **Framing materials**

The American homeowner now has many window material and construction options — wood, aluminum, steel, vinyl, vinyl clad wood, aluminum clad wood, fiberglass and composite materials. Confused? Most people are. Each material has both positive qualities and drawbacks that should carefully be considered when choosing replacement windows.

- Wood has long been a standard residential window material. It is still a leading choice for premium windows. It is strong and easy to work with. And, it can be painted or stained. For

energy efficiency, wood is an excellent insulator. Major downside: Wood windows require painting or staining for protection against the weather at regular intervals.

- Aluminum-clad wood is a popular combination because it combines high quality materials with low maintenance requirements. The exterior aluminum comes in a variety of baked-in colors. Protection against the elements is excellent. The interior wood side can be either painted or stained to match the home's décor.
- Vinyl-clad wood windows are similar in style and function to aluminum clad wood windows. The difference is the vinyl-clad exterior. Color choice with vinyl is limited, but it is highly resistant to the elements.
- Aluminum metal frames are light, strong, and generally less expensive than wood frames. Lower quality aluminum windows readily transfer cold, making them a poor choice in areas with wide temperature swings. Newer models have thermal breaks of rubber or plastic in the frame designed to reduce heat or cold conduction. Today, most aluminum frames are finished with baked enamel paint in white or bronze.
- Steel framed windows can still be found in many older homes. While durable, they require considerable maintenance, including regular painting.
- Fiberglass window frames are strong and tough. Hollow parts can be made without the metal stiffeners required for vinyl. The hollows allow manufacturers to produce higher efficiency windows by filling the voids with insulation. Generally higher priced than vinyl windows, fiberglass frames can be painted.
- Composite windows have exterior parts that are made from a blend of wood chips and recycled plastic that are impervious to rot. The material is similar to that used for composite decking.
- Vinyl windows came into their own as energy-conscious homeowners started to look for ways to retrofit their homes with double-paned insulated glass windows. Vinyl frame windows are generally half the price of wood windows. A honeycomb effect in the extruded vinyl frame provides insulation through dead air space. A major advantage is that vinyl windows can be readily constructed to fit any size opening, making them a top choice for window replacements.

All window systems offer considerable choice at a variety of price points. Both window manufacturers and their dealers/installers strive to provide the best value for the window system and price point selected to eliminate any potential failure and the need for a “callback.”

## **Insulating glass (IG)**

The Insulating glass system is a major component that directly affects the overall thermal performance and life of the window system. Insulating glass is made up of two pieces of glass that have been sealed together to keep out dust and moisture. Choosing the right type of glass depends on such factors as which direction a particular window faces, whether the home has a problem with heat gain or loss, and various building codes.

Insulating glass options include:

Argon or Krypton gases. These are inert gases sealed between the panes of glass. Because gas molecules are heavier than air molecules, heat takes longer to transfer through the gas. This in turn reduces the transmission of heat or cold from one pane of glass to the next.

High Performance Low E (Low Emissivity) Glass: Low E glass has a thin, almost transparent, metallic coating on the inside of the exterior pane of the insulated glass (IG) unit to add extra insulating power to the glass. Low E glass will not only help keep a home warmer in winter, but cooler in the summer as well. In addition, the Low E coating reduces the amount of ultraviolet light that comes through the windows.

Note that all Low E glass is not the same. There are a variety of different manufacturers, and there are different types of Low E coatings. Hence, it's important to look at the performance statistics for the Low E coating that will be used.

There are two basic types of Low E glass. The first, vacuum or sputter coated Low E, is referred to as softcoat. The second is pyrolytic Low E, commonly referred to as hardcoat. Hardcoat is generally more durable, while softcoat blocks more ultraviolet light.

Tempered (Safety) Glass is glass that has been heated and quickly cooled. In addition to strengthening the glass, it also creates surface tension so that the glass shatters into small, less dangerous pieces. In general, building codes call for safety glass to be used where large pieces of glass will be less than 18 inches from the floor, any glass within a 24-inch arc of a door, or any glass within 60 inches of the shower or tub drain.

Impact-Resistant (Hurricane Code) Glass has a tough polyvinyl butyral (PVB) protective inner layer that is laminated between two pieces of glass under heat and pressure. The laminate can withstand the impact equivalent to that of a 9-pound 2x4 traveling at 50 feet per second.

### **Spacer systems**

Spacer systems hold the panes of insulating glass apart and provide an airtight seal. While the spacer system may seem like a minor component of the overall window, it in fact is a key determinant of a window systems overall thermal efficiency and performance.

There are many different types of spacer systems in use today. Each approach “claims” that they are the best in terms of ...

- Design/function
- Sealant performance
- Structural strength
- Resistance to moisture permeability
- Gas retention over time
- Energy performance
- Appearance
- Manufacturing process repeatability

Understanding what makes a good spacer and the differences between systems can be very confusing. For an in-depth look at the major systems in use today, refer to the white paper “A Critical Look at IG Spacer Systems, Structural Performance & Thermal Efficiency.”

### **Grid assembly**

Sometimes referred to as “grilles” or “muntins”, grids are windowpane dividers. Exterior grids look better but are difficult to maintain; others are placed between the two pieces of glass in an IG unit. These last longer and allow for ease of glass cleaning.

Grid straightness and appearance can be an issue for internal grid systems. Plastic grids might deform over time. Some designs don’t allow for positive grid locking and they can go out of straightness. The best looking windows have metal grids that are positively locked into the spacer with a polymer clip that is tucked below the window sight line. The use of a polymer clip improves warm edge thermal conductivity.

### **Window System Performance Criteria**

Windows are not like walls and insulation. Windows react to outside air temperatures, sunlight and wind, as well as indoor air temperatures and occupant use. Windows are strongly affected by solar radiation and the airflow around them. And, while consumers are aware of R-values as a measurement of insulation and other building materials, they don’t accurately reflect the interaction *around* windows.

There are several rating systems designed to help consumers determine the performance of a window system. The following are explanations of those rating systems and the criteria they include:

## ENERGY STAR

The Energy Star label is arguably the most recognizable rating of a product's energy efficiency. Considering the power of the "green" movement and the demand for products that cost less to own, Energy Star has also become a powerful marketing tool.

Products that have earned the Energy Star designation have been independently certified to perform at levels that meet or exceed strict energy efficiency guidelines set by the U.S. Department of Energy.


The Energy Star criteria for residential windows, doors, and skylights are tailored to four Climate Zones. A product's energy efficiency for a given climate is based on its impact on heat gain and loss in cold weather and heat gain in warm weather. Windows that are energy efficient in Florida will not necessarily be energy efficient in Michigan and vice-versa.

A map showing the four zones can be found at [www.energystar.gov](http://www.energystar.gov). To be eligible for the Energy Star, products must be rated, certified, and labeled for both U-Factor and Solar Heat Gain Coefficient (SHGC) in accordance with the procedures of the National Fenestration Rating Council (NFRC).

## National Fenestration Rating Council

The National Fenestration Rating Council (NFRC) administers an independent, uniform rating and labeling system for the energy performance of fenestration products, including windows, curtain walls, doors and skylights. The standard is known as the NFRC 100 "Procedures for Determining Fenestration Product U-factors."

The NFRC 100 is the standard for determining heat loss of the entire window unit, including both the frame and glass. As a result, consumers are provided with an accurate, credible, and uniform energy rating for windows and other fenestration products.

 National Fenestration Rating Council® CERTIFIED	<b>World's Best Window Co.</b> Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: <b>Vertical Slider</b>
<b>ENERGY PERFORMANCE RATINGS</b>	
U-Factor (U.S./I-P) <b>0.35</b>	Solar Heat Gain Coefficient <b>0.32</b>
<b>ADDITIONAL PERFORMANCE RATINGS</b>	
Visible Transmittance <b>0.51</b>	Air Leakage (U.S./I-P) <b>0.2</b>
Condensation Resistance <b>51</b>	<b>—</b>
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. <a href="http://www.nfrc.org">www.nfrc.org</a></small>	

The NFRC Label provides two Energy Performance Ratings:

- **U-factor, or U-value**, is the most important rating for window energy efficiency. It measures the rate of non-solar heat transfer from one side of a window to the other. U-factor ratings generally fall between 0.20 and 1.20. The lower the U-factor, the better the window is at keeping heat in. In cold climates, windows should have a U-factor of 0.35 or less. In hot climates, the U-factor should be 0.75 or more. In mixed climate zones where heating and cooling are of equal importance, the window U-factor should be about 0.40.

It is easy to confuse U-factor with the R-value rating. R-value is also a measurement of conductivity. However, U-factor takes into account more than conductivity; it also is affected by the airflow around the window and the ability of the glass to absorb heat energy.

- **Solar Heat Gain Coefficient (SHGC)** measures how well a product blocks heat from the sun. SHGC is expressed as a number between 0 and 1. The lower the SHGC, the better a product is at blocking unwanted heat gain. In areas with high summer heat, the SHGC value should be 0.40 or less. In moderate climates, with little or no air conditioning needs, the SHGC value should be 0.55 or less. In northern and colder climates where it is desirable to have the winter sun add solar heat to the house, the SHGC should be 0.75 or more.

Blocking solar heat gain is particularly important during the summer cooling season. To reduce the SHGC, a spectrally selective Low-E coating can be applied to the glass. Reflective coatings and tinted glass can also help reduce the SHGC.

Three additional performance ratings can be included on the NFRC Certified Label:

- **Visible Transmittance (VT)** measures how much light comes through a product. VT is expressed as a number between 0 and 1. The higher the VT, the more light is transmitted.
- **Air Leakage (AL)** measures how much outside air comes into a home or building through cracks in a fenestration product's assembly. AL rates typically fall in a range of 0.1 and 0.3. The lower the AL the better a product is at keeping air out. Note that window coverings are not effective at reducing air infiltration. Traditionally, the best way to eliminate drafts caused by infiltration is to caulk and weather strip windows and doors.
- **Condensation Resistance (CR)** measures how well a product resists the formation of condensation. CR is expressed as a number between 1 and 100. The higher the number the better a product is able to resist condensation.

**American Architectural Manufacturers Association (AAMA) Certification Program**

The AAMA window and door certification program visually (through an affixed label) lets customers know that the product conforms to the requirements of AAMA's standards through independent laboratory testing and follow-up on-site inspections.

The AAMA performance standards cover the following:

- Air and water infiltration at the specified pressures
- Structural integrity
- Resistance to forced entry

Detailed information on the AAMA Certification Program can be found at [www.aamanet.org](http://www.aamanet.org).

## **How To Evaluate Installation**

Proper window installation is critical to overall reliability and performance. When properly installed, most windows will perform up to specifications for longer than the warranted life of the window itself. In fact, 9 out of 10 cases of excessive condensation, air leaks, heat loss, warped or out-of-square windows are caused by faulty installation, not faulty manufacture (according to the Association of Window & Door Installers).

Unfortunately, these problems won't show up until months after the installation. And worse, they are not covered by the manufacturer's window warranty.

To help ensure proper installation of windows, the Association of Window and Door Installers (AWDI) created the Installation Certification Program. This program instructs installers on the proven ways to create a "consistent opening" ready to accept the new window. The program also teaches the installer on how to remove the opportunities for mistakes rather than just avoiding them.

The AWDI Installation Guidelines are a standard by which installing contractors can be judged. Certified AWDI Installers are proud to show their credentials. Information on the AWDI Certified Installer Program can be found at [www.awdi.com](http://www.awdi.com).

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About the author:

John H. Haselow has more than 40 years of experience in writing about a wide variety of residential building products and materials. In addition to window systems and their hardware and installation sealants, his experience includes entry doors and lites, framing systems, caulk and sealants, decking, fencing and a myriad of accessories.