

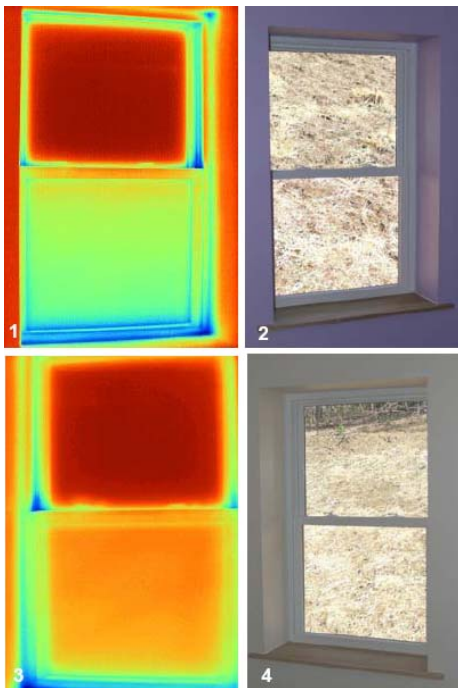


Word On Windows

a publication of the Efficient Windows Collaborative and the Alliance to Save Energy > Fall 2007

High Performance Windows: Taking an Infrared Look

This article was first published in *CARB News Vol. 10, No. 12, June 2007* (carb-swa.com/PDF%20files/CNJune07.pdf). Reprinted courtesy of the Consortium for Advanced Residential Buildings.



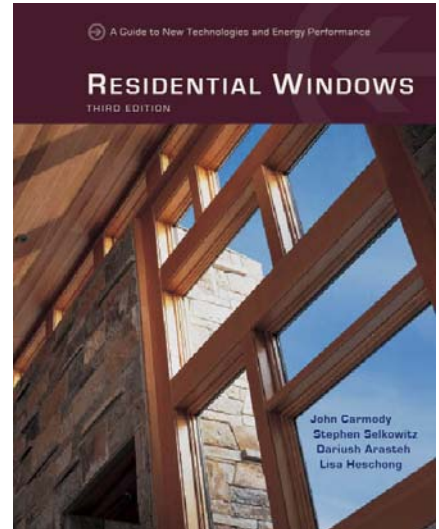
One of the key features in Building America's "near zero energy" home constructed by Rural Development Inc. (RDI) in Colrain, Massachusetts (see *CARB News*, May 2007) is its high-performance windows. The windows have double glazing (one pane has a low-e coating) and there is an additional low-emissivity polymer film suspended between the panes. This construction, along with the krypton gas used to fill the voids between the panes and the Heat Mirror® film, result in a U-value of 0.20 Btu/ft²hr°F.

Installing Heat Mirror windows in the home was a team effort. Window researchers at Lawrence Berkeley National Laboratory (LBNL) contacted Southwall Technologies, the manufacturer of Heat

Mirror film. They also contacted Paradigm Windows, the manufacturer of windows used by RDI. Together, Paradigm and Southwall were able to provide these Heat Mirror windows to the project at no incremental cost.

CARB's modeling predicts that the lower U-values of the windows will save home occupants 43 gallons of propane annually – about \$100 at current propane costs. In addition to the energy savings, there is a comfort benefit to these high performance windows. In May, researchers from the National Renewable Energy Laboratory (NREL) performed tests on the home. With an infrared camera, NREL obtained images that demonstrate the performance of these windows. The top and bottom sashes of the windows (*above*) were installed with different types of glazing, and testing has confirmed comfort differences that result. In the window in the purple wall (1,2), the top sash contains the Heat Mirror product; clear double-pane glass is in the bottom. The window in the white wall (3,4) also has Heat Mirror glazing above; the bottom sash is from a double-pane low-e window typically used by the builder.

Even with a relatively mild temperature difference (52°F outside, 69°F inside) the effect of the Heat Mirror is clear. As expected, the inside surface of the clear window is coolest at approximately 61°F. The inside surface of the double-pane low-e window is warmer at an average of 64°F, and the surface temperature of the Heat Mirror window is 68°F -- almost at room temperature. For more information on this project, contact Robb Aldrich at raldrich@swinter.com.



Guide to Residential Windows Goes Into the Third Round

Fresh off the press: The third edition of *Residential Windows: A Guide to New Technologies and Energy Performance* has just been published. Like its previous editions, this book by the window and design experts John Carmody, Stephen Selkowitz, Dariush Arasteh and Lisa Heschang provides information on window properties and technologies and their relevance for energy efficiency. The new edition of *Residential Windows* includes numerous updates, expansions, and new sections on such key topics as window installation, energy efficiency, and building codes. These additions take into account the new research and developments in the windows world since the last editions of the book was published in the year 2000.

Continued on page 2...

I N S I D E

ASHRAE, IESNA and USGBC collaborate on new green building standard	2
Coming to grips with windows and comfort	3

ASHRAE, IESNA and USGBC Collaborate on New Green Building Standard

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is leading a first-of-its-kind effort to develop minimum guidelines for green building practices. These are intended for new buildings – except low-rise residential buildings – and major renovation projects. The guidelines, supported by the Illuminating Engineering Society of North America (IESNA) and the U.S. Green Building Council (USGBC), are proposed to form *Standard 189, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*. Once completed, this will be the first green building standard of its kind in the United States.

Energy efficiency will be an essential part of the standard, in addition to site sustainability, resource and water use efficiency, and indoor environmental quality. A minimum 30 percent reduction in energy use and greenhouse gas emissions is envisaged compared to the upcoming ANSI/ASHRAE/IESNA Standard 90.1-2007. In general, however, compliance with Standard 90.1 is required where Standard 189 does not specifically state differing requirements, which then

supersede those of Standard 90.1.

Here are some examples of fenestration-related requirements in the proposed Standard 189 (from the May 2007 draft version):

- The total vertical fenestration area shall be less than 40% of the gross wall area. This requirement supersedes the requirement in Section 5.5.4.2.1 of ASHRAE/IESNA Standard 90.1 (less than 50% of the gross wall area).
- Climate zones 1-5: Vertical fenestration on the west, south, and east shall be shaded by permanent projections that have an area-weighted average projection factor of no less than 0.50. In ASHRAE 90.1, no requirement for permanent projections exists.
- SHGC multipliers for permanent projections are more difficult to achieve than in ASHRAE 90.1. For example, a projection factor of 0.8 for east-facing fenestration provides a multiplier of 0.84 instead of 0.51 provided in ASHRAE 90.1. No multiplier is provided for projection factors of 0.6 or less.
- In the southern climate zones, stronger SHGC requirements apply than in Standard 90.1. This is particularly true

for fenestration facing west and east. In climate zones 1-3, the maximum SHGC allowed for all fenestration is 0.25.

- In climate zones 5-8, the maximum U-factor for fenestration with nonmetal framing is 0.25, whereas the most stringent U-factor requirement of ASHRAE 90.1 is 0.46 in zones 5-7. For metal-framed curtainwall and storefront fenestration, the proposed standard requires a 0.35 U-factor in zones 5 and 6 and 0.30 in zones 7 and 8.

The Indoor Environmental Quality provisions of the proposed standard require daylighting by toplighting for all large spaces of more than 20,000 ft² and daylighting by sidelighting for offices and classrooms, where the minimum effective aperture must be 0.10. This is calculated by multiplying the window area as a percentage of the gross wall area by the visible transmittance of the windows. If, for instance, the window area is 0.25 percent of the wall area, windows with a VT of 0.40 or more would be required.

The proposed standard went through a public review period until July 2007. As of August 2007, changes based on these comments have not yet been released.

Residential Windows Goes into the Third Round

Continued from page 1

In addition, this latest edition includes revised energy performance data, based on updated simulation techniques.

Residential Windows provides an overview of new window products for consumers, builders, regulators, utilities, and the researchers, manufacturers, and suppliers in the window industry itself. It is an essential resource for anyone involved in window selection and design.

Residential Windows is available for \$35 from Norton Professional Books (www.wwnorton.com/NPB).

The Authors:

JOHN CARMODY, Director of the Center for Sustainable Building Research, University of Minnesota, has coauthored ten books, including *Window Systems for High Performance Buildings*.

STEPHEN SELKOWITZ, who holds degrees in physics and environmental design, directs Windows and Daylight Research at Lawrence Berkeley National Laboratory.

DARIUSH ARASTEH, who holds degrees in mechanical and civil engineering, is a staff scientist in the Windows and Daylighting Group at Lawrence Berkeley National Laboratory.

LISA HESCHONG is an architect, a partner of the Heschong Mahone Group, an architectural research firm, and the author of *Thermal Delight in Architecture*.



WORD ON WINDOWS is produced with funding from the Windows and Glazings Program at the U.S. Department of Energy in support of the Efficient Windows Collaborative. For more information on the Collaborative, contact:

Nils Petermann
Alliance to Save Energy
1850 M Street, NW, Suite 600
Washington, DC 20036
phone: 202-530-2254
email: ewc@ase.org
www.efficientwindows.org

Coming to Grips with Windows and Comfort

Quantifying thermal comfort is a difficult task. The comfort benefits of efficient windows do not lend themselves to being converted into numbers and are therefore often classified among the “non-energy benefits”, separate from the quantifiable BTU and dollar savings. However, this is only an artificial distinction: after all, creating comfort is the very reason why Americans spend over \$80 billion annually on quadrillions of BTUs to heat and cool buildings. Providing comfort with reduced energy use is the real energy benefit of efficient windows.

Albeit a complex subject, the relation between windows and thermal comfort is worth a closer look for anyone involved in building design and the windows market. It’s a high priority for consumers: while the contribution of windows to heating and cooling costs is not always obvious, occupants can directly feel the difference between comfort and discomfort. Heating, ventilating, and air conditioning (HVAC) equipment often cannot provide the desired comfort on its own. Even at adequate air temperatures, discomfort may result from cold drafts, strong solar radiation, and asymmetries in the radiation temperatures to which different body parts are exposed. Windows play an important role regarding these comfort factors.

Quantifying human comfort is difficult, but in-depth research into this subject has made it possible to put the effect of window design options on thermal comfort into perspective. An understanding of these effects can inform design decisions and window selection.

The UC Berkeley Comfort Model

To enable comparisons between windows based on comfort, the Center for the Built Environment at the University of California at Berkeley has recently designed an advanced model for determining winter and summer comfort. The methodology for this model, which is informed by a thorough assessment of previous comfort research, is laid out in the paper *Window Performance for Human Thermal Comfort* by the Center for the Built Environment. This paper summarizes important findings from applying the model to assess the effects of different window configurations on winter and summer comfort.

Winter Comfort

In the winter, window-related comfort is determined primarily by the U-factor, the window area and location, outdoor temperatures, and wind speed.

A few basics of winter comfort:

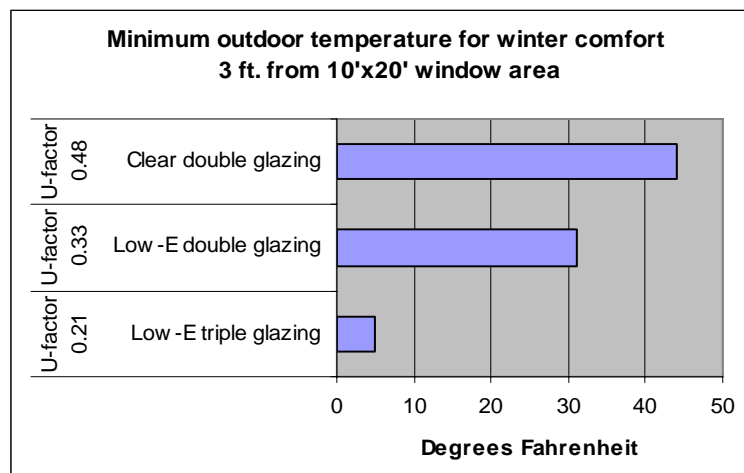
- Cold window surfaces cause discomfort through radiant asymmetry, meaning that occupants experience that those parts of their body facing the windows are colder than the rest of their body.
- Cold window surfaces cool down the air next to the window, causing downward drafts that may result in uncomfortable cold airflows at floor level.

- Windows with low U-factors are more likely to stay warm. The colder the outdoor climate and the larger the window area, the lower the window U-factor needs to be to maintain winter comfort.

In very cold climates and in homes with large window areas, meeting the comfort criteria of the North American comfort standard, ASHRAE Standard 55, may require window U-factors far below those presently used as ENERGY STAR criteria (0.35 in the northern zone). This is illustrated by the minimum exterior temperatures that the UC Berkeley comfort model determines necessary for meeting the ASHRAE comfort criteria at different window U-factors in a given setting. The graphic shows examples from a setting with a person sitting close to a window that spans one whole side of a room. Although in most settings

window areas would be smaller, making it easier to provide comfort at low temperatures, this example clearly shows that low window U-factors are crucial for winter comfort and that in much of the northern U.S., highly-insulating windows provide substantial comfort benefits.

Windows that secure comfort bring an additional advantage: they allow for minimized duct design. Instead of perimeter heating, which is the traditional way of offsetting the effects of cold window surfaces, an alternative heating system with shorter duct runs can be used if windows stay warm throughout the winter. This option not only reduces the initial cost of the duct system, offsetting part of the cost for premium windows, it also reduces losses through duct leakage and thus provides additional energy savings.



*Continued
on page 4...*

Coming to Grips with Windows and Comfort

Continued from page 3

Summer Comfort

In the summer, window-related comfort depends on the solar heat gain coefficient (SHGC) of the windows, their exposure to the sun, and the absorptance of the glass.

A few summer comfort basics:

- Direct radiation from the summer sun almost inevitably causes discomfort. Low-SHGC windows can reduce this problem, but occupants are likely to avoid long exposure by remaining in the shade.
- Windows that heat up from direct and diffuse solar radiation can become significantly warmer than average room temperature and cause discomfort through radiant asymmetry.

- The extent to which windows heat up at a given amount of radiation depends not only on their SHGC but also on their ability to absorb heat. Tinted windows, for example, may have a low SHGC but may easily heat up.

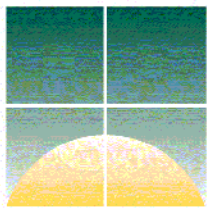
Glazing with a low SHGC and only moderate absorptance, such as spectrally selective low-E windows, are best suited to stay cool in summer, which is a significant comfort benefit. If occupants are directly exposed to the summer sun, however, only an extremely low SHGC, such as provided by electrochromic windows, can secure comfort. Therefore it is recommended to minimize direct solar radiation in the summer through overhangs, blinds, or other shading devices.



More than just a non-energy benefit

Good window design is crucial for occupant comfort in residential and commercial buildings. Air conditioning systems can do little to reduce the discomfort resulting from direct exposure to the summer sun, while heating systems have little control over asymmetric radiation due to differing surface temperatures across a room. The study by UC Berkeley shows that occupants tend to offset discomfort from windows by changing their thermostat settings, resulting in increased heating or cooling loads. Good window design, on the other hand, combining low U-factors, solar control and shading, allows occupants to feel more comfortable at moderate thermostat settings. It also allows designers to reduce equipment cost and duct losses through minimized duct design. In short, window design for comfort provides energy and non-energy benefits.

Efficient Windows



Collaborative

Efficient Windows Collaborative

Alliance to Save Energy

1850 M Street, NW, Suite 600

Washington, DC 20036

www.efficientwindows.org

Do You Have News You'd Like to Share?

We're always interested in reporting on new developments in the residential and commercial fenestration markets. If you have something you would like to share with us please contact Nils Petermann at: ewc@ase.org.

Acknowledgment: "This material is based upon work supported by the Department of Energy, National Energy Technology Laboratory under Award Number DE-FC26-06NT42766."

Disclaimer: "This publication was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."