Robert Bean, R.E.T.
Registered Engineering Technologist
Building Construction Engineering

Coast2Coast Comfort Report

Westside Report

Geoff McDonell, P.Eng., LEED AP
Senior Mechanical Engineer
OMICRON

Healthy HEATING

Comforting Your Mind, Body & *Soles*

Selecting Proper Windows For Your Climate Zone

By Geoff McDonell P.Eng., LEED AP

The most important, yet most neglected building design issue is the window and glass portion of the building envelope. Windows are the biggest influence on the size of the heating and cooling systems, and the indoor comfort for someone sitting next to that window. The key design issues are proper solar gain control and proper thermal transmission performance for the local climate.

High performance windows are the lowest life cycle cost element of a building that can provide the biggest improvements in building energy and comfort performance, bar none. They can provide effective day lighting to reduce the need for electric lights, and can provide higher levels of thermal transmission control to eliminate the differential thermal loads of the perimeter zone versus interior zone of a room.

In a heating dominated climate like most of Canada, the design issues for windows are the orientation (to take advantage of passive solar heating in winter), and thermal performance (to reduce heat losses). In a cooling dominated climate like the Southeast United States, the solar gain control and orientation is the main design issue, with thermal transmission a less critical issue. The thermal performance is critical since that represents the bulk of the heat losses through the glass. It also creates the condition where the interior glass surface can get cold enough to act as a radiant cooling panel, for which MORE energy will be required to overcome.

Solar gain design issues are primarily dealt with by:

a) Orientation and area of windows (house design).
b) Exterior shading elements (trees, awnings, exterior shades).
c) Window films, tints and coatings.

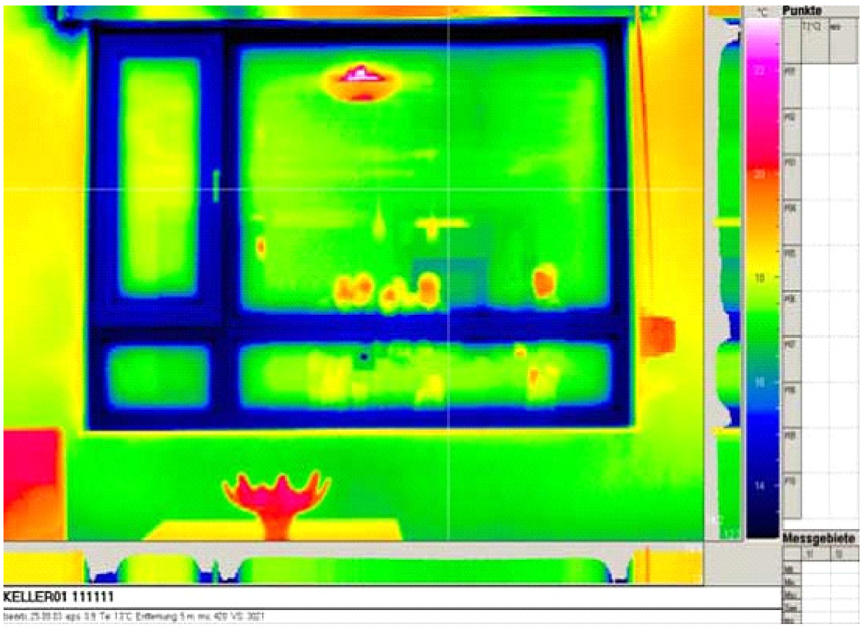
Thermal performance is a glass specification issue:

a) Number of sealed glass panes (double, triple glazed units)
b) Suspended film type glazing units
c) Low-e coatings

While some may see the need for better performing windows to be "limiting" to their desire to maximize views, it really isn't, IF the proper building designs are applied. One can have floor to ceiling glass if they wanted, BUT, the more glass you have, the higher the thermal performance it should be to keep heat losses minimized. And, the more solar gain control it should have, to avoid overheating the room in the summer. That can be achieved with a combination of tints and exterior shading devices (overhangs, louvered shades). Well designed solar shading will allow you to keep out the high summer sun to avoid overheating in the summer, and allow the lower winter sun into the room for passive solar heating when it's colder outside.

Low-e coatings applied to different surfaces of the glass act as a "heat mirror" - in a heating dominated (cold) climate, a low-e coating on the inner piece of a double glazed window will help reflect heat back into the room, and in a cooling dominated (warm) climate, a low-e coating on the inside of the outer glass will reflect heat back outside.

Now the next thing to be aware of is how the glass and window manufacturers calculate and present the performance figures for their products. When you look at a window manufacturers' data sheet, 99% of the time they will list the ratings based on the "centre of glass" performance, which shows the "best" ideal performance of the glass. The reality is that the "overall" window performance figures are what we really need to see for the actual installed performance. The "overall" window performance includes the edge losses from the framing system, thermal bridging at the framing system and sub-frames, and base-lined climate and measurement conditions. This "overall performance" can be in the range of 10% to 25% worse than the "centre of glass" figures published in the catalogue data. This can be a significant discrepancy in colder climates. [See graphic 1]



Graphic courtesy of Prof. Bruno Keller

A thermographic scan of a window- note the edge conditions and how the perimeter of the window is affected by the framing. You can see that the centre of the glass is uniform, but loses thermal performance the closer you get to the frame edge. Adding in the performance degradation from the edge losses will provide a true picture of the "overall" window performance.

Fortunately there is a way to find out what the "overall" performance will be for a particular glass and framing combination. A free software package is available from Lawrence Berkeley Labs called "Window 5.2" which will model and calculate the "overall" performance of a window system against established National Fenestration Rating Council standards. See the references below for a weblink to that program.

The installation of a high performance window is the last essential thing to get right. I have seen examples of high performance triple glazing installations with very nice thermally broken frames get installed such that the inside frame is connected to the outer cold wall, resulting in severe thermal bridging, completely negating any benefit from the thermally broken framing. The net result is that

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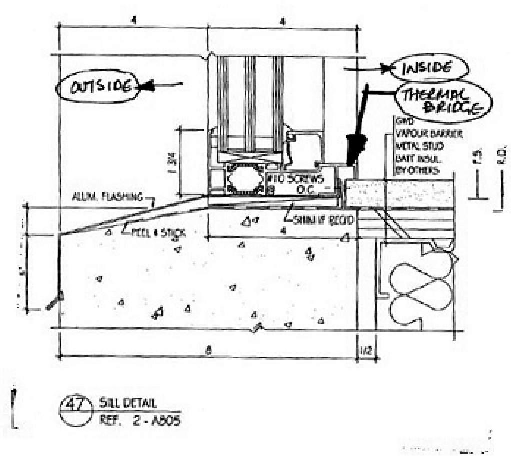
the high performance triple glazed window performed no better than a conventional double glazed window. A lot of $$ paid for nothing, due to poor detailing and installation practices.

The key is paying more money for better windows, so you can save money on the heating, cooling and electrical equipment in the house at the installation stage, and keep on saving energy $$ for the life of the building. Smart mechanical HVAC designers know how to design for windows and orientation first, then size the central equipment second.



An example of a window installation detail which defeats the performance of the triple glazed thermally broken frame window unit. The thermal bridging effectively degrades the triple glazed window and frame performance to the equivalent of double glazing with a solid aluminum frame.

REFERENCES:

1.Weblink: http://www.wbdg.org/design/windows.php
2.Weblink: http://lightingdesignlab.com/articles/glazing/glazing.htm
3.Weblink: http://www.umass.edu/bmatwt/publications/articles/windows_understanding_energy_efficient_performance.html
4.Weblink for Window 5.2 Free Software: http://windows.lbl.gov/software/window/window.html
5.Weblink: http://www.efficientwindows.org/