Cardinal®
Glass Industries Inc.

November 14, 2008

Richard H. Karney, P.E.
ENERGY STAR® Program Manager
Department of Energy
Washington, DC 20585

RE: Proposed Revisions to ENERGY STAR® Program Requirements

Dear Mr. Karney:

Cardinal Glass Industries appreciates the opportunity to provide additional comments and suggestions related to the most recent proposed revisions to the ENERGY STAR® Program for fenestration products as presented in the Windows, Doors, and Skylights Draft Criteria and Analysis, dated August 6 2008.

Cardinal has a complete line of energy efficient glass products to meet the new program requirements. We are one of the largest low-E glass manufacturer's in the world - our portfolio of coatings covers the spectrum from high to medium to low solar gain. As our primary business emphasis is in residential windows we've tuned the spectral selectivity of our low-E products for high visible light transmission, but if you require glare control we've got options for that segment of the market as well.

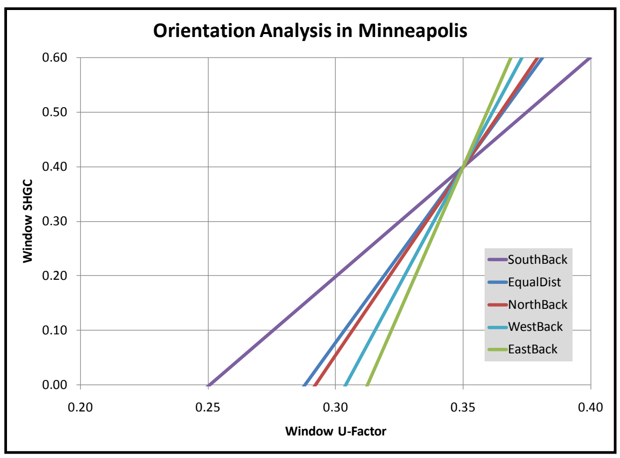
Our insulating glass products have been certified for seal durability going back more than 30 years and we support the department's position to require 3rd party testing for IG used in ENERGY STAR® windows. Cardinal's customers have premium brand names, and we could not have grown to be the largest fabricator of IGU's in North America without demonstrating our long-term viability.

Cardinal has participated in the Window and Door Manufacturer's Association (WDMA) review of these proposed revisions to ENERGY STAR® program requirements and we support the commentary provided by the association. As a voluntary program, it's crucial that the ENERGY STAR® window (door and skylight) program be pertinent to today's marketplace and achieve the highest possible penetration rates. Given the uncertainty of current economic conditions the program is only valuable when it can transform the purchasing decisions of builders and homeowners.

775 Prairie Center Drive
Eden Prairie MN 55344
www.cardinalcorp.com
952.935.1722
952.935.5538 facsimile

The bulk the comments to follow relate to technical questions on the modeling protocols and the analysis procedures applied to the simulation results.

Section 404 of the IECC sets the requirements for the performance path analysis of a building. Related to window distribution, the "budget" house has equal glazing on all 4 sides and the actual house is modeled "as designed". Most houses are asymmetric – the backside tends to have large window areas, the ends have small windows and are adjacent to other buildings, while the front is somewhat limited due to the garage and entryway. The plot below was developed using Resfen5 for a 2-story new house; it shows how the source energy balance changes with building orientation. The slope of the lines' describes the trade-off concepts introduced for the northern region criteria. Which orientation is chosen as the baseline model changes the magnitude of the trade-off.



Is the presumption that "equal distribution" represents the average of all orientations reasonable? In the winter, Btu's gained on the south side of one building can't jump across the street to average out the heat losses for a building with little solar exposure. In the summer a symmetrical building doesn't have the raw exposure that a heavily glazed western face experiences. The Building America Research Benchmark (http://www.nrel.gov/docs/fy08osti/42662.pdf) models the real building proportions and then rotates the model through 90 degree increments. I think we need some similar error analysis to understand if equal distribution can accurately reflect an average of the real world building population.

The questions raised above apply only to single family detached houses. It's unlikely that program requirements are applicable to other housing types such as multi-family and/or high rise residential buildings. Disclaimers need to be issued to avoid misuse of the criteria.

The thermostat settings used by ENERGY STAR® are not consistent with the IECC or data published in RECS. As an example, IECC doesn't show any thermostat setback, RECS suggests that only 23% of residences use a setback thermostat, and ENERGY STAR® presumes that all homeowners utilize a 5°F night setback. The setpoint differences are tabulated below. The lower cooling setpoints from RECS and the 2009 IECC have the potential to significantly alter the slope of the trade-off lines in the north (bias towards less solar benefit).

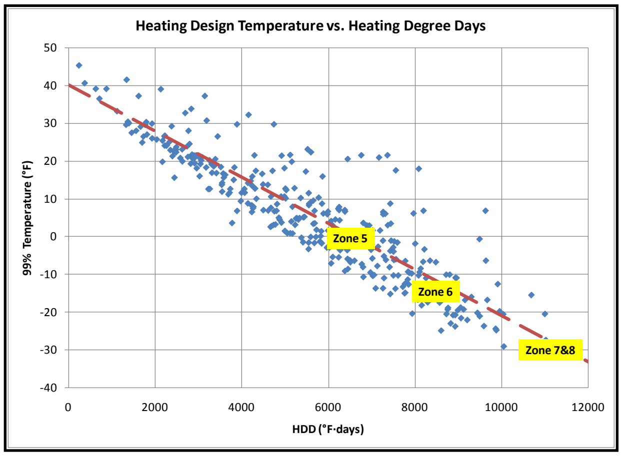
	IECC 2006	IECC 2009	RECS 2005 (occupied)	ENERGY STAR®
Heating Setpoint	68°F	72°F	70°F	70°F
Cooling Setpoint	78°F	75°F	74°F	78°F

ENERGY STAR® models usage of interior shading devices as 2/3 open in winter and 2/3 closed in summer. This protocol describes the best possible occupant response to allow passive solar gains in the winter and block excessive heat in the summer (it's likely that more energy could be saved if we could incent this behavioral response as opposed to window replacements!). With thermostat settings and shade usage patterns as a "best case" for passive solar design, the analysis for zone ES3 (IECC 4) has determined that solar heat gain control is needed. I submit that the requirements of a maximum SHGC in ES3 should be considered a solid result. Likely deviations in usage patterns would create an even lower SHGC limit for this region.

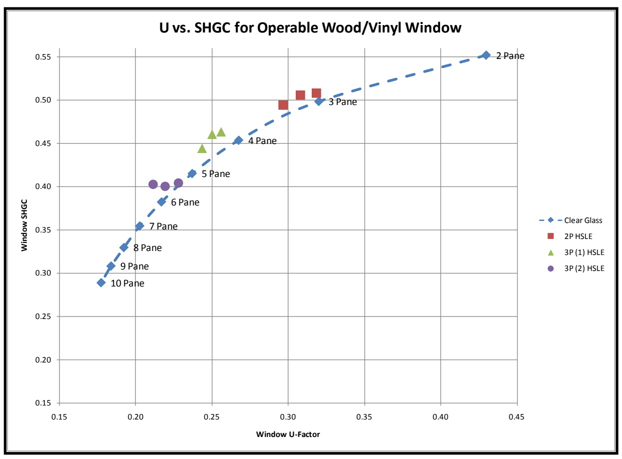
In ES4/ES5 (IECC 5-8) the slope of the line changes to where high solar gains can be used to offset heat losses and provide a positive benefit. The challenge here is to select realistic conditions. For example, at northern latitudes (40°+) sunrise in the winter will be at 7-8 am while sunrise in the summer will be around 5-6 am. Is it realistic to expect homeowners will open the blinds to the dark and cold winter morning and then close them to the bright and warm summer morning? I suggest that ENERGY STAR® model the reverse usage pattern (closed in winter, open in summer) to understand how the trade-off slopes change.

The cover story in the June2008 ASHRAE Journal is titled "Don't Manage Energy at the Expense of Comfort". Phase 2 criteria for the north violates this suggestion by allowing trade-offs to higher U-Factors in ES5 than in ES4. The broad range grouping in ES5 (all climates with HDD>7200 °F·day) gives heating design temperatures of -30°F while ES4 is around 0°F (see plot on next page).

Using the comfort routines from the Efficient Windows Collaborative (see http://www.efficientwindows.org/comfort.cfm) ES4 should have a maximum U-Factor of 0.32 while ES5 needs to max out around 0.25. Trade-offs from these hard points can be allowed to lower U-Factors so as to maintain comfort.



As U-Factors are lowered, the extra glass layers and/or low-E coatings added to the structure will reduce the maximum solar gain of the window. The chart below shows that high solar gain low-E coatings (3 variants modeled) can displace layers of clear glass, but it's difficult to get above the basic profile shown.



(chart developed using Window 6)

The published phase 2 criteria show ES4/ES5 trade-offs starting at SHGC=0.55 with U-Factors less 0.28. The only products that can reach that are fixed windows with narrow frame profiles.

For ES5 to fit the comfort mantra, the trade-off point should be around U=0.25 and SHGC=0.35 with a sloped line down and to the left that fits a revised orientation/thermostat/shade usage analysis. Note that SHGC values greater than 0.35 can be allowed but that U shouldn't drift to the right.

If the analysis for ES4 suggests a U-Factor of 0.30 or less it looks like the inflection point will be around an SHGGC of 0.40.

Using the regression formulas provided, the ENERGY STAR® suggested maximum SHGC of 0.55 for zones ES4 and ES5 is appropriate. Source energy savings with a U-Factor of 0.35 are maximized with SHGC ~ 0.50. If phase 2 drops the U-Factor to 0.25 that SHGC plateau is reached around 0.45. The message here is that once the maximum energy savings has been achieved, additional solar gain is a risk for thermal discomfort throughout the year.

Did the analysis use TMY2 or TMY3 data? I initially used TMY3 heating degree day summaries and found a number of IECC 5 cities that would drop into zone 4.

The ENERGY STAR® program has undergone three zone definition changes since 2002. Starting with the old North/Central/South, moving to N/NC/SC/S, and finally now to a five zone model. Instead of requiring a translator to explain that ES2 = IECC3, ES4= IECC 5, and so on, can't we simply call them for what they are? Let's label the zones as IECC 1-2, IECC 3, IECC 4, IECC 5, and IECC 6-8. If we change the groupings in the future, we change the titles and show precisely what IECC zones are involved. Seems like a win for everyone if more people are familiar with and understood the requirements of the model code.

Lastly, the quality of the background data provided to reviewers is poor. Many of the spreadsheets have incomplete data. Most of them don't include the math formulas. For example, the spreadsheet Model 44 Results doesn't show the RECS "calibration", the trade-off summary, or how the penetration rates are calculated. There are instances where the slope of the trade-off line changes direction with calibration (by the way – RECS calibration is NOT part of the model code procedures). Reverse engineering the regression coefficients from the Output Data spreadsheet gives different results from the Regression Expressions. Most troubling is the scatter in the regional trade-off ratios within the Regression Expressions spreadsheet. For the trade-off to work across multiple zone groupings it should present similar results in narrow geographic regions; Denver and Grand Junction vary by a factor of 10. From reviews I've done of the Canadian Energy Rating System, I'm concerned that these northern trade-offs don't correlate well to the traditional measure of climate using heating degree days.

Regards,

Jim Larsen

Jim Larsen
Director, Technology Marketing