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Comments Regarding:

**U.S. Department of Energy - ENERGY STAR Program
Windows, Doors, and Skylights
Draft Criteria and Analysis dated August 6, 2008**

Issued November 5, 2008

On August 13, at the Department of Energy building auditorium, VELUX offered several preliminary comments at the Stakeholder Meeting DOE held to take initial feedback on the above document. At that time, we stated our intent to make further comment after analysis and review of the details mainly related to the "skylight"-focused elements of the report. This document contains those additional comments, most of which expand on the concepts introduced in our five-minute presentation.

We would first like to acknowledge that DOE and its assisting organizations deserve praise for the open and considerate process under which the effort to modify the qualifying criteria have been conducted. We also recognize that window issues have far greater impact on aggregate energy use in buildings than roof windows/skylights/TDDs do, and deserve a rigorous review process that generally saps the time and personnel resources that might be helpful in deepening your understanding of the unique issues presented by the toplighting segment. In the spirit of filling some of the resulting "resource gap", we offer our insight to all involved in the following statements. We also remain committed to providing further assistance as appropriate, as we have since the input process started over a year ago.

In addition to these comments filed on behalf of VELUX, we are an active participant in the groups at both AAMA and WDMA that are formulating separate comments from the overall industry perspective. We generally support their efforts to help make the final fenestration product criteria truly effective as energy savers, and encourage acceptance of the following specific items from our understanding of their main concerns:

- Fewer zones, the boundaries of which should be climate-driven and not politically-driven or "code-driven".
- Simpler criteria that yield comparable (or better) estimated savings to those previously proposed.
- Serious consideration of ways the program could facilitate and accelerate the replacement of grossly inefficient existing products, beyond minimal tax policy, with excellent products that yield the bulk of the benefits "New Construction" criteria would bring if they were more affordable.

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- It is time to recognize that glazed fenestration saves significant lighting energy that should be considered by DOE to offset some of the “energy penalty” a hole in the envelope creates (especially a hole in the roof). This is becoming an imperative as pressure to reduce SHGC maximums threatens to greatly reduce the number of available products that can transmit sufficient light to allow electric lights to be switched off in average daylight conditions.
- While the goal of achieving criteria that is “better-than-code” is admirable, please recognize that there are many jurisdictions where energy codes are either not the most current, are not widely enforced, or are non-existent. In such regions a jump to very aggressive criteria may again work against the use of “better” products where the “best” products are either not common or are just too expensive to find wide usage or acceptance.
- A longer interval of time should elapse before the criteria are changed again, barring breakthroughs of technology that allow for rapid implementation of more energy-efficient products.

Now, back to “skylights”...

1. Accounting for effective free light (and ventilation, as appropriate):

- a. Relative to vertical fenestration, toplighting as provided by roof windows/skylights is much more efficacious. It is more intense; it reaches further into the occupied areas of the room; and it is controllable through shading. We recently sent to D&R (c/o Alice Dasek) a publicly available study report (in two phases) that vividly shows the magnitude of the difference. We believe the striking conclusions from this study will support our contention that lighting savings from the use of skylights (and TDD’s) merit significant credit in any thorough criteria analysis. (Double-click on a box to open)



These reports indicate the following:

- Three identically-built fenestration options were tested in a “standard” test room; vertical window, dormer window, and roof window/skylight
- “Radiance” was used to assess lighting performance
- Several daylight “quality” measures were evaluated;
 - Horizontal illuminance and daylight factor

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- Cylindrical illuminance, center of room, horizontal and vertical plan
 - Illuminance on cube, center of room
 - Vertical-to-horizontal illuminance
 - Luminance distribution
 - Luminance ratios, perspective view towards window
 - Average luminance in the field of view, 40° band
 - Daylight Glare Index (DGI)
 - Luminance Difference Index (LD index)
 - Scale of shadow
- Other assessments covered:
 - Need for shading devices
 - Effect on lighting conditions of two low-e coatings in a three-layer glazing unit, as compared to one low-e coating in a typical two-layer low energy glazing unit

Key Results:

- At solar altitudes less than 25° (sunny conditions), the roof window/skylight provided significantly more light 0.7m above the floor – double the daylight factor of the window and triple that of the dormer window. Therefore, many fewer square feet of “holes in the envelope” are needed to achieve equivalent light efficacy, yielding additional heating and cooling energy savings when daylighting is the design driver.
 - The roof window/skylight is the only option providing over 5% daylight factor for a substantial portion (15%) of the occupied room area.
 - Daylight Glare Index calculations revealed that glare from the roof window/skylight option was the smallest.
 - The roof window/skylight exhibited a wider range of daylight factors, providing desirable “visual interest”.
- b. We also sent Ms. Dasek another publicly available study report that looks at how a measure could be developed that would be important to a robust energy savings analysis. (Double-click on box to open)

Climate-Based Daylight Analysis
for Residential Buildings

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Features of this study:

- Considered two residence types, several combinations of window arrangement and external obstructions, all at eight different building orientations and six climate zones (three in North America). A total of 480 unique daylight simulations were thus analyzed.
- Focused on the concept of “Useful Daylight Illuminance” (UDI), founded on human factors data
- Results were presented both graphically and in tabular form, so inferences about their sensitivity to all variable types
- Daylight factor and climate-based UDI results correlate negatively in some cases, and poorly in many others
- The more skylights added to a given scenario, the higher the occurrence of preferable UDI-a (the type that allows artificial lighting to be switched off)
- Daylight factor is not a good predictor of actual annual performance due to its insensitivity to climate and building orientation

The last paragraph sums it up well:

“A wealth of insightful data on the daylighting performance of residential buildings with and without skylights has been generated, plotted, reduced and analysed. The daylighting performance has been analyzed using the recently formulated useful daylight illuminance scheme. The UDI scheme has shown itself to be a powerful tool to aid the reduction and interpretation of the voluminous amount of data generated by this parametric study. The important features of the results have been noted and the improvement in performance from the addition of skylights quantified.”

- c. We suggest that in order to capture the lighting energy savings, qualifying criteria should be checked against the effect on visible transmittance. Values proposed for skylights make it imperative that a firm floor be established, using energy-optimized light-to-solar gain ratio(s), for example.
- d. TDD’s should definitely NOT be excluded from qualification, especially in Phase 1.

It has been suggested that TDD’s be lumped in with skylights as to qualifying criteria, but we respectfully disagree. While many of the TDD products currently shown on NFRC’s CPD would generally meet current skylight criteria, new data shows that is likely to change as

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they recertify and become subject to the new "test-only" procedure NFRC has established for these products.

Our earlier recommendation for TDD's is even more apropos given this emerging data - all TDD's should be considered qualified (if a dual diffuser at ceiling level is used, and the air leakage and durability requirements contained in the skylight labeling provisions of the 2003 and 2006 IRC and IBC are met) based on the following facts:

- i. They are often used where no other fenestration product is feasible. (Many green building programs even award points in such instances.)
 - ii. They are effectively "ENERGY STAR Lighting" qualified, as they require no wattage to operate.
 - iii. They are merely 1.1 square foot or less in area for typical residential installations (at 14 inches in diameter or less), so the actual Btu loss per unit is quite small even for U-factors above current qualifying criteria. (Given their high light transmittance this is a reasonable trade-off.)
- e. NFRC is actively developing ratings for shading products that also significantly change whole-product thermal performance. The announcement of criteria to be implemented years from now that do not account for these developing "ratable" product combinations seems premature.

2. Characterizing and Accounting for "the Skylight Market":

- a. The analysis of NFRC's CPD for skylights needs to be updated. Using the listings available as of August 1, 2008, we constructed a spreadsheet that has also recently been provided to Ms. Dasek. It contains all CPD "skylight" entries, even those that do not meet the DOE or the ICC definitions of skylights and TDD's, and is enhanced by the addition of descriptive columns and extensive filtering capability. In reviewing its contents with Ms. Dasek, we made several suggestions for condensing the data table so that it accurately lists skylight options that truly fit the unit skylight definitions. Some of the suggestions were:
 - Analyze TDD's separately from the skylight analysis
 - Filter out products offered only on captive projects (e.g. Four Seasons)
 - Filter out all validation listings, as they do not represent a product

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- Filter out all products with a Vt of zero
 - Filter out products intended for the commercial building segment (translucent sandwiched roof panels, monumental sloped glazing assemblies / Kalwall, Major, etc.)
 - Filter out dynamic-glazed listings (technology is not ready for large scale adoption)
 - Consider the exclusion of very low Vt listings for the reasons stated elsewhere in these comments
- b. After a general review of the CPD data condensed as described above and the websites of some of the manufacturers with large numbers of entries, we noted several issues that warrant a deeper investigation into the presumed availability of the products listed:
- i. A preponderance of listings comes from a handful of manufacturers that are regional suppliers. To blindly count all such listings as being available nationally may not be appropriate, if:
 - A manufacturer does not have (and is unlikely to develop) the infrastructure to manufacture and/or distribute the demand that new criteria may engender in all ENERGY STAR zones, contrary to previous assumptions
 - A manufacturer has many “theoretical” products simulated, but may have low to zero volume of sales for these listings
 - A manufacturer lists products that are not even available for sale through that manufacturer (Empire Pacific, for example)
 - ii. It appears that criteria previously announced for Phase 2 were based on many listed product types that are rarely, if ever, used in residential construction.
 - iii. We are convinced that criteria previously announced for Phase 2 exceed the capabilities of glazing that will be commercially feasible during the intervening years.
 - iv. A quick analysis of filtered CPD listings indicates that no more than 10% of the residential unit skylight listings can meet the criteria previously announced for Phase 2 for any of the proposed ES climate zones.

NOTE: These last three points explain why we have concluded that the Phase 2 criteria proposal is totally inappropriate and is unacceptable to us.

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- v. We believe it would be instructive to do a separate analysis of the CPD residential unit skylight listings that are shown to be in the curb mount family. This family is most prevalent in the existing installed skylight base, and plays a crucial role in the economical replacement of highly inefficient existing units.
- c. The 2009 IRC will contain significantly different prescriptive U-Factor and SHGC minimums than the 2009 IECC. We encourage DOE to focus on the IRC limits when comparing their proposed criteria to “code”, especially for skylights, since they are usually a much more discretionary choice in selecting livability enhancements for homes. The proven non-energy benefits of daylighting to occupant well-being should be considered, as should the different influences and limited options available in residential construction, which the ICC seemed to recognize in setting the IRC values.

3. Economic Justification:

- a. Any incremental cost analyses and cost savings calculations should factor in all the above comments. In addition, they need to: 1) include an assessment of price elasticity for buying and installing skylights, recognizing that the decision to install or replace is highly discretionary; 2) recognize the unique skylight market characteristics; and 3) account for the significant costs of converting regional manufacturers to national ones should the final proposed criteria assume that would be needed. Otherwise, no economic analyses could be considered realistic.
- b. DOE should take care not to set future qualifying criteria at levels that might cause significantly less use of this most efficient segment of natural light sources. The significant incremental costs required to supply qualifying products threaten to remove skylights and TDD’s from consideration on more projects.
- c. Based on the comment at 2.b.iv., major investments in technology will be needed in order for the DOE-targeted 25% of skylights to qualify. These technology investments do not appear to be reflected in the cost projections used.

4. Miscellaneous

- We have not yet seen an erratum that acknowledges the error for Phase 1 Skylight U-Factor in ES1. (0.55 should have been shown as 0.65 – compare page B-15 to page 57, and compare Phase 1 to Phase 2 on page 57)

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- Savings for doors are stated to warrant a review in 2011. We believe there is even more justification to apply that to skylights and TDD's, prior to the implementation of any Phase 2 criteria, based on all the above.

VELUX continues to recommend the skylight-only (not TDD's) criteria values submitted to DOE in our May 9, 2008 letter to Steve Bickel (2015 values subject to further adjustment based on better market analysis):

ENERGY STAR ZONE	MAX. U-FACTOR (@ 20°)		MAX. SHGC	
	2010	2015	2010	2015
Canada D	0.38	0.35	nr	nr
Canada C	0.42	0.38	nr	nr
Canada B	0.46	0.42	nr	nr
Canada A	0.50	0.46	nr	nr
5	0.50	0.46	nr	nr
4	0.55	0.50	0.40	0.35
3	0.55	0.55	0.35	0.32
2	0.57	0.55	0.32	0.30
1	0.65	0.60-0.65	0.30	0.27

We realize that fine tuning to account for final zones and economic studies may be needed in order to address all skylight ENERGY STAR Partner concerns, and we look forward to participating in a dialogue on these issues at the appropriate time.

We also offer to work further with Ms. Dasek as she evaluates the new CPD data, and assesses the validity and impact of our comments.

Thank you again for the opportunity to share our insights and concerns.