

# AEP Subcommittee Meeting

NFRC Spring Meeting

Austin, TX

March 6, 2007

# Commercial Buildings AEP Task Group

- Proposed Scope:
  - “Evaluate the feasibility of calculating fenestration annual energy performance in commercial buildings, and make recommendations about an appropriate calculation methodology to the AEP subcommittee.”
- Members:
  - Mahabir Bhandari (chair)
  - Steve Selkowitz or LBNL representative
  - Tom Culp
  - Chris Mathis
  - Who else?

## **NFRC 901**

*“Guidelines to Estimate Fenestration Heating and Cooling Energy Performance in Single Family Residences”*

Ballot results:

6 Approve

2 Approve with Comment

8 Do Not Approve

10 Abstain

# Andersen Negative

- I continue to question the need for these AEP Guidelines within NFRC. Sophisticated home energy evaluation and rating programs already exist that can address fenestration energy performance in relation to whole house energy usage using customer specific information.
- I also question the validity and value of the output of these AEP guidelines for the consumer, given all of the input assumptions and ranges of values.
- The document does a pretty good job of establishing the boundary conditions affecting fenestration energy performance; and therefore I suggest we rename the document “Guidelines for Energy Analysts to Use When Seeking to Estimate Fenestration Heating and Cooling Energy Consumption in Single Family Residences”

# Simonton Negative - Item #2

- Whole document – leave reference house unchanged and uncomplicated. Document is meant to be a comparison of window A to window B. Detailed white paper by LBNL showed that existing assumptions were still valid.

Three related negative comments expressing concern about the **range of operating parameters** and requesting **example calculations**:

- LBNL
- Roetzel & Andress
- Birch Point Consulting

# LBNL Negative - Item #1

- There need to be assumptions for typical operating use, not just extremes.
- An uncertainty range around the typical case would be much more useful than best/worst.
- Some examples of best/worst data need to be presented to see if there will be any meaning from the proposed results.
- There needs to be an explanation of what this best/worst approach is getting at ... why show results for the extreme folks at the 1% level and the 99% level? Why not focus on the typical, median, range of operating conditions? Why are operating conditions allowed to be varied but not construction characteristics?

# Roetzel & Andress Negative - Item #4-5

This draft of 901 proposes to increase the range of heating set-points from a low of 68 and a high of 72, or a 4° difference, to a low of 68 and a high of 75, or a 7° difference. This represents nearly a **100% increase** in the range of thermostat settings. While a large range might be acceptable in the specific house, such a large range in the reference house is not only unrealistic but will dilute beyond recognition and useful comparisons of products using these guidelines, thus, leaving the consumer will no useful information from which to make an intelligent choice.

The enlargement of cooling setpoints is an equally dramatic **100% increase**. It goes from a low cooling of 78 to a high cooling of 75, or a 3° difference, to a low cooling of 78 to a high cooling of 72, or a 6° difference. The breadth of this range, likewise, dilutes the guideline to a point that it will not usefully differentiate between any products, thus, leaving the consumer will no useful information from which to make an intelligent choice.

No data substantiates these ranges. In fact, they are counterintuitive. For example, in what home would anyone set the highest heat setpoint at 75, but the highest cooling setpoint to only 72? Would the same person likely be comfortable at 75 if the heat is on, but equally comfortable at 72 if the air conditioner is on? The range and the high numbers in this draft make no sense.

Perhaps, the selection of this range should be deferred until some real runs of energy usage using the numbers proposed for the reference home can be run by LBNL.

# Birch Point Negative – Item #2

- I am concerned about the broad range of some of the operational parameters. While I do support the concept of using a range, I am worried that the ranges of the temperature setpoints on both the heating and cooling sides are so broad that the results may become meaningless. Having a range so broad that it captures 95% of all behavior but gives a meaningless result is not the intent of this document. This is a concern the subcommittee should investigate and keep in mind as this document moves forward.

# BBRS Negative - Items #2,6

Only have reference house for new construction, not existing construction:

**Revise** Table 1, - Reference House – delete all references to “Existing Construction” and “New Construction” and use one Reference House consisting of the defaults for New Construction. Add a note that specifically directs users who want to apply the guidelines to existing construction to use the Specific House option.

**Revise** Section 7.2.2 Construction Type with language on next slide.

*Reasoning:* The Subcommittee voted at a previous meeting that limiting the guidelines for use only with new construction was unacceptable and that we needed to permit application to existing construction as well. However, this still leaves open the question whether to have a separate Reference House for each housing type (new v. existing). The trouble with establishing an existing construction Reference House is that with existing housing stock ranging from a few years old to a hundred years old, it is simply impossible to specify a reasonable reference house (insulation levels, HVAC system efficiencies, etc. all vary widely). The best workaround for this problem would be to have one Reference House – based on a new construction, but not designated as new construction – and notes that encourage the user to use the Specific House option for existing construction.

# BBRS Negative - Items #2,6 cont.

**Revise** Section 7.2.2 Construction Type:

*Replace:*

“Choose between New or Existing. The New home choice is intended to represent homes that are insulated in accordance with recent energy codes, and that use HVAC equipment with current efficiency levels. The Existing home choice is intended to represent homes with no or minimal insulation, and with less efficient HVAC equipment.”

*with*

“The Reference House is primarily designed around parameters reflecting expected new house characteristics (e.g., updated insulation levels, HVAC efficiencies, etc.) Due to the difficulties in generalizing about existing housing stock, these guidelines do not specify an existing construction Reference House. Users who wish to use these guidelines for existing construction are directed to the Specific House option, where the user can input specific house characteristics for the specific existing construction being considered.”

# Pilkington Negative - Items #1,2

- 1) The intent of this document is not to estimate fenestration heating and cooling energy consumption. I recommend the following change to the title of this document.

“Guidelines to Estimate [the Impact of Fenestration Products on the Annual](#) Heating and Cooling Energy Consumption in Single Family Residences”

- 2) Replace the following phrase throughout this document (many locations):

*Old language:* ‘fenestration heating and cooling energy consumption’

*New language:* ‘[the impact of fenestration products on the annual](#) heating and cooling energy consumption’

Note: IWFA has similar approve-with-comment to use  
“Guidelines to Estimate [the Effects of Fenestration on](#) ...”

# Pilkington Negative – Item #3

- 3) Add the following to the end of the last sentence within the Foreword and the last sentence within section 9.2.2:

Old language: “Users should be cautioned that estimated energy consumption is only one of many parameters that should be considered in selecting a fenestration product. For example, this estimated energy consumption analysis does not factor in issues such as comfort, durability, visible light transmission and condensation.”

New language: ... durability, visible light transmission, condensation [and fenestration costs](#).

## Two related negatives about source energy

- Simonton
- Roetzel & Andress

# Simonton Negative - Item #1

- Section 9.1: Don't use source energy. Confusing. Testimony at IECC by "Edison" about its inappropriate application.

# Roetzel & Andress Negative - Item #1

This is a guideline intended for consumers, not scientists. The title of 901 says that this is a guide to estimate “Energy Consumption” in “Single Family Residences.” Those single family residences are the “site” of the energy consumption. The consumers using this guide only care about how much energy used at that site will cost them and they don’t care at all about the cost of that energy at its source or how much losses occur in different forms of energy from source to site. This document should be written for the consumers that will be using it, not to satisfy a scientist’s need for accuracy.

This standard is intended to provide more of an apples-to-apples comparison, than a scientifically accurate computation. While using source energy would add accuracy, it adds little or nothing to assist the consumer in making an apples-to-apples comparison.

Source energy is often used when heating and cooling are added to determine total energy use. This guideline does not add heating and cooling.

The IECC currently uses site energy or cost in comparing standard and proposed designs. See, IECC § 404.3. A proposal to change IECC from site/cost to source was rejected by the IECC Committee in its current development cycle.

The use of a 3.1 electric multiplier and a 1.1 multiplier for all other forms of energy is not accurate. A 3.1 inaccurately magnifies electric energy and a 1.1 for all other fuels inaccurately minimizes the losses experienced by all other energy forms. This skews energy consumption by providing higher than accurate cooling loads and lower than accurate heating loads.

At the IECC code hearings in this cycle, a proposal was submitted to use this same 3.1 multiplier for electricity. A representative from the Edison Institute testified at the hearing that this number was completely inaccurate. The IECC Committee rejected the proposed change based in part on the fact that testimony.

It is also well known that significant natural and propane gas losses and other inefficiencies occur not only at the well-head, but throughout the distribution systems. A 1.1 multiplier represents a significant underestimation and is not based on science or intuition.

Two related negative comments about fenestration distribution in the reference house:

- Birch Point Consulting
- Roetzel & Andress

# Birch Point Negative – Item #1

## **Fenestration distribution for the reference house**

In Section 7.2.4 and Table 1, restore the previous language about fenestration distribution for the reference house (equal distribution on all four sides, rather than inputting specific area for each orientation).

The intent has always been to have a reference house with a minimal number of inputs. This is so the consumer can perform a simple and basic fenestration product comparison without requiring detailed information on the house construction, and/or the window manufacturer can provide general guidance without specific knowledge of the home. If they want to understand the impact for the specific orientation / distribution of their home, they can use the specific house case.

Equal distribution is also consistent with the IECC reference house.

# Roetzel & Andress Negative - Item #2

## **Table 1 – Parameter – Fenestration Area & Distribution.**

Distribution should remain equally distributed on all four sides.

This draft calls upon consumers to input a “percentage area for each cardinal orientation” for both the reference house and the specific house. This makes absolutely no sense. It makes the “standard house” the specific house and vice versa. The underlying principal of 901 is to differentiate between the standard house and the specific house.

This would actually require the consumer to measure or estimate window to wall ratios in order to complete a computation based on the reference house. That defeats the purpose of having a reference house.

The IECC uses equal distribution on all four sides of the reference house.

Fenestration distribution is so varied among houses, the only logical thing to do from an overall standpoint is to say that on average, the standard or reference house should have equal fenestration distribution on all four sides.

# Roetzel & Andress Negative - Item #3

## **Table 1 – Parameter – External Shading.**

Changing this to none is completely unrealistic. Over the life of the windows in a residential building, where are there no overhangs, bushes, trees or buildings that cause shading? There are none.

# BBRS Negative – Item #1

## Revise Forward:

These guidelines make use of building energy software to model a hypothetical home under a set of specific assumptions. The combination of simplifying assumptions used in this procedure **may will** not give results exactly consistent with a particular home. Recognizing that homeowner behavior can vary, this procedure provides results over a range of certain operational variables, such as thermostat settings and seasonal use of internal blinds. However, other factors such as year-to-year variations in weather and differences between the assumed and actual housing characteristics will impact actual energy consumption and the role that fenestration products play in the building performance.

*Reasoning:* These guidelines do not estimate all aspects of fenestration performance; at best, they provide an estimate of annual and peak energy consumption. Use of the word “may” suggests that the procedure could give results “exactly consistent” with a particular home, resulting in misleading the user. Since this is not true, the word should be changed to “will.”

# BBRS Negative – Item #3

## Revise Section 7.3.15, Utility Costs:

As an option, the user may input local utility costs to estimate energy costs associated with fenestration heating and cooling energy consumption. Recent local utility costs should be used whenever possible, but users should also consider the expected escalation in such costs over the expected life of the fenestration products. *Delete:* [If this data is not available, average cost data is available from the US DOE Energy Information Agency ([www.eia.doe.gov](http://www.eia.doe.gov)):

**Electricity:** [http://www.eia.doe.gov/cneaf/electricity/epm/table5\\_6\\_b.html](http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html)

**Natural gas:** [http://www.eia.doe.gov/pub/oil\\_gas/natural\\_gas/data\\_publications/natural\\_gas\\_monthly/current/pdf/table\\_21.pdf](http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_monthly/current/pdf/table_21.pdf)

Users should also be cautious that cost estimates for different types of energy can be highly volatile. and use of current prices can produce misleading results. Since the relationship between heating and cooling costs using different fuels (e.g., use of electricity for cooling and gas for heating) may change substantially over time, users should not combine heating and cooling energy costs.

# BBRS Negative – Item #3 cont.

*Reasoning:* As discussed at a previous subcommittee meeting, calculating utility costs for alternative fenestration choices is problematic at best. The subcommittee chose to keep utility costs as an option only for the specific house option and using local energy costs input by the user.

Referencing the EIA data is not a reasonable approach. The EIA data is historical, short-term data, typically representing a state average, and often changing remarkably over time (natural gas prices are particularly highly volatile, and can change by more than 100% in one year, depending on weather and world events). EIA data is typically not sufficiently specific to give accurate results; moreover, since the fenestration will save future energy costs over many years, using a short-term historical price snapshot is unreasonable.

Ideally, any cost comparison should use costs that will be in effect for the life of the fenestration (10 to 30 year future energy costs), since those are the costs that will be affected by the choice of fenestration. Unfortunately, such future energy costs are unknown. Moreover, gas heating costs tend to be far more volatile than electric cooling rates and such swings are often not in sync. For these reasons, as well as the reasons for not combining energy consumption results, the user should be cautioned regarding the risks of using energy costs as a comparison and not to combine heating and cooling cost results.

# BBRS Negative – Item #4

**Revise** Section 9.1, Results Presented:

Insert the following language as indicated:

Heating Energy Use and Cooling Energy Use results (and Cost where applicable) shall be reported separately, and a combined value for heating and cooling shall not be presented. It is recommended that users not attempt to combine heating and cooling values into total annual energy use for comparison purposes due to the risk of misleading results.

*Reasoning:* This should be an editorial change – this language is necessary to encourage users not to simply mathematically combine heating and cooling results. The Board compromise to continue with AEP guidelines specifically required separate heating and cooling numbers to be reported (and not a combined figure) to avoid controversial and contentious issues regarding how these two should be combined and to avoid misleading the user as to the results. Given the good reasons for the software not to report combined values, the user should be cautioned not to circumvent this decision.

# BBRS Negative – Item #5

**Revise** Section 9.1, Results Presented:

Insert the following language as indicated:

Optionally, a statement may also accompany the results indicating whether the specified window system does or does not meet the prescriptive code requirements of Table 402.1.1 of the 2006 International Energy Conservation Code (IECC). If the specified window system does not meet the prescriptive requirements of Table 402.1.1 of the 2006 IECC, the statement shall also indicate that (a) the window system may be in compliance with local codes if those code requirements differ from the 2006 IECC, and (b) compliance under the 2006 IECC may still be demonstrated by using trade-offs from Section 402.1.4 (Total UA Alternative) or Section 404 (Simulated Performance Alternative), so long at the mandatory provisions of Section 402.6 establishing maximum fenestration U-factors or SHGCs are satisfied.

*Reasoning:* This should be an editorial change – the language is necessary to accurately state the requirements of the 2006 IECC. While trade-offs are permitted under sections 402.1.4 and 404, such trade-offs are limited by the maximum fenestration performance values in 402.6.

# Cardinal Glass – Item #1

## Infiltration

The value shown in Table 1 for new construction is wrong. From the 2006 IECC the correct parameter is 0.000036 SLA (specific leakage area) which will translate to approximately 0.4 ACH.

I recommend we use 0.60 ACH for an existing structure under the presumption that façade improvements typical of window replacements will reduce envelope air leakage.

# Cardinal Glass – Item #2

## Interior Shade Scalars

The scalars listed in Table 2 are “legacy” values carried over from old versions of the energy code and are inaccurate for a wide variety of glass and shade types. The table below, from the REM/Design program, summarizes data presented in the ASHRAE handbook and demonstrates that a fixed scalar for all window types is wrong:

	Single Pane	Double Pane	Double Pane Low SHGC
Venetian blinds – light color	0.68	0.66	0.86
Venetian blinds – medium color	0.75	0.71	0.90
Roller shades – translucent light	0.45	0.46	
Roller shades – opaque white	0.40	0.40	
Curtains – open weave, light color	0.69	0.67	0.90
Curtains – open weave, dark color	0.82	0.75	0.93
Curtains – closed weave, light color	0.48	0.51	0.73
Curtains – closed weave, dark color	0.69	0.67	0.90

# Cardinal Glass – Item #2 cont.

In simple terms, the reduction in solar gain from an interior blind can be expressed as:

Transmission In \* Reflectance Off Blind \* Transmission Out

For the 901 Guideline we need to define (4) attributes of the shade system:

Glass solar transmission: Tglass

Window transparency area: GlassFraction

Shade reflectance: Rshade

ShadeUse

The total scalar for an unshaded window SHGC will be:

$1 - (T_{glass}^2 * R_{shade} * GlassFraction * ShadeUse)$

For the reference house I suggest we define a typical shade as an open weave light color curtain, the “more open” shade usage is open 2/3 of the time (1/3 closed), and the “more closed” usage is closed 2/3 of the time. The software program will calculate the total shade scalar based on the selected window properties.

For the specific house we could use the same blind as well and allow user input to shade usage schedule.

# Cardinal Glass – Item #3

## Existing House Foundation and Conditioning

No basement insulation and partially conditioned conditions seems inappropriate for an existing house. Most homeowners will, over time, expand into the basement as additional living space and/or bedrooms. This expansion includes insulating and finishing off the below grade walls.

I recommend we set the space conditions to conditioned (same as above ground) and insulate the walls to R5 (1/2 the value in the IECC and comparable to 1” foam sheathing to the interior).

# Cardinal Glass – Item #4

## Existing House Wall Insulation

A value of R7 seems too low for northern climates.  
I recommend a minimum R11 for zones 5-8.

# Cardinal Glass – Item #5

## Existing House HVAC Efficiency

A 70% furnace and 8 SEER air-conditioner may be appropriate for original equipment, but the DOE building energy databook suggest that both these appliances have typical lives at less than 20 years ago. Since 1987 AFUE has been 78% and since the early 1990's SEER has been 10.

I recommend we assume that the home owner has already had to replace the HVAC equipment to these efficiency levels (78% AFUE, 10 SEER)

# Cardinal Glass – Item #6

## HVAC System Sizing

The safety factor of 1.3 is too large. Florida code dictates 15% maximum oversize and ACCA recommends 20%.

# Cardinal Glass – Item #7

## Structural Mass

The 2003 version of the IECC gave specific requirements for heat storage (thermal mass) at 3.5 lb/ft<sup>2</sup>. The Resfen program included this note to document how the value was developed:

Interior wall amount based on MEC (1ft<sup>2</sup> of wall has 6.64 lbs of mass; 0.527 ft<sup>2</sup> int. wall /ft<sup>2</sup> floor = 3.5 lbs per ft<sup>2</sup> of floor)

To ensure that thermal storage is correctly modeled, I recommend that we replace the wording of “Other walls, ceilings, floors: wood frame construction” with the specific requirement of 3.5 lb/ft<sup>2</sup>.

# Cardinal Glass – Item #8

## Software Validation

Add a reference to the BESTEST protocol developed by NREL to ensure that any software developed to these guidelines is consistent with the validation procedures used for code complaint energy analysis procedures.

*Note: Not our issue? Approval of any software will need to be through Software Review Subcommittee in accordance with the Software Approval Guidelines document.*

# BBRS Negative – Item #7

**Revise** Table 1, Interior Shading

Reference House:

~~*Delete: [Internal blinds used in non-ideal manner for each season (0.85 multiplier in summer, 0.7 multiplier in winter).]*~~  
*Internal blinds used seasonally – more open in summer, more closed in winter (0.85 multiplier in summer, 0.7 multiplier in winter).*

*Reasoning:* This is also an editorial change; it does not change the requirement – the language for the Reference House should be corrected to reflect the same language used in the Specific House.

***Editorial – this change was previously made on the specific house, but missed change on reference house.***

# Pella Approve-with-Comment

Editorial comments:

- Missed reference to AAMA/WDMA/CSA 101/I.S.2/A440 – 05
- Numerous changes of “windows” to “fenestration”

# Background Info

## Scope and Board Guidelines

# Scope

The Annual Energy Performance Subcommittee shall be responsible for developing the procedures to rate the annual energy performance of fenestration products and fenestration product attachments in homes taking into account the variability of housing characteristics and operation.

The Annual Energy Performance Subcommittee shall report to the Technical Committee.

# Board Guidelines

In September, Board issued guidelines regarding AEP:

- Develop and approve NFRC 901 calculation guideline document first.  
AEP Rating would be developed afterwards, if warranted.
- Provide for variability; final result must be a range.
- Two ratings with separate heating and cooling results.  
May also reflect climate zones or other factors.
- Include user-specific variable behavioral inputs (e.g. thermostat set points, shading, and orientation).
- Any assumptions must be supported by research and technically sound.
- Intended audience is the consumer and/or builders in both new and existing markets. Not intended for code use.
- Any rating program that is developed must have revenue generation and IP protection consistent with supporting NFRC.

# Proposed Calculation Approach

## *Fixed vs. Operational Variables*

- Several assumptions fixed for the home.
- Certain operational variables identified as homeowner-dependent:
  - Temperature setpoints, use of blinds, use of dynamic windows, window ventilation
  - Ranges will be defined for higher and lower heating / cooling.

## *Reference home*

- Standardized other than input of window values and city.
- Four results will be calculated based on range of operational variables:
  - Highest Cooling, Lowest Cooling
  - Highest Heating, Lowest Heating

## *User-specific home*

- User can make several choices about home size, type, foundation, orientation, shading, HVAC.
- User also puts in specific values for operational variables (e.g. setpoint) which best matches their behavior.