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ALUMINUM EXTRUDERS COUNCIL RECOMMENDATIONS FOR A PERFORMANCE-BASED MODEL ENERGY STAR -WINDOWS CRITERIA

Overview

ENERGY STAR is the program created by the Department of Energy to identify those products, within numerous industries, which set the standard for energy efficiency. In most industries, such as with appliances, this is a forthright matter ... the less electricity consumed the more efficient the product. The attempt to bring windows into this program has proven to be a much more complicated endeavor. Windows, being part of a building system, have many more factors that contribute to their efficiency. One set of criteria, which is suitable in a given climate, may be totally inappropriate in another. While it should be stated that **ENERGY STAR** is a voluntary program and not a code, the program does set a performance standard that many architects and specifiers have adopted as a requirement.

Several attributes contribute to the total energy efficiency of a window. For better or for worse the Department of Energy has focused solely, at least for the time being, on U-Factor and Solar Heat Gain Coefficient. While these two attributes are easily tested on new products many questions arise as to what roles product use and climatic conditions play on these ratings over the lifespan of the units. As further research and discussion continue, issues such as Air Leakage, Installation, Long Term Energy Performance, Recyclability and the effects of different materials on the environment, all have come to the forefront. At this stage the industry is unable to put a quantifiable number on some of these issues and has thus chosen to address only those that are quantifiable within the RESFEN program: U-Factor, SHGC and potentially Air Leakage.

On May 28th of this year the new **ENERGY STAR** criteria for windows was announced. In a letter to the stakeholders Assistant Secretary David Garman outlined the rationale for the new four-zone standard and what led the Department of Energy to their decisions. The new requirements fell short of the expectations held by the aluminum industry, however, in his letter Mr. Garman added “Given the concerns raised by the aluminum frame window manufacturers and for other reasons, the Department wishes to explore the concept of a ‘performance based’ approach with industry and other stakeholders." The Aluminum Extruders Council has taken up that challenge and drawn upon the expertise of technical consultants nationwide to develop the framework for what we believe is a workable Performance-Based Model.

ALUMINUM EXTRUDERS COUNCIL

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Analysis and Recommendations

A "performance-based" standard offers a significant benefit to all manufacturers as compared to the current prescriptive method, by allowing the manufacturer to meet the requirement however they choose. For example, currently in the South Region the only way a manufacturer can have an **ENERGY STAR** product is if they have a U-Factor of 0.65 and a SHGC of 0.40 (or less), no exceptions. Using the DOE funded software RESFEN numerous energy simulations have been performed by AEC's technical consultants. In these simulations it was found that in the South Region, a product's U-Factor determines about 20% of how much energy it will consume, while the Solar Heat Gain Coefficient (SHGC) contributes 80%. If a window manufacturer produces a window that has a SHGC of 0.32, which is far superior in energy saving than the criteria of 0.40, however if the U-Factor is 0.67 under the current criteria this window will not be an **ENERGY STAR** compliant product. Interestingly enough, if the **ENERGY STAR** criteria for South Region, U-Factor 0.65 and SHGC 0.40, are plugged into RESFEN for the South Region city of Brownsville, Texas the annual heating and cooling cost will be $453.64, while if a window with a U-Factor of 0.67 and a SHGC of 0.32, which currently does not qualify for **ENERGY STAR** in the South Region, is plugged into RESFEN for that same city and the same house the annual energy costs will be $431.53. The question is why is this window not eligible for an **ENERGY STAR** label?

This is simply one scenario, the same simulations can be done in every city throughout the Four Zones. What the Department of Energy must come to realize is that if there is a window that can save as much, or more energy than that established by **ENERGY STAR** criteria, then it too should be an **ENERGY STAR** product no matter how the savings are achieved.

Using a similar process as that described above, five cities within each zone were modeled with products meeting the current **ENERGY STAR** criteria and then changing the U-Factor and SHGC to determine what percent each played in saving energy (Table 1). Once that was calculated a mathematical equation was derived reflecting those numbers (Table 2). The number 1 was chosen for simplicity and when using the equations if the manufacturer's product performance when plugged into the equation for the given zone is 1.00 or less (rounded to 2 decimal points), then that product should be designated as **ENERGY STAR** for that region.

Average Contribution Factor to Energy Cost - Table 1

ZONE	U-Factor	SHGC
Northern	80%	20%
North Central	85%	15%
South Central	44%	56%
Southern	20%	80%

The AEC Model (Equation) - Table 2

ZONE	EQUATION
Northern	1.00 = 3.48 (U-Factor) - 0.87 (SHGC)
North Central	1.00 = 2.01 (U-Factor) + 0.36 (SHGC)
South Central	1.00 = 1.10 (U-Factor) + 1.40 (SHGC)
Southern	1.00 = 0.44 (U-Factor) + 1.78 (SHGC)

ENERGY STAR Rating for 1.00 or Less

Example

One example is that currently in the North Central Zone to be labeled **ENERGY STAR** a window must have a U-factor of 0.40, which is very difficult to do, however the SHGC must be 0.55, which is easier to achieve. Normally if you use a low-e soft coat your SHGC is around 0.38, which is far superior to that of the 0.55. Logically manufacturer should get credit for this, and with the performance based equation they would. The studies for the North Central Zone showed the U-Factor to control 85% of the energy consumption and the SHGC to contribute only 15% but using what is described above and the derived equation with the SHGC of 0.38 the U-factor can now be 0.43 and still be an **ENERGY STAR** product for this zone. The equation for the North Central is 2.01 (U-Factor) + 0.36 (SHGC) =1 or less. When the 0.43 U-Factor and the 0.38 SHGC are put into the equation the results equal 1.0011, rounded to 1.00. Allowing the window to have a U-Factor of 0.43 (as long as the SHGC is 0.38) means that aluminum windows should have a viable existence in this marketplace.

To verify that this theoretic window is worthy of being labeled **ENERGY STAR** the two performance numbers were put into RESFEN in a North Central city (Memphis, TN). When a window with the current **ENERGY STAR** requirements (0.40, 0.55) was modeled the annual heating and cooling costs were $363.38. When the other window's performance (0.43, 0.38) was simulated the annual heating and cooling cost were $360.86 saving an additional $2.52 annually, justifying why it too should be labeled **ENERGY STAR**.

Alternative Model Utilizing Air Infiltration

On the 8th of July the AEC held a working meeting of technical experts to discuss the potential alternatives within the framework of a performance-based criteria initiative and to see if that group could reach a consensus on an appropriate model. During the meeting there was discussion relative to including Air Leakage, Long Term Performance and Recyclability in the equation. It was suggested that because of the relationship between the DOE and the NFRC, that only criteria where the NFRC has established testing methods be included. The NFRC does have a method for testing Air Leakage (NFRC-400) however unlike U-Factor and SHGC this test remains optional. The second group of equations was derived including Air Leakage and its effects on energy savings (Tables 3-4).

Average Contribution Factor to Energy Cost Including Air Leakage (AL) - Table 3

ZONE	U-Factor	SHGC	AL
Northern	75%	18%	7%
North Central	80%	13%	7%
South Central	42%	53%	5%
Southern	20%	75%	5%

The AEC Model (Equation) With Air Leakage - Table 4

ZONE	EQUATION
Northern	1.00 = 3.14 (U-Factor) - 0.75 (SHGC) + 0.29 (AL)
North Central	1.00 = 1.94 (U-Factor) + 0.31 (SHGC) + 0.17 (AL)
South Central	1.00 = 1.06 (U-Factor) + 1.34 (SHGC) + 0.13 (AL)
Southern	1.00 = 0.45 (U-Factor) + 1.69 (SHGC) + 0.11 (AL)

ENERGY STAR Rating for 1.00 or Less

The number 0.30 was chosen because currently AAMA 101/IS.2-97 requires a 0.30/Ft^2 or less to pass and within this group it was the most widely accepted and tested. The advantage of having Air Leakage in the equations is two-fold. Firstly, the manufacturer gets credit for building a better quality product. Secondly, inclusion of an Air Leakage factor lessens (1-5%) the role that U-Factor plays in achieving **ENERGY STAR**. It does however add additional testing which manufacturers may not currently perform. While this model is an immediate answer it is not the final solution, the industry must continue to conduct research so that issues such Long Term Energy Performance and a material's "green" attributes can be quantified. Only at that time will a true performance rating be available.

We will welcome your comments and questions. Please direct your questions to:

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