ENERGY STAR for Exterior and Interior Storm Panels

Specification Framework Document
January 7, 2016

Please send comments on this document to windows@energystar.gov no later than Friday, February 12, 2016

Background

The ENERGY STAR program, managed by the U.S. Environmental Protection Agency (EPA), with support from the U.S. Department of Energy (DOE), serves to identify energy-efficient products currently available to consumers in the marketplace. For each new product category, a unique specification is developed to describe the energy performance requirements that a product must meet to receive the label. This specification development process relies on rigorous market, engineering, and energy savings analyses, as well as input from industry and other stakeholders. Once a final specification is released and it is determined that a model meets the program requirements through an established third-party certification process, the product brand owner may use the label to identify that model as ENERGY STAR certified.

The ENERGY STAR program follows a set of guiding principles when considering the appropriateness of developing a specification for a new product category. These principles include:

- Significant energy savings can be realized on a national basis.
- Energy efficiency can be achieved through one or more technologies such that qualifying products are broadly available and offered by more than one manufacturer.
- Product performance can be maintained or enhanced with increased energy efficiency.
- Product energy consumption and performance can be measured and verified with testing.
- Purchasers will recover their investment in increased energy efficiency within a reasonable period of time.
- Labeling would effectively differentiate products and be visible for purchasers.

With the launch of all ENERGY STAR new product specification development efforts, EPA engages early with stakeholders and may release a framework document that initiates development of an approach for the specification, as well as definitions and eligibility criteria. The ENERGY STAR specification development effort is an open and transparent process that depends on stakeholder engagement. Accordingly, this specification framework for ENERGY STAR Storm Panels includes requests for stakeholder input on issues key to developing an effective voluntary energy efficiency program.

Opportunity and Rationale for Labeling Exterior and Interior Storm Panels with ENERGY STAR

Exterior and interior storm panels (also known as storm windows) have been a common choice for consumers for many years. Recent developments in the market have introduced an opportunity to achieve significant national energy savings from these products.

Beginning in 2009, exterior and interior storm panels that use glass with low-emissivity (Low-E) coatings became commercially available. When combined with other features that reduce air leakage, this new generation of products can provide better thermal performance than traditional storm panels.

In order to provide accurate information on the performance of these products, DOE is sponsoring the development of procedures for certifying the energy performance of storm panels and other fenestration attachment products. The Attachments Energy Rating Council (AERC), which is leading these efforts, expects to begin certifying products by early 2017.

In addition, DOE has sponsored research by Pacific Northwest National Laboratories (PNNL), Lawrence Berkeley National Laboratories (LBNL), and other organizations that provides new insights on exterior and interior storm panels. Specifically, the research quantifies the energy savings that can be achieved by installing Low-E exterior and interior storm panels, assesses the current and potential market for such products, and identifies barriers to widespread adoption. EPA reviewed the following papers when preparing this framework document:

- Drumheller SC, C Kohler and S Minen. 2007. *Field Evaluation of Low-E Storm Windows*. LBNL-1940E, Lawrence Berkeley National Labs, United States.[1]
- Cort KA. June 2013. *Low-E Storm Windows: Market Assessment and Pathways to Market Transformation*. PNNL-22565, Pacific Northwest National Laboratory, Richland, WA.[2]
- Culp TD et al. 2013. *Low-E Retrofit Demonstration and Educational Program.* United States. doi: 10.2172/1209340[3]
- Knox JR and SH Widder. May 2014. *Evaluation of Low-E Storm Windows in the PNNL Lab Homes*. PNNL-23355, Pacific Northwest National Laboratory, Richland, WA.
- Culp TD and KA Cort. September 2014. *Database of Low-e Storm Window Energy Performance across U.S. Climate Zones*. PNNL-22864 Rev 2, Pacific Northwest National Laboratory, Richland, WA.
- Culp TD, SH Widder and KA Cort. July 2015. *Thermal and Optical Properties of Low-E Storm Windows and Panels*. PNNL-24444, Pacific Northwest National Laboratory, Richland, WA.
- Culp TD and KA Cort. October 2015. *Energy Savings of Low-E Storm Windows and Panels across US Climate Zones*. PNNL-24826, Pacific Northwest National Laboratory, Richland, WA.

Based on this research, EPA believes that the following conclusions can be made:

- *High per-unit savings:* Installing Low-E storm panels instead of clear glass storm panels can reduce heating and cooling energy use by 5%-14%, depending on the climate in which they are installed.[4]

[1] Available at http://eetd.lbl.gov/sites/all/files/publications/1940e.pdf
[2] The PNNL research cited above can be accessed at http://www.pnnl.gov/publications/
[3] Available at http://www.osti.gov/scitech/biblio/1209340
[4] Culp TD and KA Cort, PNNL-24826. The paper concludes that installing Low-E storm panels over primary windows will result in energy savings of 15%-35%, depending on the properties of the primary window. EPA conducted further analysis to isolate incremental savings between clear and low-e glass using the results published in

- *Large potential market:* Storm panels are installed in approximately 500,000 homes annually, but it is estimated that only 10% currently use Low-E glass.[5]
- *Existing market barriers*: Lack of recognition by energy rating and certification systems has been cited as a reason for low market adoption.[6]
- *Affordable and cost-effective:* With an average price premium of 10%-15% over clear glass storm panels, Low-E storm panels have an expected incremental payback of approximately 5 years or less (not including savings from reduced air leakage).[7]

Based on these conclusions, EPA believes that introducing an ENERGY STAR specification would increase the market share for Low-E exterior and interior storm panels and help consumers save energy nationwide.

Discussion Questions:

i. Are there other studies that support or refute the research outlined above to assess the energy savings potential and cost-effectiveness of exterior and interior storm panels? Please include detailed analysis to support any concerns about the research.

ii. Are there any general concerns with EPA developing an ENERGY STAR specification for exterior or interior storm panels? Please include detailed analysis to support your argument.

Specification Framework

This framework document is intended to outline EPA's initial assessment of exterior and interior storm panels for the purposes of developing a first draft Version 1.0 specification. This document includes EPA's initial thoughts on terms and definitions, scope, test methods, and timeline for efficiency requirements. EPA has organized this framework document to mirror the ENERGY STAR specification structure, with questions at the end of each section to encourage feedback about the proposed approach and further EPA's understanding of this product category. Please note that this document is not intended to be a comprehensive review of the ENERGY STAR perspective on exterior and interior storm panels; rather, this framework document serves as a starting point for EPA's specification development efforts.

Appendix C of PNNL-24826 because ENERGY STAR uses incremental savings to estimate energy savings and cost-effectiveness. For each city and base window type listed, EPA calculated the difference in source energy consumption between clear and Low-E storm panels, then averaged the results for the cities in each IECC climate zone. Of the 5%-14% range cited above, the lower bound represents savings in Zone 8 for wood frame, double-pane primary windows, and the upper bound represents savings in Zone 1 for metal frame, double-pane primary windows.

[5] Cort KA, PNNL-22565.

[6] Ibid.

[7] Estimates of price premiums for Low-E storm panels are from Cort KA, PNNL-22565. Incremental payback calculations for Low-E storm panels are from Culp TD and KA Cort, PNNL-24826.

I. Definitions

a. Purpose: Each product specification has its own set of terms and definitions that explicitly describe the covered products, their features, and their functionality.

b. Approach: EPA prefers to make use of existing, industry-accepted definitions. Where definitions are not available or appropriate, EPA works with stakeholders to amend or develop acceptable definitions.

c. Proposed Definitions:

Product Definitions

1. **Exterior storm panel:** A fenestration attachment product consisting of a frame component and one or more pieces of glazing, installed over the exterior of a primary window in a residential building.
2. **Interior storm panel:** A fenestration attachment product consisting of a frame component and one or more pieces of glazing, installed over the interior of a primary window without the use of nails, screws, or adhesives.
3. **(Primary) Window:** An assembled unit consisting of a frame/sash component holding one or more pieces of glazing functioning to admit light and/or air into an enclosure and designed for a vertical installation in an external wall of a residential building.
4. **Operator type:** A designation used to distinguish between fenestration products based on the how and if the products open and close.
    a. **Operable product:** A product with panels that may be opened and shut to accommodate ventilation needs.
    b. **Non-operable product:** A product with panels that do not open (also called "fixed").
5. **Low-E Coating/Glazing:** A microscopically thin metal or metallic oxide composition that is deposited directly on a glass surface. There are two categories of low-E coatings that can be applied to glazing products:
    a. **Pyrolytic or "Hard-Coat" low-E:** A coating that is bonded to the glass during manufacturing while glass is in a semi-molten state through chemical vapor deposition.
    b. **Sputtered or "Soft-Coat" low-E:** A coating that is applied to the glass after manufacturing is complete through physical vapor deposition.[8]

Performance Metrics

6. **Emissivity:** The ratio of the radiative energy emitted by a surface to that of a black body at the same temperature. The ratio varies between zero (0) and one (1).

[8] A Sputtered or "Soft-Coat" low-E is not durable enough to be applied to glazing surfaces that are exposed to the environment.

7. **Solar transmittance (Tsol):** The fraction of solar energy that passes through a glazing material. The value is expressed as a number between zero (0) and one (1).
8. **Visual transmittance (VT):** The fraction of visible light that passes through a fenestration system, including the glazing material and frame. The value is expressed as a number between zero (0) and one (1).
9. **U-factor:** The heat transfer per time per area and per degree of temperature difference (Btu/h $ft^2 \cdot ^\circ F$). The U-factor multiplied by the interior-exterior temperature difference and the projected fenestration product area yields the total heat transfer through the fenestration product due to conduction, convection, and long-wave infrared radiation.
10. **Solar Heat Gain Coefficient (SHGC):** The ratio of the solar heat gain that passes through a fenestration system to the incident solar radiation.
11. **Air leakage (AL):** The volume of air flowing per unit time per unit area (cfm/ft^2) through a fenestration system due to air pressure or temperature difference between the outdoor and indoor environment.
12. **Annual energy rating:** A characterization of the total energy performance of a fenestration system, taking into account insulation, solar heat gain, and air leakage.

Other Definitions

13. **Residential building:** A structure used primarily for living and sleeping that is zoned as residential and/or subject to residential building codes. For the purposes of ENERGY STAR, "residential building" refers to buildings that are three stories or less in height.
14. **Multi-family building:** Buildings that contain 20 or more residential living units.
15. **Climate Zone:** Geographic regions that share general climatic conditions, such as a range of heating degree days and cooling degree days. The climate zones referenced are defined in the ENERGY STAR Windows, Doors and Skylights program. These zones are based on the International Energy Conservation Code (IECC), with some modifications.
16. **Solar control:** The ability of glass to allow sunlight to pass through while radiating and reflecting away a portion of the sun's heat.
17. **Weep hole**: Small openings in the frame of an exterior storm panel that allow water to drain out from between the storm panel and primary window.
18. **Single-glazed:** A window with one pane of glass.
19. **Double-glazed:** A window with two panes of glass with an air space between.
20. **Thermal break:** An element of low conductivity placed between two conductive materials to limit heat flow; in the context of storm panels, thermal breaks are used with metal frame windows.

d. Discussion Questions:

i. Are there more widely accepted terms industry uses for exterior and interior storm panels?

ii. Do the performance metric definitions match industry terms?

iii. Are there other terms relevant to this product category that should be defined as part of the specification development process?

II. Scope

a. Purpose: For each product category, EPA identifies specific products to be covered by the specification, as well as product types that are ineligible for ENERGY STAR qualification. Products are ineligible for inclusion in the scope of the specification if they are unable to be tested with the identified test method, feature proprietary technologies, have limited availability of efficiency data, or cannot be differentiated from conventional products based on their energy efficiency.

b. Included Products: EPA proposes that the scope of the specification cover products that meet the definitions of exterior and interior storm panels that are intended for use in residential buildings. EPA is focusing on exterior and interior storm panels at this time because of the availability of new research on these products and the potential significant energy saving impact, as described above.

c. Excluded Products:

- **i.** Exterior storm panels without weep holes or other features that allow moisture to drain from between the storm panel and primary window.
- **ii.** Partial components of exterior or interior storm panels.
- **iii.** Storm doors or door inserts.
- **iv.** Other related fenestration attachments, including window films, curtains, blinds, shades, shutters, awnings, and jalousie windows.

d. Discussion Questions:

- **i.** Is additional research and analysis currently available that supports the inclusion of any of the excluded products in the scope of this specification development?
- **ii.** Are there any subtypes or applications of exterior and interior storm panels that should be ineligible for ENERGY STAR certification? Please explain why these should be excluded.

III. Qualification Criteria

a. Purpose: Once a product category's eligibility is determined, EPA identifies applicable metrics and proposes energy efficiency performance criteria that recognize the top-performing products in the marketplace. Efficiency metrics referenced by the ENERGY STAR specification are based on widely accepted test procedures.

b. Approach: EPA is not proposing specific qualification criteria for exterior and interior storm panels at this time. If warranted, these qualification criteria would be developed through an iterative specification development process that assesses potential qualification criteria against the ENERGY STAR Guiding Principles. At this time, EPA is proposing certain potential elements of the ENERGY STAR specification for exterior and interior storm panels for the purposes of inviting stakeholder discussion, including:

i. **Performance Metrics**: EPA proposes that storm panel qualification criteria be based on emissivity, solar transmittance (Tsol), and air leakage. EPA is not proposing the use of U-factor and SHGC for the criteria as these metrics account for the energy performance of frame materials in addition to glazing materials. Research shows that in most applications, the frame of an exterior or interior storm panel product has a negligible impact on product performance.[9] Emissivity and Tsol are glass-only properties, and EPA believes that these metrics directly distinguish higher-performing, energy-saving products from conventional products.

ii. **Example Programs:** EPA proposes to consider qualification criteria that have already been used by energy efficiency and/or utility programs as the basis for ENERGY STAR qualification criteria for exterior and interior storm panels. EPA is aware of the following storm window programs:
    1. Efficiency Vermont offered a pilot program in 2015 that provided discounted prices on qualifying Low-E storm panel products at a limited number of retail locations. Efficiency Vermont is expected to publish a paper on the results of the pilot in early 2016.[10]
    2. The Regional Technical Forum (RTF) of the Northwest Power and Conservation Council added Low-E storm panels as an approved measure in July 2015. The criteria can be accessed at the following address: http://rtf.nwcouncil.org/measures/measure.asp?id=153

iii. **Climate Zones:** EPA proposes that storm panel qualification criteria vary based on the climate zone in which the product is installed.
    1. EPA proposes that a minimum solar transmittance value be required for products installed in the ENERGY STAR Northern and North-Central Climate Zones.
    2. EPA proposes that a maximum solar transmittance value be required for products installed in the ENERGY STAR South-Central and/or Southern Climate Zones.

iv. **Installation instructions:** EPA proposes that ENERGY STAR certified exterior and interior storm panels be required to have installation instructions that are packaged with the product or readily available online that contain the following elements:
    1. A list of hardware and tools required for installation.
    2. Diagrams and descriptions of product installation.
    3. Guidance on proper installation distance from primary window.
    4. Guidance on thermal breaks when installed over metal frame primary windows.

[9] Most storm panel products have aluminum frames. When mounted over wood or other nonmetal framed primary windows, the aluminum frame does not adversely impact product performance because there is no continuous thermal bridge between the panel frame and the primary window frame. The exception is for exterior storm panels installed over metal framed primary windows. For such applications, installers should create a thermal break between the storm panel and the primary window frames (Culp TD and KA Cort, PNNL-24444).

[10] The program is described briefly in this article: https://www.efficiencyvermont.com/blog/blog/2015/09/16/could-new-storm-windows-save-you-money-this-fall

5. Guidance on properly sealed installation.
6. Information on applicability of the storm panel operator type to primary window operator type, especially with respect to any egress requirements.
7. Information on installing the storm panel on different types of openings.

c. Discussion Questions:

Metrics

i. Are any additional criteria needed to effectively differentiate energy-efficient exterior or interior storm panels?
ii. Are any additional criteria needed to ensure that ENERGY STAR exterior and interior storm panels are recognized as high-quality products? Please provide specific evidence to support recommendations.
iii. Are there other metrics that should be considered for the energy performance of storm panels, such as U-factor and SHGC? If so, please provide a detailed explanation.

Possible Criteria

iv. Should EPA align ENERGY STAR qualification criteria with identified example programs?
v. What specific performance levels should EPA propose as qualification criteria for emissivity, solar transmittance, and air leakage that will effectively differentiate high-performing products? Please provide support for any suggestions.
vi. For exterior and interior storm panels, what range of air leakage performance is common in the market?
vii. Does the use of different solar transmittance requirements for products installed in the ENERGY STAR Northern and Southern climate zones (as described above) seem reasonable? If not, please provide a detailed explanation.

Negative impact

viii. Is there a concern that interior storm panels with low SHGC may lead to overheating that may damage primary windows? Please provide detailed input to support or oppose making interior panels with low SHGC ineligible for ENERGY STAR certification.
ix. Are there other scenarios or applications where exterior or interior storm panels may damage or otherwise adversely affect the performance of primary windows? Please provide supporting documentation to describe specific circumstances.

Installation Instructions

x. What additional elements should be required for installation instructions? Are there any elements that should not be included in the installation instructions?
xi. Are there other suggestions to encourage consumers or installers to properly address egress requirements when installing storm panels?

IV. Test Methods

a. Purpose: Product testing has the following important roles:

- **i.** To yield accurate and repeatable energy consumption values for establishing ENERGY STAR levels.
- **ii.** To create a level playing field for fair comparison of products.
- **iii.** To verify that labeled products are performing at the appropriate levels and delivering on ENERGY STAR's promise to consumers.

b. Approach: As mentioned above, DOE is sponsoring the development of a certification program for exterior and interior storm panels under a new organization, the Attachments Energy Rating Council (AERC). AERC is working to develop technical procedures for product certification and expects to begin certifying products in early 2017. The International Glazing Database (IGDB), which is managed by Lawrence Berkeley National Laboratories (LBNL), contains performance ratings for glazing systems used with exterior and interior storm panels. EPA proposes that product performance ratings listed in the IGBD be used to evaluate potential qualification criteria in advance of the publication of AERC's technical certification documents. At this time, EPA seeks comment on the applicability of the following industry-accepted test methods to exterior and interior panels:

- **i.** Measurement of glazing materials for solar transmittance shall be done in accordance with NFRC 300-14[11] and be listed in the IGDB managed by LBNL.
- **ii.** Measurement of glazing materials for emissivity shall be done in accordance with NFRC 301-14[12] and be listed in the IGDB managed by LBNL.
- **iii.** Measurement of the product for air leakage shall be done by an accredited, independent laboratory in accordance with ASTM E283[13] at a test pressure of 75 Pa (1.57 psf) applied to the exterior and interior sides of the product.

c. Discussion Questions

- **i.** Can the test methods listed above be used to accurately measure the energy performance of exterior and interior storm panels for the purposes of an ENERGY STAR program?
- **ii.** Can the performance ratings in the IGDB be used to assess the availability of glazing options when evaluating qualification criteria? If not, what specific alternatives do stakeholders suggest?
- **iii.** Considering that weep holes or other water drainage features are a necessary component of high-quality storm panels, should an alternate air leakage test method be considered?

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[11] NFRC 300-2014, *Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems,* National Fenestration Rating Council, Greenbelt MD, 2014.

[12] NFRC 301-2014, *Standard Test Method for Emittance of Specular Surfaces Using Spectrometric Measurements,* National Fenestration Rating Council, Greenbelt MD, 2014.

[13] ASTM E283-04(2012), *Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen*, ASTM International, West Conshohocken PA, 2012.

Next Steps and Schedule

Stakeholders are encouraged to submit written comments on the discussion questions listed above, and on any other issues related to the development of a new specification for exterior and interior storm panels no later than **Friday, February 12, 2016**. Please send all comments and supporting information to windows@energystar.gov. EPA will host a webinar on January 14, 2016 to review the specification framework document and answer clarifying questions.

Specification Framework Webinar	January 14, 2016
Deadline for Written Comments on Framework Document	February 12, 2016
Draft 1 Specification Issued	Summer 2016
Final Specification Issued and Effective	2017