BIRCH POINT
Consulting

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Dear Doug:

I appreciate the opportunity to comment on the framework document for the proposed new Energy Star® program for exterior and interior storm panels. As you know, I've been closely involved with both the research and companies developing low-e storm windows and panels, and I enthusiastically support this new program. Low-e storm panels offer significant promise for cost effectively upgrading the energy efficiency of existing buildings, in particular filling the gap where homeowners cannot or will not replace their windows due to historical restrictions or income limitations. Poor performing windows in existing buildings have been overlooked for far too long, so this proposed program is important and right on target.

Below, I've tried to address many of the discussion questions from the framework document.

I. Definitions

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

A variety of terms are used in the industry including storm window (usually for exterior products), storm panel, and interior panel. Suggested modifications to the product definitions:

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~~. Also known as exterior storm windows.

Reason: These products are also used in other building type (e.g. historic churches, schools), but I understand the focus of this program is lowrise residential. However, the limitation of the program to lowrise residential buildings can be done in the scope, so it is not necessary here.

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~~. Also known as interior panels or interior storm windows.

Reason: Most interior panels are attached with screws, and in fact, attachment with nails, screws, or adhesives is desirable to help ensure permanency and persistence of the energy savings.

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(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.

Reason: The limitation of the program to lowrise residential buildings can be done in the scope, so it is not necessary here.

Low-E Coating/Glazing: A microscopically thin metal or metallic oxide composition that is deposited directly on a glass glazing surface to reduce its thermal infrared emittance. 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.

Reason: While the suggested definition is true, it is not really necessary to include the differences between pyrolytic and sputtered low-e. In fact, there are some new sputtered coatings that are durable enough to be used in this application. I also changed glass to glazing, because although low-e coatings are generally on glass, it is conceivable low-e coatings could be put on other materials too.

ii. *Do the performance metric definitions match industry terms?*

Generally yes, although it may not be necessary to include some of these terms if they are not used in the specification.

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

Just one more suggested change:

Thermal break: An element of low conductivity placed between two conductive materials to limit heat flow such as wood, plastic, or other nonmetal materials; in the context of storm panels, thermal breaks are used with metal frame primary windows.

II. Scope

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.*

I am in agreement with the proposed list.

III. Qualification Criteria

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.*

If the purpose is to distinguish energy efficient products from conventional products, the proposed criteria of emissivity and solar transmittance are simple and appropriate, and will clearly differentiate energy efficient low-e storm windows and panels from conventional clear glass storm windows. While U-factor and SHGC metrics are certainly valid, they are not necessary to provide differentiation between storm window products. As noted in the framework document and referenced papers, differences in performance between storm window products are dominated by the glass type (low-e or not) and air leakage reduction. Unlike primary windows, differences in frame material actually has little impact because even for aluminum framed storm windows (which are the vast majority due to structural, durability, and design benefits), the storm window panel is attached to nonmetal components like wood brick mold, wood blind stops, inside drywall or wood trim that act as a thermal break. In fact, the use of emissivity and solar transmittance may be viewed as preferential for this particular product category because:

a) emissivity and solar transmittance clearly and easily differentiate energy efficient products from conventional products,
b) product verification is made very simple by just confirming the glass type being used with the International Glazing Database (and a list of compliant glazing products can easily be generated),
c) emissivity and solar transmittance provide consistency with the metrics used by other programs such as the RTF utility program in the Pacific Northwest, and
d) emissivity and solar transmittance will not be confused with U-factor and SHGC ratings currently used in the Energy Star program for windows, doors, and skylights.

Once the AERC rating program is complete, EPA can consider transitioning to use AERC ratings for storm windows, but emissivity and solar transmittance are appropriate for the initial Energy Star specification.

There is value in providing additional recommendations about proper installation to ensure Energy Star panels are recognized as high-quality products, but that is covered in the installation instruction section.

Possible Criteria

iv. *Should EPA align ENERGY STAR qualification criteria with identified example programs?*

Yes, consistency will help the success of both the Energy Star program and the other programs, and will prevent confusion in the marketplace.

I would also point out that in addition to the two programs listed (Efficiency Vermont, RTF of the Northwest Power and Conservation Council), Pennsylvania's weatherization program also includes low-e storm windows with an emissivity ≤ 0.22 on their weatherization measure selection priority list for single family homes (see page 17 of http://www.paweatherization.org/vertical/Sites/%7BF27E296C-7668-49FF-9408-DF453C70C62E%7D/uploads/%7BCA71D0C1-C3CE-4B1A-9858-B75BD3F5AF92%7D.PDF).

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.*

<u>Emissivity:</u>

The RTF of the Northwest Power and Conservation Council and the Pennsylvania weatherization program set a maximum glass emissivity of 0.22. This allows low-e products from all five glass manufacturers (see list in Appendix A) while also clearly differentiating the proposed Energy Star product from conventional clear glass products.

However, you may want to consider a slight modification to set the emissivity at 0.30, which would allow two more products to be included: Guardian ClimaGuard IS-30 for the north (e=0.302, Tsol = 0.80-0.85) and AGC Sunergy for the south (e = 0.30, Tsol = 0.54). This would still clearly differentiate from uncoated glass (emissivity = 0.84).

<u>Solar Transmittance:</u>

Following analysis of the energy impact by PNNL, the RTF of the Northwest Power and Conservation Council set a minimum solar transmittance of 0.55 for the northwest. This seems to be a reasonable dividing line between high solar gain and low solar gain products. High solar gain low-e products have Tsol between 0.60-0.75 (see Appendix A), and low solar gain durable low-e products that can be used in this application have Tsol between 0.40-0.55 on clear substrates, and lower on tinted substrates.

<u>Air Leakage:</u>

This is the most challenging criterion to set. While reducing air leakage is a significant benefit of storm panels as demonstrated in the field studies and models, I do not know what levels of air leakage are most common for storm panels in lab testing. This is confounded by the fact that it does not really make sense to test the air leakage of a storm panel alone (especially an exterior panel with weep holes) when it is intended to be used over a primary window. What we really care about is the air leakage of the combined assembly.

In modeling energy savings of low-e storm windows in PNNL-24826, we used 3 cfm/ft^2 for single-pane base windows, 1 cfm/ft^2 for double-pane base windows, 0.3 cfm/ft^2 with exterior storm windows installed, and 0.1 cfm/ft2 with interior panels installed. These values were considered reasonable but conservative for predicting the reduction in air leakage for storm windows and panels over older windows in existing buildings, and were derived from case study measurements as described in PNNL-24444. However, these numbers are for the combined assembly, not the panel itself. In recognition of this problem, AERC is currently conducting a short research project with ATI to evaluate a new test method that would measure air leakage using the normal ASTM E283 methodology but with the storm panel mounted over a calibrated test panel that contains orifice holes to create a nominal air leakage characteristic of a primary window. This will give a better representation of the air leakage performance of the storm panel when used as intended in combination with a primary window. We hope the research and new test method will be completed in the next few months to be available for use for both this program and AERC, although we will still need to establish what level would be appropriate as a performance criterion. Alternately, an air leakage requirement could be implemented in a later phase of this program.

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.

On the webinar, one person asked a question implying that adding a low-e storm panel over vinyl primary windows could potentially damage the primary window from heat buildup. I am not aware of this being a problem in the field, and do not think it has any real basis. The maximum temperature of the primary window glass can be calculated using WINDOW7 software under 783 W/m^2 direct solar radiation and an outside temperature of 32°C / 90°F (NFRC summer conditions). The vinyl frame temperature would be the same as or less than the glass temperature. This temperature is listed in the table below for various configurations over single pane and double pane clear glass windows that would be common in older homes:

Panel type and location	Primary window – single or double pane	Max primary window glazing temperature
Exterior high solar gain low-e	Single pane clear	37.4 C / 99.4 F
	Double pane clear	41.9 C / 107 F
Exterior low solar gain absorbing low-e	Single pane clear	33.4 C / 92.1 F
	Double pane clear	41.1 C / 106 F
Interior high solar gain low-e	Single pane clear	35.9 C / 96.6 F
	Double pane clear	44.1 C / 111 F
Interior low solar gain absorbing low-e	Single pane clear	37.8 C / 100 F
	Double pane clear	48.4 C / 119 F

The heat distortion temperature of vinyl siding ranges from 61 – 89 C (142 – 192 F) with an average of 74 C (165 F), and it can be assumed the heat distortion temperature of vinyl windows is similar or higher because of larger wall thickness. The calculated temperatures are well below this point for all configurations. Additionally, we know vinyl frames and spacer materials perform well in windows that use tinted or low solar gain glass that create similar temperatures. For example, generic gray glass reaches 42.9 C / 109 F under the same conditions, LoE2-272 reaches 40.6 C / 105 F, and LoE3-340 reaches 46 C / 115 F. If these products cause no problem for vinyl windows, there is no reason to expect low-e storm panels to do so either.

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?*

I believe the list in the framework document is appropriate and covers the most important aspects.

xi. *Are there other suggestions to encourage consumers or installers to properly address egress requirements when installing storm panels?*

The installation instructions can include information about egress windows, and recommend that the installed storm panel be of the same opening type as the existing prime window (fixed over fixed, operable or removable over operable). The RTF of the Northwest Power and Conservation Council included this in their program specification.

IV. Test Methods

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?*

Yes. As discussed earlier, emissivity and solar transmittance provide simple and appropriate metrics to differentiate energy efficient low-e storm windows and panels from conventional products. The listed test methods are the appropriate references, are standard within the glass industry, and have been used for many years within NFRC. These same test methods for emissivity and solar transmittance and are also listed in the program specification from the RTF of the Northwest Power and Conservation Council.

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?*

Yes. As shown by Appendix A, it is easy to generate a list of compliant products using data from the IGDB. The certification body will simply have to verify the glass product being used, and confirm the properties from the IGDB meet the program requirements.

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?*

Yes – what is important is the air leakage performance of the combined assembly, not just the panel alone. As mentioned previously, AERC is currently exploring a new test method that would give a better representation of the air leakage performance of the storm panel when used as intended in combination with a primary window. The measurement standard listed in the framework document (ASTM E283 at a test pressure of 75 Pa) is the correct reference, but AERC is currently conducting a short research project with ATI to evaluate a new test method that would measure air leakage using ASTM E283 with the storm panel mounted over a calibrated test panel that contains orifice holes to create a nominal air leakage characteristic of a primary window. We hope the research and new test method will be completed in the next few months to be available for use for both this program and AERC, although we will still need to establish what level would be appropriate as a performance criterion. Alternately, an air leakage requirement could be implemented in a later phase of this program.

The framework document mentions measuring air leakage from both the exterior and interior sides of the product. While this is easily done, I just wanted to note that standard practice in the U.S. is to only measure air leakage of windows from the exterior side of the product.

Please contact me with any questions, and I look forward to helping however I can with this effort.

Best regards,

Thomas D. Culp
Birch Point Consulting LLC

Appendix A - Glazing products in compliance with RTF Low-E Storm Window specification

(emissivity ≤ 0.22, Tsol ≥ 0.55)

International Glazing Database version 41.0

Other products may also comply but may not be listed here - these may be checked for compliance as listed in the International Glazing Database.

ID	Manufacturer	Product Name	Glass Thickness (mm)	Emissivity	Tsol	File Name
1031	AGC Glass Co. N.A.	Comfort Select 73 on Clear	2.2	0.148	0.73	CS73_2.afg
1032	AGC Glass Co. N.A.	Comfort Select 73 on Clear	3	0.148	0.69	CS73_3.afg
1033	AGC Glass Co. N.A.	Comfort Select 73 on Clear	4	0.148	0.69	CS73_4.afg
1034	AGC Glass Co. N.A.	Comfort Select 73 on Clear	5	0.148	0.68	CS73_5.afg
1035	AGC Glass Co. N.A.	Energy Select 73 on Clear	6	0.148	0.67	ES73_6.afg
2158	Cardinal Glass Industries	i89 on 2.2mm Clear	2.2	0.149	0.75	i89-2.CIG
2159	Cardinal Glass Industries	i89 on 3mm Clear	3	0.149	0.73	i89-3.CIG
2160	Cardinal Glass Industries	i89 on 4mm Clear	4	0.149	0.71	i89-4.CIG
2161	Cardinal Glass Industries	i89 on 5mm Clear	5	0.149	0.70	i89-5.CIG
2162	Cardinal Glass Industries	i89 on 6mm Clear	6	0.149	0.68	i89-6.CIG
3167	Guardian	SunGuard® IS 20 Interior Surface LE on 5mm clear	5	0.198	0.74	SGIS20C5.grd
3168	Guardian	SunGuard® IS 20 Interior Surface LE on 6mm clear	6	0.198	0.73	SGIS20C6.grd
3179	Guardian	SunGuard® IS 20 Interior Surface LE on 3.2mm Clear	3.2	0.198	0.77	SGIS20C32.grd
3180	Guardian	SunGuard® IS 20 Interior Surface LE on 4 mm Clear	4	0.198	0.75	SGIS20C4.grd
3324	Guardian	ClimaGuard IS-15, Interior Surface LE on 2.0mm Clr	2	0.149	0.65	CGIS-15C2.grd
3325	Guardian	ClimaGuard IS-15, Interior Surface LE on 2.3mm Clr	2.3	0.149	0.64	CGIS-15C23.grd
3326	Guardian	ClimaGuard IS-15, Interior Surface LE on 2.7mm Clr	2.7	0.149	0.64	CGIS-15C27.grd
3327	Guardian	ClimaGuard IS-15, Interior Surface LE on 3mm Clr	3	0.149	0.63	CGIS-15C3.grd
3328	Guardian	ClimaGuard IS-15, Interior Surface LE on 4mm Clr	4	0.149	0.62	CGIS-15C4.grd
3329	Guardian	ClimaGuard IS-15, Interior Surface LE on 5mm Clr	5	0.149	0.61	CGIS-15C5.grd
3330	Guardian	ClimaGuard IS-15, Interior Surface LE on 6mm Clr	6	0.149	0.60	CGIS-15C6.grd
5242	PPG Industries	Sungate® 500 on Clear	3	0.215	0.70	S500CL_3.PPG
5244	PPG Industries	Sungate® 500 on Clear	4	0.215	0.69	S500CL_4.PPG
5246	PPG Industries	Sungate® 500 on Clear	5	0.215	0.68	S500CL_5.PPG

5248	PPG Industries	Sungate® 500 on Clear	6	0.215	0.66	S500CL_6.PPG
5295	PPG Industries	Sungate® 600 on Clear	2.3	0.144	0.66	SG600 Clear_2h.PPG
5296	PPG Industries	Sungate® 600 on Clear	3	0.144	0.64	SG600 Clear_3.PPG
5297	PPG Industries	Sungate® 600 on Clear	4	0.144	0.63	SG600 Clear_4.PPG
5298	PPG Industries	Sungate® 600 on Clear	5	0.144	0.62	SG600 Clear_5.PPG
5299	PPG Industries	Sungate® 600 on Clear	6	0.144	0.60	SG600 Clear_6.PPG
9920	Pilkington North America	Energy Advantage Low-E on clear	2.2	0.164	0.75	EnAdvLE2.LOF
9921	Pilkington North America	Energy Advantage Low-E on clear	3	0.164	0.74	EnAdvLE3.LOF
9922	Pilkington North America	Energy Advantage Low-E on clear	4	0.164	0.73	EnAdvLE4.LOF
9923	Pilkington North America	Energy Advantage Low-E on clear	5	0.158	0.68	LOW-E_5.LOF
9924	Pilkington North America	Energy Advantage Low-E on clear	6	0.157	0.66	LOW-E_6.LOF
9925	Pilkington North America	Energy Advantage Low-E on clear	8	0.157	0.62	EnAdvLE8.LOF