February 12, 2016

Mr. Doug Anderson
Project Manager
U.S. Environmental Protection Agency
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Dear Doug:

Larson Manufacturing Company is appreciative of the opportunity to review and provide input to the specification process for the proposed Energy Star program for interior and exterior storm windows. In light of the high percentage of U.S. homes containing clear single-glazed or clear double-glazed windows, storm windows provide an affordable and effective means to homeowners and building owners to easily improve the energy efficiency of these inefficient windows.

While the existing Energy Star program for windows guides those wishing to improve the performance of their windows to energy-efficient replacement windows, this alternative is beyond the financial resources of many home and building owners. Storm windows provide a reasonably-priced solution that enables a much greater percentage of the population to upgrade the performance of their windows than the Energy Star program for windows offers. Storm windows also offer, as noted in the Specification Framework Document, a very reasonable payback period.

When inquiring about storm windows, utility efficiency program managers, weatherization professionals, those engaged in historic renovation and preservation projects, and home performance contractors invariably ask whether storm windows are Energy Star qualified. This suggests that these professionals are seeking a means to evaluate the effectiveness of storm windows, and that Energy Star is the recognized and preferred method for identifying the most energy-efficient products in a particular category.

In summation, not only are interior and exterior storm windows an affordable and effective means for home and building owners and energy efficiency providers to significantly improve the energy performance of existing windows, but an Energy Star program would provide these decision-makers with an independent and credible means for comparing available products. Larson urges the EPA to continue moving forward with the development and release of an Energy Star program for storm windows, and offers the following input in response to the Specification Framework Document that was released on January 7, 2016.

I. Terms and Definitions:

Within the industry, exterior products are generally referred to as “storm windows” while interior products are generally referred to as either “storm windows” or “storm panels”. With regard to the proposed definitions as presented in the Specification Framework Document, Larson offers the following:

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.

   It is not necessary to limit a storm panel (or window) to residential buildings only since the same products are frequently used in light commercial and professional buildings.

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.

   Larson suggests removing the phrase “…without the use of nails, screws, or adhesives.” As with exterior products, these attachment methods are commonly used to securely fasten an interior storm panel (or window) to the primary window or surrounding frame. In addition to providing a robust mounting method, such fasteners ensure the product stays in place long-term to deliver the intended energy efficiency, and the use of adhesives and sealants can minimize air leakage.

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.

   As with exterior storm panels (windows) above, Larson suggests removing “…of a residential building” from this definition. Primary windows are used in building types beyond residential buildings.

4. Operable product: A product with panels that may be opened and shut to accommodate ventilation needs.

   Larson suggests modifying this to read “…to accommodate ventilation and/or egress needs.” Some storm products, such as an interior panel installed over an outswing casement window, provide consumers with the ability to save energy when the ability to ventilate isn’t a requirement. Such products may still be designed to enable the panel to be removed easily for egress purposes; for these products, “operable” is a more appropriate operator type than “non-operable”. Additional input is provided later under Installation Instructions.

5. Solar Heat Gain Coefficient (SHGC): The ratio of the solar heat gain that passes through a fenestration system to the incident solar radiation.

   It is suggested that this be rephrased as "The ratio of the solar *radiation* (emphasis added) that passes through a fenestration system to the incident solar radiation". As currently worded, much of the term being defined is used in the definition.

6. Multi-family building: Buildings that contain 20 or more residential living units.

   The definition, as currently presented, excludes any building containing 2 to 19 living units. It is suggested that this be modified to "…two or more residential living units".

7. Solar control: The ability of glass to allow sunlight to pass through while radiating and reflecting away a portion of the sun's heat.

   Since solar control involves controlling radiation as well as heat, Larson suggests replacing "heat" with "energy" so it reads "…while radiating and reflecting away a portion of the sun's energy".

II. Scope:

Larson generally supports the scope of products included in the section II.b. of the Specification Framework Document ("exterior and interior storm panels that are intended for use in residential buildings"), provided the suggested modifications to the definitions of exterior storm panel and interior storm panel proposed above are adopted. Larson proposes, however, that the limitation "that are intended for use in residential buildings" be removed. Storm products such as those contemplated in this specification are very suitable for use in light commercial and professional buildings such as doctor's offices, clinics, churches, and schools and provide the same energy efficiency benefits. As such, restricting storm products from use in these types of buildings seems counterproductive to the Energy Star program's guiding principle of saving energy on a national basis.

While an Energy Star program for storm doors would be of interest to Larson at some point in the future, it is recognized that research on storm doors (hinged products generally made of an extruded aluminum or vinyl frame or a laminated wood construction and installed over a hinged wood, steel, or fiberglass entry door) is currently insufficient to support such a program. Perhaps this can be part of a future effort or expansion of the program.

It is suggested that an additional subtype of storm products, patio storm doors, be included in Energy Star specification. Patio storm doors amount to very large horizontal sliding storm windows designed to be installed over sliding glass patio doors. Construction is nearly identical to a storm window, with glass panels surrounded by vertical and horizontal rails that slide laterally in a frame that is normally mounted to the exterior sliding glass patio door. The same types of glazing, including low-E glass, are used in patio storm doors as are used in storm panels and windows (though tempered glass is mandated by code), but

because the glazing area is larger than that of a typical prime window, the benefit and energy savings resulting from the installation of a patio storm door is magnified. An image of a typical patio storm door is shown below:

No known research or analysis specific to patio storm doors is available, but low-E patio storm doors were installed over two 72" x 80" sliding glass patio doors and contributed to the results of the PNNL Lab Home project documented in "Evaluation of Low-E Storm Windows in the PNNL Lab Homes" (Knox and Widder, PNNL-23355 Section 3.2, 2014).

III. Qualification Criteria:

1. Performance Metrics:

   A number of different performance-related criteria, including U-factor and SHGC, could potentially be used to differentiate energy-efficient storm products from standard storm products. The proposed glass properties of emissivity and solar transmittance, however, are adequate to provide this differentiation and can be easily administered.

   Simulations performed by an NFRC-certified simulation lab clearly show that glass type is the primary driver of storm window performance. Exterior double-hung, picture, and sliding storm windows from three different Larson storm window product lines utilizing different frame designs and both clear and low-E glass were simulated in accordance with NFRC-100 and NFRC-200 procedures over wood-framed double-hung, picture, and sliding primary windows, respectively, all containing clear single glazing. When comparing both the U-factor and SHGC for the combination of the primary window and

storm window across the three different product lines of storm windows, in no case did either the U-factor or SHGC ever differ by *more than* 0.01 for the same type of window (DH or picture or sliding window) and same type of storm window glazing (clear or low-E). Conversely, when comparing the U-factor and SHGC for the combination of the primary window and storm window between the two types of glazing (clear and low-E), in no case did the U-factor or SHGC ever differ by *less than* 0.10 for the same type of window (DH or picture or sliding window) and same product line of storm window (Product Line 1, 2, or 3). Stated another way, the type of glazing in the storm window (clear of Low-E) had a far greater impact than did the storm window frame design (Product Line 1, 2, or 3) on the overall performance of the combination of the primary window and storm window. With this in mind, glass properties can be an effective differentiator of energy-efficient storm products from conventional storm products, at least until the rating and certification being developed for fenestration attachments by the Attachments Energy Rating Council (AERC) is more fully developed. At that time the AERC performance metrics can be considered for use in an Energy Star program.

Administration of an Energy Star program based on glass properties would be very straight-forward, as well, since verification would be a matter of simply verifying the glass type used by the manufacturer and confirming the glass properties in the International Glazing Database.

Air leakage presents some unique challenges. While the air leakage level of a storm window can certainly be measured using established procedures such as ASTM E283, this isn't necessarily representative of the true performance of an installed storm window. Air can flow relatively unimpeded through the weep holes of a stand-alone storm window; however, when installed over a primary window, cool air sinking to the bottom of the airspace between the windows is competing with air being pushed through the weep holes due to the applied test pressure. Airflow through the weep holes of an installed storm window is limited, since it is difficult for air to move in and out of the same weep holes simultaneously.

A more relevant measure is the air leakage of the *combination* of a storm window installed over a primary window. This is the approach being contemplated by AERC, which is currently working with Architectural Testing, Inc. (ATI) to research and develop a test method in which a storm window would be installed over a calibrated test panel with a known air leakage level representative of a typical primary window. A performance specification would still need to be established, though it is hoped that the project with ATI will lead to a test method relatively quickly. In regard to application of the test pressure to both the exterior and interior sides of the product, it is recommended that the air leakage test procedure remain consistent with ASTM E283 (pressure applied to the exterior of the product only) and not be changed just for an Energy Star specification for storm products.

It is Larson's understanding that energy savings from reductions in air leakage are not being used as justification for the overall proposed Energy Star program. If meeting a

prescribed level of air leakage ultimately becomes a product specification for an Energy Star program for storm products, it is Larson's belief that the energy savings from reduced air leakage should be captured as part of the overall program justification, as well.

2. Example Programs:

   Regarding glass properties, there would be benefit to aligning qualification criteria with existing programs as this would minimize confusion in the marketplace and provide consistency in qualifications across multiple programs. The Regional Technical Forum of the Northwest Power and Conservation Council adopted an emissivity level of less than or equal to 0.22 as one of its storm window glazing criteria, and this level is also utilized by the Pennsylvania weatherization program. This is a reasonable criterion as multiple glass manufacturers (AGC, Cardinal, Guardian, PPG, and Pilkington) offer glass products meeting this criteria based on properties listed in the IGDB. Input on solar transmittance properties is provided in the following section.

3. Climate Zones:

   Larson is not opposed to establishing separate criteria for solar transmittance based on climate zone, but recommends that this be limited to no more than two different levels of solar transmittance. While this will create complexity in manufacturing, sales, marketing, and distribution, Larson recognizes and supports the Energy Star guiding principle of creating significant energy savings on a national basis and understands the benefit of maximizing opportunities for passive solar heating in northern climate zones while reducing solar heat gain in southern climate zones. Furthermore, an Energy Star program is ultimately about consumers, not manufacturers. Customer-focused manufacturers aim to provide consumers with products that best meet their needs, and establishing different solar transmittance criteria based on geography and climate is a step in this direction. A solar transmittance of approximately 0.55 corresponds to a natural break between low solar gain and high solar gain glazing products, and is also the Tsol limit established by the Northwest Power and Conservation Council RTF.

4. Installation Instructions:

   The items listed in the Installation Instructions section of the Specification Framework Document all present valuable information to the installer and/or consumer. Many of these items are already included in the installation instructions for Larson's storm products, and efforts to include several of the remaining items are already underway. Larson has no objections to the items listed, and further suggests that care and maintenance procedures also be required, including procedures for properly cleaning low-E glass.

   Specific to egress requirements, Larson understands and values the safety of both occupants and emergency responders. It is suggested that the type of storm window or

panel correspond to the type of primary window over which it is installed. That is, an operable or removable storm window (under the modified definition proposed previously) is recommended for installation over an operable primary window and a non-operable storm window is recommended for installation only over a non-operable primary window.

5. Negative Impact:

   There seems to be a perception by some that installing low-E storm windows over vinyl windows or over windows containing low-E glass can damage the primary window. Larson's experience has been to the contrary, and Larson is unaware of any scenarios or applications in which exterior or interior storm panels may damage or otherwise adversely affect the performance of primary windows. Self-storing storm windows that could be permanently installed and left in place year-round were among the first products produced by Larson when the company was founded over 60 years ago, and low-E glass was first available as a Larson storm window glazing option in 1999. Larson is a market leader with national distribution and millions of storm windows in service across the United States, but inquiries with several long-time members of Larson's Customer Care and Quality departments (125 total years of service and an average of nearly 21 years of service each) yielded not a single instance of a customer call regarding damage caused by a storm window to a primary window.

IV. Test Methods:

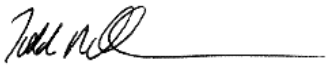
As discussed earlier, the proposed glass properties of emissivity and solar transmittance and air leakage are believed to be adequate to distinguish energy-efficient storm products from standard storm products. The test methods listed in the Specification Framework Document for measuring glass properties – NFRC 300-14 and NFRC 301-14 – are appropriate and commonly used in the industry.

While ASTM E283 is an established test procedure for measuring air leakage through windows, an alternative to consider is the approach being developed by AERC and ATI, which will measure the air leakage through a storm product installed over a calibrated test panel and is believed to be a more relevant measure than the air leakage through the storm product alone. Furthermore, it is recommended that the air leakage test procedure remain consistent with ASTM E283 (pressure applied to the exterior of the product only) and not be changed solely for an Energy Star specification for storm products.

Larson Manufacturing Company has been involved in EPA, DOE, and industry efforts to develop an Energy Star program for fenestration attachments for nearly ten years. Prior efforts were unsuccessful for a variety of reasons, but the creation of the Attachments Energy Rating Council, through the support and efforts of both the Department of Energy and industry stakeholders, has been a monumental step towards the development of a fair and credible

rating and certification program for fenestration attachment products. The release of the EPA's Specification Framework Document for an Energy Star program for exterior and interior storm windows is another significant milestone in this effort. For the reasons cited earlier, Larson strongly supports the continued development and release of an Energy Star program for storm products. Larson appreciates the opportunity to review and comment on the initial specifications, and looks forward to continuing to participate in the process. Larson also has information it considers proprietary that may help resolve technical issues and questions raised in the Specification Framework Document, and would be willing to discuss this in a follow-up conversation. If there is anything additional Larson or I can do, please do not hesitate to let me know. Thank you.

Regards,



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