Surrogates for Product Performance Durability? A Review of Window Warranties

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ABSTRACT

How long should a home last? 30 years? 50 years? 100 years? Unfortunately, builders, architects, remodelers and homebuyers have no reliable metrics for building durability and delivered long-term performance. Building products age at different rates. Many may experience dramatic changes in performance over time. Also, different performance attributes may change at different rates. For example, a product's energy performance may change at a different rate than its structural performance. Do predictive performance models capture this variation in performance life expectation? Are a consumer's initial product selections predicated on some expectation of delivered, long-term performance?

There are a few established surrogates for delivered long-term performance. One of the most common is building product warranty.

This study specifically investigates the chaos, confusion and contradictory claims in window warranties. Over 70 product warranties were compared as to various aspects of typical product coverages. Warranty issues investigated range from glass and hardware coverage to transferability terms, to declining and prorated coverage terms, installation coverage terms, climate-specific variables addressed and specific warranty exclusions. The financial implications of each warranty issue will be discussed from the perspective of the manufacturer, builder, remodeler and homebuyer/homeowner.

Based on a review of the literature the authors believe that this represents the first independent, non-commercial comparison of warranties for specific building products. The findings from this study should help builders, architects, consumers and others better understand the implications associated with window warranty provisions. The findings from this study should also encourage research on warranties in other building product areas where delivered long-term performance is deemed important.

BACKGROUND

"Sustainability" is the latest focus of the building industry. While many might argue over what constitutes truly sustainable building solutions, no one would argue that "energy efficiency" and "durability" are key elements of any sustainability equation.

Energy efficiency is a recognized part of the sustainable buildings equation. Buildings account for more than 40% of the total US energy consumption annually and almost 50% of the total electrical consumption. (EIA, 2006)

Durability is also recognized as an essential component of any sustainability effort, yet the building industry has few reliable metrics by which to measure it.

Analytical models used to predict building performance over time make gross assumptions about buildings and durability issues. For example, the economic models used to establish the national standard for minimum efficiency in commercial buildings, ASHRAE 90.1, has some built-in assumptions about expected building component "life" with which to conduct its cost-effectiveness tests. (ASHRAE, 2006, McBride 2001). Here, the economic assumptions for building envelope components (curtain walls, insulations,

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etc.) are based on 30 year life expectancy. Costs for HVAC components are modeled assuming a 15 year life expectancy. In both cases "professional judgment" was the primary determining factor in establishing the expected durability of the building components included in the models. The result of these decisions helps to determine the stringency of the code—the minimum efficiency.

What if these assumptions are wrong? What if the building elements last dramatically longer? Or dramatically shorter periods of time? What if their performance changes over time?

Parametric studies could be conducted using these economic models (such as to determine the most cost-effective insulation levels or what air conditioner efficiencies were most cost-effective for a given building in a given location.) But these would not make the models better predictors of a specific building's operational reality. Such parametric modeling would not hone professional judgment associated with any particular product specification or purchase. Certain questions would remain—such as "How long will it last?", or "How long should it last?" or "How long will it perform?" or "What is the most sustainable product solution?"

Durability seems to be a weak link in the knowledge base necessary for any sustainable building effort. The term "weak link" is used because the building products marketplace has not established reliable and repeatable ways to measure long term performance. Product manufacturers have laboratory "torture tests" to simulate accelerated aging of products, but these tests are rarely extrapolated into meaningful equivalents of long-term performance or compared to the performance durability demonstrated on real buildings.

Yet, many products can last a long time in a building. American log cabins over 150 years old or European timber structures over 500 years old, or adobe and mud buildings over 1000 years old all demonstrate that building durability actually can be delivered.

Surrogates for durability have long been used in commerce. The most common of these is product or system warranty. Whether a sales tactic or meaningful measure of performance expectations, warranty is advertised and marketed as meaningful in a product purchase decision. Warranty is a form of promise from the manufacturer that, should a problem arise in the future, (within the limits of the terms described) some help will be provided.

For some products—such as structural brick and concrete and structural steel, the market has come to rely on engineering calculations (based on the performance of known formulations). Specifiers don't typically ask how long the foundation block will last. In some cases structural warranties are requested and provided—based on engineering calculations, certification tests or both. But over time the marketplace has come to accept some building materials' performance reliability based on their proven track record, reliable chemical and physical properties, or industry standards.

The performance and durability of certain products is hidden from the occupant—such as insulations. The marketplace relies on third-party certification programs for assurance that the labeled performance indices are trustworthy (such as for R-value) and expects that the performance is further assured by proper installation. But once hidden from view, consumers can only hope that the installed performance is equivalent to the predicted models as well as the expectations established by the labeled performance indices.

Other products have performance indices that are more evident—such as water heaters and air conditioners. Again, the marketplace relies on third-party certifications to deliver confidence in the energy ratings. But that confidence is limited by the fact that the ratings are typically for one set of operating conditions—usually conditions that the buildings rarely see.

Building commissioning may help increase the likelihood of delivered performance to match the model, specification or plan. Pre-occupancy measurement (kWh, Btu's, etc.) may deliver a gross metric of deviation from plan or model. But these measurements do not (typically) indicate which building element is not performing up to spec nor which one(s) may be over-performing.

Windows play a key role in building energy performance. Their energy performance is highly variable, depending on technologies employed. Third-party certification provides instantaneous performance indices for product comparison. But what about performance over time? What assurance does the purchaser or specifier have that the performance modeled will be delivered?

Warranty is the primary means available to assess the long-term performance assurance for windows—and it is a poor surrogate for durability at best. The term "poor surrogate" is used here because even the best warranty cannot fully capture the long-term performance variables and marketplace expectations for windows.

Windows are very complex systems within the building envelope. Their performance impacts heating, lighting, cooling, ventilation, water management, egress and many other building loads and operations. Small differences in one performance element can have a huge impact on total building performance.

For example, the air conditioning load for a 2000 sq. ft. single-family home can double or be cut in half just by which type of low-e window is used. (EnergyPlus analysis, 2006)

But what happens if the glass seal fails? How does the energy performance of the window change? How does this change impact energy bills? How does this change impact the achieving of a project's sustainability objectives?

A review of window warranties was conducted to begin to understand what one key building industry sector does to address the issue of performance durability. This review should help to establish targets for future research at ASHRAE and elsewhere regarding establishing truly sustainable building decisions.

WINDOW WARRANTY ELEMENTS

Windows are often complex systems, and, as such, often have complex warranty provisions. The primary warranty provisions addressed in this study are listed here along with a general definition for the reader.

- *Insulating Glass*—How long the seal between the various panes of glass is warranted to last. This is critical to the performance of low-e glazings and those with gas fills.
- *Hardware*—This addresses the operable parts of the window, such as balances, hinges, locks, etc.
- *Material* (structural framing)—Formerly wood, steel, aluminum or vinyl. Today windows are made from a variety of materials and systems to deliver the required structural performance.
- *Finish*—The coatings, paints or cladding typically delivering color or wear resistance.
- *Screens*—For ventilation in operable windows (insect screens)
- *Installation*—Some windows are installed by the warranty provider.
- *Owner*—To whom the warranty is granted (not always the same entity)
- *Transferability*—Once sold, who gets the warranty next? What do they get?
- *Pro-ration*—Any change in terms of coverage over time
- *Exclusions*—What is not covered or what voids a warranty

WARRANTY REVIEW

Insulating Glass

Insulating glass is one of the most critical components of the delivered energy performance of a window or glazing system. Over the past few decades the glass industry has produced significant innovations that deliver superior energy performance compared to the windows of a generation ago. Low-emissivity coatings, gas fills and insulating spacers are all innovations designed to improve overall window efficiency. Critical to the delivery of this improved performance is a durable seal and appropriate amounts of desiccant within the sealed unit. The combinations of multiple panes of glass sealed together with a spacer material and desiccant is referred to as an "insulating glass unit"—or IGU.

In a review of 72 window manufacturers' warranties the coverage on the IGU ranged from "none" to "lifetime". If the performance of the IGU is so critical to the energy performance of the window, how can there be this much range of warranty variation? The real variations are found in the small print details.

Figure 1 shows the distribution of insulating glass coverage (in years) for the warranties reviewed. Note that these are the coverage claims as first indicated in the warranties. Further reading in the warranties shows an array of exclusions, non-transferability clauses and other notable specifics that significantly reduce the effective coverage terms of many of these warranties—especially the "lifetime" ones. Examples of these exclusions, exceptions and limitations are described in subsequent sections of this paper.

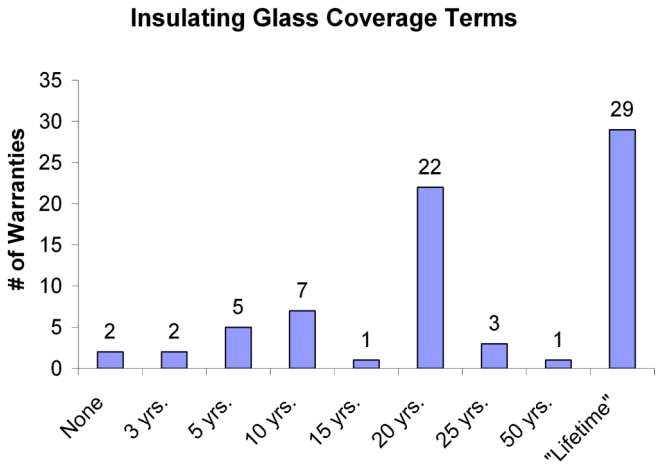

Figure 1 *Initial insulating glass coverage terms.*

Hardware

Window hardware comes in many forms—from locks and handles to balances and ventilation stops. Manufacturers offer an array of hardware finish choices to deliver style and design options to buyers. Yet hardware performance over time is seldom considered a component of window durability or performance longevity.

Operable windows represent over half the market of new and replacement windows sold (Ducker, 2005). So their ability to open (for passive ventilation) and close (for security and air tightness) plays a key role in long term performance reliability.

Warranty coverage on hardware isn't easily generalized. First, there are wide array of materials involved—from metals to engineered plastics. These materials all respond differently to different forces (ultraviolet radiation, use fatigue, etc.) Also, the durability of some hardware is also dependent upon the weight of the window element being opened or moved. Sash balances, for example, are typically designed to address the weight of the sash - which is very size dependent.

Hardware designs must also address the environmental extremes to which the window and hardware might be subjected. For example a casement window sash opened for ventilation in an area of periodically high wind speeds might have a very different life expectancy than one used in low wind speed areas.

This review of window warranties showed a wide distribution of coverage terms related to hardware performance—from "none" to "lifetime" (Figure 2). Thirty-five (35) of the warranties showed "lifetime or "limited lifetime" as the hardware coverage terms. The second most common coverage period found was 10 years.

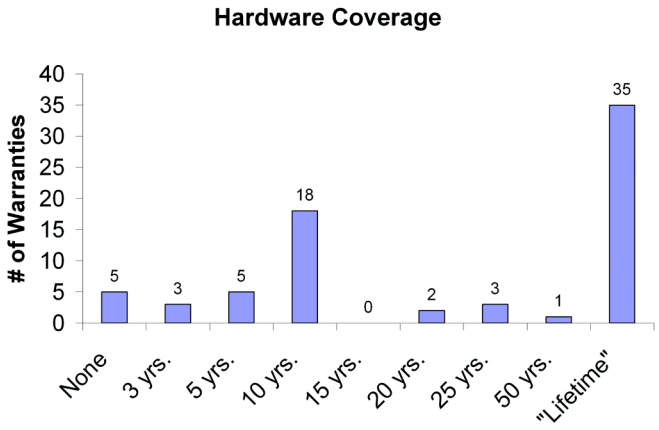

Figure 2 *Hardward coverage terms.*

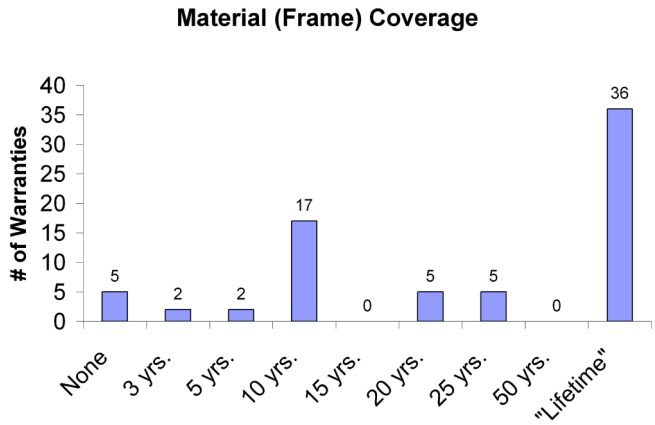

Figure 3 *Material (frame) coverage terms.*

Exceptions and exclusions were just as common in the area of hardware coverage as in insulating glass coverage. "To the original purchaser" and "excluding hardware finish" and "100% coverage for 5 years" were common exceptions and clarifications to the "lifetime" terms.

In no cases were the hardware coverage terms linked to claims of energy performance longevity.

Materials

Most of today's windows can only be referred to as "composites"—meaning, windows are made from a variety of materials with a variety of thermo-physical properties. Just a few decades ago windows were typically defined in categories delineated by frame type—wood, vinyl, steel, aluminum. Today all of these materials (and others) are used in combination to produce windows with a variety of resultant composite properties. There are composite windows, made from completely new generations of materials that did not exist a decade ago—such as new composite materials made from wood fiber and plastics in combination.

So what is "material coverage" in a warranty? For the most part, warranties still refer to the framing components when discussing "material coverage".

Figure 3 shows the distribution of coverage terms among the warranties reviewed for this study. It is interesting to note that some of the warranties were specific in changing the terms of coverage depending on which frame material the buyer selected. Often there were different coverage terms for "vinyl" versus "wood" frames.

Again, issues of ownership, transferability and pro-rated coverage effectively limited the actual coverage in those warranties claiming "lifetime" coverage.

Finish

Figure 4 shows the coverage terms for "window finish". This warranty coverage topic has the most exclusions and exceptions regarding the terms of coverage. Thirty of the 72 warranties reviewed either showed no coverage or specifically excluded finish from the coverage terms.

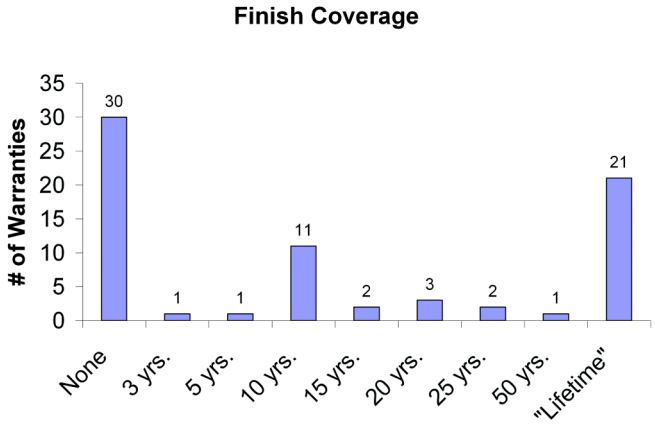

Figure 4 *Finish coverage.*

While finish may not be a huge aspect of energy performance durability, it does play a role in the energy required to maintain a window product. How often must the buyer paint, stain, clean, scrape, sand or otherwise repair the finish of the window? Are these operations and maintenance costs and energies included in any attempt to quantify long-term performance or sustainability metrics? How do these operations and maintenance costs play into decisions about replacement?

The list of exceptions and exclusions regarding window finish coverage terms is lengthy. Almost all warranties specifically state that certain environmental exposures can void the warranty on finish. First atop all of the exclusions is exposure to acid rain (though no specific definition of acid rain was offered in any warranty.) Other exclusions include extreme sun, rain and hail conditions (undefined), certain solvents and cleaning agent use, dust storms and ice build-up (among others).

Without any substantiating field survey data one can only speculate how much of a role finish plays in the decision to replace a given window. Past surveys have captured "comfort", "energy efficiency", "improved operation" and "improved house value" as the primary determinants of a window replacement decision.

Screens

Screens are an essential element of operable window performance, especially for seasonal passive ventilation. Many manufacturers provide screens along with warranty coverage for screens with their operable window products. However, few manufacturers offer warranty coverage specific to the screen frame or mesh materials.

Fifty-six (56) of the warranties reviewed showed no coverage for screen mesh or screen frame (Figure 5). Of those that offered warranties, one was specific to state 20 year coverage on the frame material and 5 year coverage on the mesh material.

Analyses have shown that the solar optical properties of window screens can have a big impact on total window solar heat gain, visibility, visual clarity and daylighting potential (WINDOW 5 analyses and personal correspondence with window and screen material manufacturers). While there are efforts underway to provide meaningful marketplace indices for these properties (NFRC) the marketplace has yet to fully embrace a reliable system for rating the energy performance properties of screens and their resultant impact on total window energy performance.

This quantification problem is exacerbated by the fact that, for many windows, screens are optional or seasonally removable. Therefore, even if the energy performance impacts of screens were well known, relying on their presence in any window or building thermal modeling effort (or building energy code) would be immediately suspect.

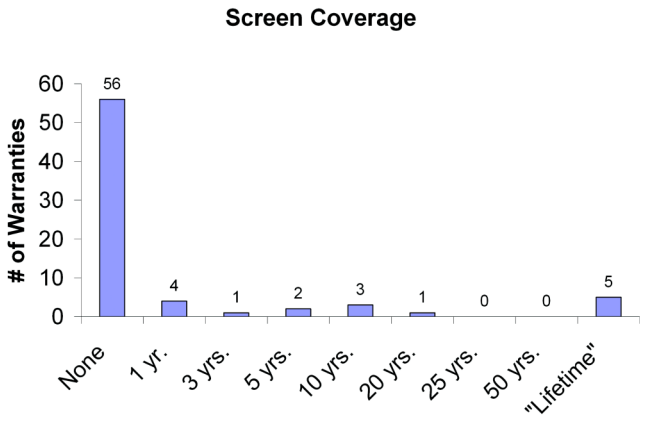

Figure 5 *Screen coverage.*

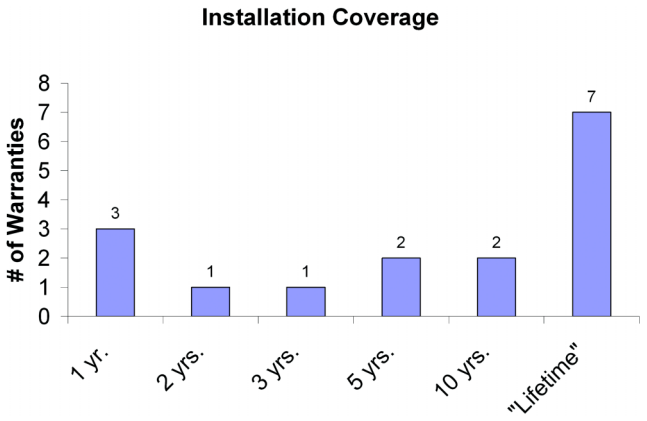

Figure 6 *Installation coverage.*

Installation

Most window manufacturers do not know where or how their windows are installed. Typical construction commerce models usually include various distribution channels that distance the manufacturer from the details of the job site.

However, there are a few "installed sales" business models where warranty coverage of the actual installation is addressed. Of the 16 warranties reviewed that addressed installed sales, seven of the 16 were of the "limited lifetime" variety. Figure 6 shows the distribution of installation coverages found.

While window manufacturers may not typically offer installation coverage (unless they are actually doing the installation), this brings into focus one of the most critical areas of delivered, long-term window performance—was it installed properly?

Improper integration of windows into walls is probably the single most common reason for a warranty claim (This statement is based on personal correspondence with several major window manufacturers.) This fact is supported further by the array of professional associations, building scientists and others who are actively engaged in developing standards and training programs specifically to address proper window installation. (EEBA, ASTM, AAMA, etc.)

Quantifying the importance of warranty coverage related to installation is difficult. Whether the window is going into new construction or is a replacement product creates a completely different risk exposure for window manufacturers.

In theory, installation in new construction should be a lower risk proposition for manufacturers due to the ability to more easily integrate the window into the wall's overall water management strategy. This assumes that proper installation techniques are known and followed.

However, approximately half of the windows sold are for the replacement and remodeling markets. (Ducker 2005) In replacement situations, installers have less control (and flexibility) over proper integration methods. Depending upon whether the frame is replaced or kept, exterior finish trim or brick mold is also being replaced, whether the wall already has a good water management system or not and other site-specific variables, the final installed performance of a brand new replacement window can be seriously jeopardized.

Ownership/Transferability

Warranty provisions addressing ownership are curious and confusing. Rather than the warranty explicitly addressing

the actual product—i.e., "the window", most warranties go to some length to address home ownership, what happens when the home is sold and what warranty provisions change as soon as the title to the home changes hands. The most common (curious) example of this warranty structure is that the terms of coverage are reduced upon the sale of the home. A meaningful analogy might be buying a used car that is still "under warranty" yet the warranty coverage is now reduced because of a new owner.

If "warranty" is a surrogate for "durability" then what does home ownership have to do with long-term window performance? Evidently it is meaningful at some level because warranty transferability is a major differentiator among the warranties reviewed.

Figure 7 shows the diversity among warranties when considering ownership and transferability.

While the sales reasons for such odd warranty provisions may not be immediately obvious, it is clear that "warranty transferability" is a major source of product/manufacturer differentiation. For 21 of the warranties reviewed it was clear that the warranty coverage stayed with the product regardless of homeownership. This implies a degree of confidence in the long-term performance reliability for the total window as well as each of the elements addressed in the warranty.

In contrast to the "fully transferable" warranty examples, 23 of the 72 warranties included a variety of terms, exceptions and clauses that, in effect, limit or reduce the terms of warranty coverage. These include: provisions that require new owners to contact the window manufacturer and pay a fee for the warranty provisions to remain in effect; provisions that allow for one and only one warranty transfer—sometimes only within a certain time period; and provisions that allow for the warranty to be transferred, but with significantly reduced length of coverage term.

Pro-Ration

One of the most understandable risk reduction strategies for window manufacturers is the reduction in warranty coverage over time. Should problems arise and warranties need to be exercised, the age of the product often defines the percentage of replacement price that will be covered. This is commonly referred to as "pro-rating the terms of the warranty".

The primary difference among pro-ration strategies is the rate of coverage reduction—or, how fast (in terms of window age) does the warranty coverage go to zero?

Figure 8 shows the variety of pro-rating strategies employed in the 72 warranties reviewed. Some are stepped with coverage declining incrementally over the typical 20-year term. Others cover full replacement for a brief period (2 to 5 years). Most are explicit to address the ability of the manufacturer to provide replacement parts as a warranty remedy.

Few warranties offer provisions for paying for repair labor. Those that do typically limit the labor inclusion coverage to 1 to 2 years.

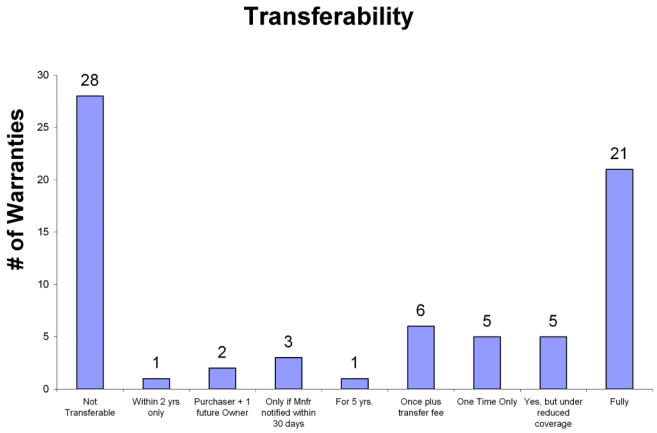

Figure 7 *Transferability.*

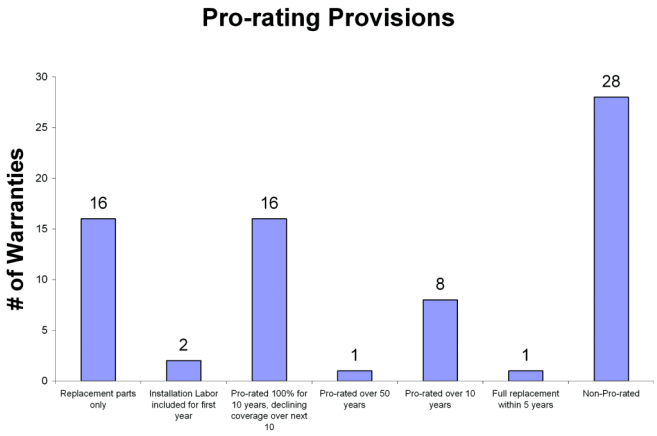

Figure 8 *Pro-rating provisions.*

Twenty-eight (28) of the warranties reviewed reflected some semblance of full coverage for the full term of the warranty. These are referred to as "Non-pro-rated" warranties where the age of the product does not matter.

Exclusions and Exceptions

As with many consumer product warranties, the exclusions and exceptions provide the most interesting reading.

Typical warranty exclusions include "Acts of God", "Fire" and "Flood". Some warranties go to great lengths to cite additional exclusions: "… volcanic ash, fire, lightning, earthquakes, windstorms, tornadoes, or any other act of God, explosions, riots or civil disturbances, war, misuse or abuse, or other causes beyond the control of…"

"Improper Maintenance" is also a common term of warranty exclusion even though it is not particularly well-defined. Some warranties expressly cite cleaning and maintenance provisions as necessary to maintain the warranty terms (much like automobile warranties). Many also cite maintenance and cleaning materials as items that can void warranties.

As mentioned earlier "Acid Rain" is explicitly cited as an exclusion in almost every warranty. Other interesting exceptions include "exposure to excessive heat or rainfall", "improper handling" and other non-defined or ill-defined terms.

Location can bring with it conditions that may unexpectedly void warranties. For example, "exposure to salt air" (such as exists in every coastal environment) is an exclusion in many warranties. Similarly, some warranties specifically cite application "at altitudes over 5000 feet" as a warranty exclusion condition. But most manufacturers do not know where their product will end up, so planning for every possible climate and location-specific variable that might impact window performance is unrealistic.

"Faulty or improper installation" is the most common warranty exclusion provision. This may be some indicator of what is viewed by the window industry as the most risky component of long-term window performance. Among window products that might otherwise be considered "durable goods", installation may be the most limiting factor to delivered, long-term performance.

This review of window warranties also revealed an interesting array of exceptions and limiting language that bring into focus the reality that most manufacturer's rely on a buyer's laxity at reading or considering warranties. As previously mentioned, many of the warranties include timelines for transferability upon home sale that no new buyer (focused on getting moved in) would ever exercise (within 30 days—for example). Similarly, one would have to be very interested in what warranty comes with the windows of their recently purchased house to find out that the new owner must file a new owner notification with the window company within 45 days of transfer of title, along with a $100 fee, to transfer the coverage under the existing warranty terms (assuming the "lifetime warranty" was still in effect.) Interestingly many of the warranties state that "as long as the original purchaser owns and resides in the home in which the product was installed…" the warranty remains in effect—implying that the warranty has more to do with the owner than the product.

The word "Lifetime" is usually accompanied by the word "Limited" with dozens of exceptions that essentially make exercising the warranty provisions impossible.

Conclusion

Energy performance durability is essential for any utility, local, state or national energy policy planning effort. Unfortunately we have little assurance of energy efficiency durability for one of our most important building elements—windows. Product warranties appear to be a poor substitute for assuring truly long-term performance reliability. "The large print giveth and the small print taketh away."

Some (few) window companies use well structured product warranties to deliver high degrees of performance assurance reliability. Their warranties are fully transferable, cover critical energy performance elements such as insulating glass for at least 20 years, are non-prorated, covering the entirety of the product price over the term of the warranty, cover hardware, such as locks and balances, and cover durable finishes, as well as proper owner maintenance and upkeep responsibilities and recommendations.

Installation is a problematic area in terms of product warranties. Most manufacturers are not involved in the installation of the product and must rely on local trades people or Do-It-Yourself-ers to deal with the challenges of proper integration of the windows into a wall system. One area where manufacturers are engaging in further warranty risk reduction is through active involvement in builder training programs specifically on window installation techniques.

It is understandable that window manufacturers would want to limit their risk exposure over time, especially due to the fact that most have little to no control over their product once it leaves the factory or is installed. Compare this to an automobile warranty where regular maintenance is required to keep warranty provisions in place. Similar business models are being considered by the appliance industry to address minimizing warranty risk and to create long-term connections with past customers.

Beneficial future research might be a similar review of actual warranty claims. However, it is easy to understand that such data might be difficult to acquire without a high degree of assured confidentiality and a willingness on the part of the window industry to share the weak links in these coverages. Perhaps certain elements could be captured, such as glass failure claims or hardware claims. Of additional interest would be to acquire data that could be mapped by geographic region to examine regional and environmental variables contributing to warranty claims.

Windows play such a critical role in the overall performance of both residential and commercial buildings that manufacturers might well consider these types of new warranty and product protection mechanisms, especially for those that are manufacturer-installed. Instead of merely focusing on "How long should it last?" manufacturers might well begin asking the question "How can we keep a brand relation with this customer and this product for life?"

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