White Paper

How to Select a Green Door:

Sustainability Concerns for Exterior Doors in Commercial and Institutional Environments

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> "*Eco-effectiveness means that we start by redefining how we measure progress — that we start measuring our legacy, not our activity. That brings up a whole new set of questions: What if your product is your worst emission? Do you become eco-efficient and devise ways to make it less toxic? Or do you become eco-effective and move beyond superficial adjustments? …*
>
> *Start thinking about good design rather than just green design."*
>
> William McDonough, renowned architect and co-founder of the Cradle-to-Cradle model for Life Cycle Assessment

Introduction

There is perhaps no more basic mechanical element in the built environment than the exterior door. Whether it is a hunting shack or a high school, a building before anything else has walls and some type of entrance system. The more elaborate the building, the more elaborate the entrance system. A high-security structure will have a high-security door. A high-design facility will have a high-design door. A green building will have a green door.

If only it were that simple.

A surprising number of entrance systems specified for commercial and institutional environments are not built to withstand the rigors of heavy use, continuous exposure to the elements and occasional abuse common to high traffic entrances.

Despite all the attention currently being given to the improvement of building components to align with the continuously growing green building movement, little thought has been given to the basic issues of sustainability and performance commonly affecting exterior doors. To remedy this, it is necessary to understand the role exterior doors play in achieving the sustainability goals of a structure, and likewise, to recognize the various considerations and priorities that do not precisely align with standard green building practices and philosophies.

External Door Functionality

To understand what makes a door sustainable, it is first necessary to define what makes an entrance system successful. On a very basic level, the functional requirements of an entrance system are that it:

- Allow safe ingress and egress for building users
- Provide a physical barrier to secure the building against undesired entry
- Serve as a thermal barrier between indoor and outdoor temperatures

- Separate indoor air from outdoor air to facilitate HVAC processes
- Keep out rain, wind, pests and other natural elements
- Withstand the rigors of normal usage and occasional abuse

In addition to these functional requirements, an entrance system should also

- Provide a meaningful touch point for building users
- Conform to the general aesthetic and sustainable design themes of the building

Beyond these characteristics, it is assumed that *the ideal entrance system should not demand any more attention in a facility's maintenance routine than its windows, walls or roof.*

Defining Sustainability

So what makes a door green? And for that matter, what makes any product green?

In creating a set of guidelines for environmental claims, the Federal Trade Commission determined that it is misleading to refer to any product, package or service as having too general of an environmental benefit. So in a strictly technical sense, no product should be called "green", "eco-friendly," or "sustainable." It is best to consider sustainability a moving target, with certain features and metrics implying various levels of sustainability.

These sustainability metrics come in two forms:

Performance metrics of sustainability measure the quality of a product and are concerned with:

- Lifetime of the product
- Maintenance requirements of the product (monetary and environmental)
- Operating characteristics of the product (monetary and environmental)
- Overall efficiency and effectiveness of the product

A key attribute of any performance metric is that all claims must be verifiable. These metrics create a sustainability conversation about outcomes, efficiency and effectiveness, not ancillary factors such as geography or content.

Prescriptive metrics measure certain attributes commonly associated with sustainable design and development. Unlike performance metrics, which require deeper product knowledge for specification, prescriptive metrics are easily defined. Although at times arbitrary to real-life product concerns, these easily understood metrics are largely preferred by third-party sustainability standards, including the U.S. Green Building Council's Leadership in Energy and Environmental Design Green Building Rating System.

Unfortunately, these metrics can sometimes be blind to critical performance issues. Following the LEED guidelines to the letter would, for instance, add additional maintenance costs and potentially limit the lifespan of an entrance system.

As such, *Special-Lite believes that <u>it is more appropriate to use performance metrics to evaluate the sustainable attributes</u> of a building product such as exterior doors, reasoning that <u>a sustainable exterior door must first and foremost provide the necessary functionality of its role</u>.*

With that said, green building standards such as LEED are the common language for sustainability in the commercial and institutional facilities markets, so it is still important to understand how an exterior door fits into those systems.

Tradeoffs

There are inherent sacrifices in any sustainability feature, regardless of whether the product in question is an exterior door, automobile or soda pop bottle. The most recognizable tradeoff is the price of the product: Savvy, educated buyers recognize that they are "paying for quality." Exterior doors are no exception. A long-lasting, high-performance exterior door will be a somewhat larger investment than the alternative.

Concerning specific sustainability attributes, there are a number of features that are in direct conflict with each other. For example, design elements such as daylighting and views, a key piece of sustainable design for their effect on worker health and productivity, have a correspondingly negative effect on thermal efficiency. Other elements, such as the use of rapidly renewable or recycled materials, make no sense if the product does not fulfill the performance requirements for which it is specified.

A necessary part of the design and specification process, this balancing act can easily introduce subjective decisions to objective guidelines. The purpose of the following discussion is to assist in those decisions as they pertain to exterior doors.

Performance Metrics for Sustainability

The next major shift in the business world will come as buyers begin looking past basic green claims to examine the underlying performance of a product. The eventual standard for evaluating sustainability features of a building product will almost certainly be **Life Cycle Assessment**, a process that measures the impact of a product at every stage of its life cycle. This model examines the monetary and environmental implications of a product from raw material extraction to disposal.

According to the United Nations Environment Programme, Life Cycle Assessment is characterized as:

- Awareness that selections are not isolated, but influence a larger system.
- Making choices for the longer term and considering all environmental and social issues associated with those.
- Improving entire systems, not single parts of systems, by avoiding decisions that fix one environmental problem but cause another unexpected or costly environmental problem.
- Informed selections, but not necessarily ‘right’ or ‘wrong’ ones. Life cycle thinking simply puts decisions in context with facts from all parts of the system or life cycle — look for unintentional impacts.

This model is the underlying rationale for the performance metrics for sustainability. Put in the simplest of terms, LCA takes into account both prescriptive and performance values, accounting for trade-offs and hidden effects. The use of LCA allows a buyer to see the underlying costs of product and material choices — uncovering whether or not a seemingly sustainable item is appropriate for its intended use. This perspective reveals how truly sustainable a product is.

A Note on LEED

The LEED Green Building Rating System is a voluntary, consensus-based national standard for high-performance, sustainable buildings. Members of the U.S. Green Building Council, representing all segments of the building industry, developed LEED and continuously work to improve the system, including a significant update in early 2009. The various standards are discussed at length in the Performance Metrics section of this paper.

Only structures and campuses are currently certified under the LEED standard. Green building professionals do have the option to earn LEED accreditation, but LEED is and for the foreseeable future will be product neutral. There is no such thing as a LEED certified product. Note that a USGBC shield in product literature does not imply a LEED endorsement for that product or its manufacturer, only USGBC membership.

LEED is organized into six categories, each containing a number of prerequisite (mandatory) requirements and a number of optional (project team selected) credits or points, the total of which are applied on a progressive scale of Basic, Silver, Gold and Platinum. The categories are:

- Sustainable Site Development
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation and Design Process (essentially bonus points for exemplary effort in the five main categories)

Although the LEED credit system is not perfect, it has become a fairly ubiquitous standard for green building design and construction. Its five main categories provide a clear guide to the performance themes consistent across all sustainable development.

Two of those themes, Sustainable Sites and Water Efficiency, are not generally relevant to exterior doors. The themes that are relevant to entrance systems are:

<u>Energy Efficiency:</u> Properly known as Energy & Atmosphere, this category encourages thermal efficiency and alternative energy.

<u>Materials & Resources:</u> This category is concerned with the various life cycle issues of product use and specification.

<u>Indoor Environmental Quality:</u> More of a human health concern than a standard environmental issue, this category promotes increased occupant comfort and the elimination of indoor toxins.

In order to best compare the sustainability effects of performance and prescriptive metrics, these three themes will be examined in relation to each of the following prescriptive metrics for sustainability in exterior doors. In addition, a fourth theme of Maintenance will be examined as well. While not a direct sustainability factor, the potential impact on maintenance costs in time and labor for an inferior entrance system is significant enough to be measured as a performance value in its own right.

Structural Strength

This requirement is obvious on the surface level. An exterior door must be able to withstand malicious attempts to damage or breach it. What is not obvious is that the door must be able to withstand literally thousands of small collisions during normal usage each day.

The inertia created by opening and closing a door subjects it to physical forces that stress the door itself and the hardware that moves and supports it. The door is being stressed and twisted with each use, while the hardware is being strained and struck.

Understanding this requires the recognition that an entrance is actually a system consisting of door, hardware and framing — a deficiency in any one component will affect the entire system — as well as a passing familiarity with the laws of physics.

Newton's laws of motion state that the energy required to move an object is directly related to the mass of an object. The heavier the door, the greater the load placed on the hardware and framing elements as it opens and closes.

Likewise, the force required to stop the movement of an object also increases proportionally. Where ***F****orce* is a product of ***m****ass* and ***a****cceleration,*

$$F = ma$$

Think of slamming a door: Is a heavy or a lightweight door more likely to rattle the room? Now think of what type of damage a few hundred thousand of those collisions can do to the entrance's framing components and associated hardware over the course of the year. While the door itself may be able to withstand these impacts, the other essential components may not.

So the heavier the door, the more force required to move it, the more stress on the hardware to control it and the more powerful the impact on the hardware and framing elements.

What this means is that the ideal door is one that minimizes the damaging effects of its motion. Not only should the door be lightweight (less mass: less force), it should also be flexible, not rigid. Flexibility is directly proportional to a door's ability to absorb and equally distribute the force of an impact, a property known as flexural strength. Reinforcement is only necessary at the corners, edges, hinges and hardware attachment. The Special-Lite flush doors accomplish this through the secure attachment of hardware; full length, continuous gear hinges; and mitered corner joints secured by angle blocks and full-width, three-eighths-of-an-inch-thick galvanized steel rods.

A door is not a wall — it should not be designed like one. It only needs to be rigid and solid enough to provide the desired functionality. Any more than that is counterproductive and will increase the wear and tear on associated hardware.

As the hardware and framing components wear out, the door may go out of adjustment and fail to latch properly; creating leaks that will affect weather resistance and thermal integrity.

This design philosophy does run counter to conventional industry thinking that insists on heavy, rigid doors. To prove the durability of doors built in this manner, Special-Lite tested its lightweight, flexible Fiberglass Reinforced Polyester Doors to the ANSI A250.4 standard to 25 million open and close cycles (the equivalent of 1,000 occupants passing through a door every day for 62 years), as well as the NWWDA T.M. 7-90 cycle-slam test through 5 million cycles. The doors passed both tests easily.

Special-Lite also created its own proprietary “slam test.” A bag with 215 pounds of sand was suspended in front of the door, pulled back a measured distance, and allowed to slam into the door. This test was performed at increasing velocity to the point of failure on both the company’s doors and doors produced by competing companies with more conventional design and manufacturing philosophies. Proving the design principles explained in this section, the lightweight, flexible doors manufactured by Special-Lite continued to function normally after the conventionally designed doors had reached the point of failure.

Also, it is incredibly important to examine an entrance for the quality of its structural components. Special-Lite fabricates all of its structural components from aluminum, as opposed to steel. The high strength-to-weight ratio, natural corrosion resistance, excellent workability, and ability to accept a wide range of finishes make it an excellent choice for architectural products.

Relevance of Structural Strength to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
As a door and its hardware wears out, it may begin losing its ability to seal properly, negatively affecting the thermal efficiency of a structure.	A structurally unfit door will need to be replaced sooner than the alternative. Hardware and framing components will need to be replaced sooner than the alternative.	None.	Increased cost for repair and replacement of door and/or hardware.

Impact Resistance

As mentioned above, an exterior door must be durable enough to withstand kicks, shoves and occasional blunt force collisions from human (a run-away cart, a homerun baseball) and natural (high-velocity winds, hail) sources.

It is no coincidence that the easiest requirement to understand is also the most likely for an exterior door to meet. Every door should be expected to function as an effective barrier. The true test is whether a door can do so without significant damage. Special-Lite has found that the most effective face material for impact resistance is Fiberglass Reinforced Polyester or Acrylic-Modified Polyester.

In some areas, a second set of criteria are in place for impact resistance. Hurricane-prone areas around the Gulf of Mexico have specific impact resistance standards for structural elements. For a manufacturer's entrance system to meet local building codes in these areas, the exterior door and associated hardware must first pass a barrage of tests that approximate hurricane conditions.

Relevance of Impact Resistance to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
Negligible, but a hole in the door would harm thermal efficiency.	A door not built for impact resistance will need to be replaced sooner.	Negligible, but products used for repair of door could introduce toxins to structure.	Scratches, dents and other damages will increase cost for cleaning, repair and replacement.

Chemical and Corrosion Resistance

Really two different sustainability metrics, the same features are common to the ideal door for Chemical Resistance and Corrosion Resistance. Look for non-corroding materials, lifetime factory finishes and easy-cleaning surfaces. This will provide protection against graffiti and abrasive cleaning agents that could stain or corrode the surface of the door. Such cleaning agents are also a sustainability concern in their own right, introducing toxic chemicals and fumes to the structure while wasting energy and labor.

While the threat of graffiti is common to all commercial and institutional facilities, these two metrics are not going to be a top priority for every facility. Be especially wary if the door is installed in a humid environment or near the ocean, at industrial facilities and water or wastewater plants, pools or in locations likely to face wind-driven rain or snow. Even sidewalk salt can take a heavy toll on a door.

Addressing corrosion damage is not only a frustrating maintenance cost, it is one of the most alarming environmental and health concerns associated with entrance systems. In a manufacturing setting, door finishing operations are strictly regulated for worker and environmental safety. Field refinishing essentially transfers a secure industrial process to an occupied open air facility. Particulates from sanding and the high-VOC, highly toxic finishing chemicals and paint are introduced to the facility.

If that weren't enough, corrosion can also attack the inside of a door. As will be discussed in the Moisture Resistance section, an improperly sealed door can create a scenario in which a door corrodes from the inside-out. If it needs to be said, there is no way to refinish the inside of a door.

Aluminum, FRP and AMP are all potential face materials for these types of applications. These materials are scratch resistant and offer excellent cleanability.

Relevance of Chemical/Corrosion Resistance to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
As a door corrodes, it may begin losing its ability to seal properly, negatively affecting the thermal efficiency of a structure.	An easily corroded door will need to be replaced sooner than the alternative. Rusted hinges and hardware will need to be replaced sooner.	Products used for repair could introduce toxins to structure. Field refinishing will introduce toxins and particulates.	Increased cost for repair and replacement of door and/or hardware.

Weathering Resistance

This critical issue corresponds to the weather-related concerns cited above. Daily exposure to extreme heat and intense direct sunlight can damage entrances just as easily as intentional abuse. Some damage from exposure is inevitable, but a high-performing door can greatly decrease the amount of damage over time.

Door skin temperatures can reach 200 degrees Fahrenheit in direct sun. In a temperature controlled building, that can mean a difference of over 100 degrees between the two sides of the door. In another application of basic physics, this temperature variance will cause the opposite faces of the door to expand or contract at different rates, introducing unseen forces that pull the sides of the door in opposite directions.

A door that is glued together could conceivably be pulled apart by these forces. (Glue is also a source for harmful gasses that will negatively impact the indoor air quality of the structure, as is discussed later.) As previously mentioned, Special-Lite doors are assembled using mitered corner joints and tie rods. A core of poured-in-place urethane foam securely seals the door from within and removes any potential pathways for moisture to penetrate the door. No glue or other adhesives are used.

In addition to assembly concerns, thermoplastic materials will soften, expand and delaminate under intense exposure conditions, as opposed to a thermoset plastic such as FRP or urethane, which will retain form under most any conditions, although FRP can show weathering damage if not of the proper grade or thickness.

To test the design and manufacturing principles recommended in this section, Special-Lite sought out one of the most extreme North American locations for weathering resistance…the Arizona desert…with over 80 percent sunshine annually and average high temperatures above 100 degrees Fahrenheit all summer long.

Relevance of Weathering Resistance to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
Thermal extremes will exacerbate the deficiencies of an improperly sealed door.	A door that is not resistant to thermal extremes will need to be replaced sooner than the alternative.	Negligible, but products used for repair could introduce toxins to structure.	Increased cost for repair and replacement of door and/or hardware.

Mold and Moisture Resistance

This could also be seen as two separate sustainability metrics, but the same ideal features and concerns are common to Mold and Moisture Resistance. In truth, the ideal door for these metrics has much in common with the ideal door for Corrosion Resistance, Weathering Resistance, and Thermal Efficiency.

The key attribute is a properly sealed door, accomplished through conscientious construction (as discussed earlier) and an impenetrable core. Special-Lite has found that the ideal core is urethane foam injected into a pre-assembled door body. It is essentially the same material applied below deck in pleasure boats to provide floatation. In tests, a sample of Special-Lite's flush door as small as 20" by 20" floated like a cork.

The common alternative is a honeycomb paper or polystyrene foam core that is glued in place during assembly. The paper core, in particular, is prone to trapping moisture in the foam or rainwater and condensation. When coupled with a poorly constructed assembly, dirt will also penetrate the door, creating the theoretical potential for not only rust and corrosion, but also mold growth.

There are only three prerequisites for mold growth:

- Moisture will occur inside a door as a result of
    - Improperly sealed construction
    - Condensation, which forms on a surface when the temperature falls below the dew point of the surrounding air
- Nutrients
    - Present in dirt
    - Organic component materials, such as paper and wood

- Spores
    - Ever present in dirt

Preventing mold is a top priority for not only green buildings, but all buildings. The adverse health effects of mold are well documented, as are the liabilities incurred by contractors and facilities managers that do not take proper steps to prevent it.

Relevance of Mold/Moisture Resistance to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
As a door corrodes, it may begin losing its ability to seal properly, negatively affecting the thermal efficiency of a structure.	If a door contains any organic material, it will provide a potential nutrient source for mold. If mold occurs, it will necessitate the replacement of the door.	Mold is a top concern. Other particle matter could also introduce toxins to the structure. Products used to remove rust and mold or otherwise repair the door could introduce toxins to structure.	Increased cost for repair and replacement of door and/or hardware. Mold is notoriously difficult to remove.

Thermal Efficiency

The importance of thermal efficiency to green building can not be overstated. Study after study has shown that improved energy efficiency is the top driver behind sustainable design across all industries. The improvement of heating and cooling efficiency is the single most important attribute of the LEED standard, with efficiency thresholds being raised with each subsequent version of the standard. It is also the metric with the most obvious return on investment.

Although only a small portion of a structure’s surface area, exterior doors are a functional part of the building envelope and can play an important role in the overall energy efficiency of a building. As with windows or walls, care should be taken to specify components that limit thermal exchange (the transfer of heat from one side of the door to the other).

Some of the following steps for accomplishing this have already been discussed in the preceding chapters:

- Properly sealed construction
- Resistance to thermal extremes

- Superior insulation
- Thermally improved framing
- Insulated panels in adjoining side lites
- Insulated glass of at least one-inch thickness
- Keep vision lites to a minimum*

*This is one of the most significant trade-offs in the sustainability metrics for exterior doors. Glass provides a direct thermal transfer point, so flush doors and insulated side panels are ideal for thermal efficiency. However, these are not generally ideal when aesthetics are a top concern, while daylighting and views are also desired outcomes for a green building.

Of any entrance system performance metric, thermal performance has the most easily represented, verifiable and measurable values. Without getting into technical details, the U-Value of a product should be low, while the R-value should be high. Special-Lite has tested its FRP Flush Doors for thermal efficiency. The results are shown below. Use this as a comparison point against other entrance products. If no data is available for a product, assume the worst.

Component	U-value	R-value
1.5" urethane foam only	.11	9.1
1" FRP and urethane foam panel	.23	4.3
1.75" FRP and urethane foam panel	.10	10.0
SL-17 Special-Lite® FRP Door Assembly	.29	3.4

Tests conducted by Architectural Testing, Inc.

Relevance of Thermal Efficiency to LEED Themes and Maintenance

Energy Efficiency	Materials & Resources	IEQ	Maintenance
Thermal efficiency is the primary concern for energy efficiency of entrance systems.	Not relevant	Not relevant	Not relevant

Aesthetics

It is necessary to briefly mention the impact of aesthetic design on the potential sustainability of an entrance system. More so than any other attribute, aesthetic concerns can lead toward negative impacts on building performance. In order to specify a truly sustainable door, it is necessary to first look at the expected performance of an entrance system.

There are many, many attractive options available that meet the assorted performance criteria for sustainability. Aesthetics should be a secondary concern.

Prescriptive Metrics for Sustainability

LEED
In the following pages, we have identified all of the LEED credits that could conceivably be affected by an entrance system. As previously mentioned, there are a variety of LEED standards available, including:

- New construction and major renovation projects (LEED-NC)
- Existing building operations and maintenance (LEED-EB)
- Commercial interiors projects (LEED-CI)
- Core and shell projects (LEED-CS)
- LEED for Homes (LEED-H)
- LEED for Neighborhood Development (LEED-ND)

Unless otherwise noted, the following information translates equally between LEED-NC, LEED-CS, and an alternate market-specific version of LEED-NC, LEED for Schools. Information pertaining to LEED-CI and LEED-EB is separate. For obvious reasons, we have not examined LEED-H or LEED-ND.

Energy & Atmosphere
EA Prerequisite 1 Fundamental/Enhanced Conditioning
EA Prerequisite 2 Minimum Energy Performance
EA Credit 1 Optimize Energy Performance

This is one of the few LEED credits which offer an option to satisfy either prescriptive or performance requirements, although the choice makes little difference in respect to entrance systems.

LEED requires projects to conduct enhanced fundamental commissioning of building energy systems, meet the stringent requirements of ASHRAE/IESNA Standard 90.1-2007, and surpass that standard’s energy efficiency requirements by at least 10 percent (5 percent for renovations), or an alternate path as specified by ASHRAE or the New Buildings Institute. These credits carry over into LEED-EB and LEED-CI, but are calculated on a different scale, with LEED-CI measuring the performance of specific components.

The basic principles discussed in the earlier Thermal Efficiency section all apply here. Entrance systems should always be evaluated for thermal efficiency when being specified for a green building. In LEED-EB, the exterior door may also be a concern for *EA Credit 2 Existing Building Commissioning, Implementation* if it becomes apparent that the door is negatively impacting energy efficiency.

Potential LEED Tradeoffs
Daylight and Views
All Material Credits
Aesthetics

Materials & Resources
Entrance systems could affect the outcome of nearly all of the LEED material credits. However, several of these credits are in direct opposition to other performance and prescriptive (LEED) sustainability metrics.

As an example, Special-Lite has determined that the most sustainable component materials are a urethane foam core, an FRP or AMP face and aluminum structural components.

Aluminum is an excellent material choice for sustainable construction. It's the most abundant metallic element in the Earth's crust, and can be infinitely recycled without degradation of properties. Aluminum's high scrap value and well-established recycling infrastructure make it the most frequently recycled material, so much so that 73 percent of the aluminum ever produced is still in use today.

Urethane, FRP and AMP are clearly ideal materials for sustainable construction when evaluated on a performance basis. Unlike aluminum, they do not meet any of the prescriptive requirements. These materials are all derived from petroleum, the polar opposite of a renewable resource. None are made from recycled materials and none, to date, can be recycled.

This is the ultimate question facing sustainable design today: Should materials be specified for their performance and longevity or the raw materials they are made from? Good design or green design?

Perhaps the most ubiquitous "green" product on the market today is the compact fluorescent light bulb, designed to last years longer and require substantially less wattage than the standard incandescent bulb while providing the same amount of light. The average CFL is not made from recycled or rapidly renewable materials. It can not be recycled. It is most likely not locally produced and even contains a small amount of mercury. Yet, because of its ability to conserve electricity and the energy expended in making replacement light bulbs, the CFL is universally recognized as a sustainable alternative.

Entrances should be examined in the same way. When identifying sustainable products, it is necessary to look past form and instead concentrate on function.

With that said, here is a brief guide to the LEED materials credits.

Recycled Content

MR Credits 4 Recycled Content 10%-20% (1-2 points)

Intended to reduce the amount of virgin material used in the construction process, these credits encourage the use of post-consumer (waste generated by the end user) and pre-consumer (waste generated during manufacturing that would ordinarily not have been re-used) materials. Pre-consumer recycled materials are worth half the value of post-consumer recycled materials in the LEED calculations, meaning that if a product is 100% pre-consumer recycled material, 50% would count toward the credit. This is represented by the formula:

Cost of item **x** (% post consumer + 1/2% of pre-consumer, by weight)

The total percentage of recycled materials in a structure is determined by dividing the total value of recycled material by either:

1. 45% of construction costs
2. Actual material value

As an example, Special-Lite doors source aluminum extrusions made from prime-equivalent billet, which is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes. The extrusions produced from this prime-equivalent material are equal in all respects to those made from virgin material, but have a smaller environmental footprint. By weight, Special-Lite Flush Doors are 33% aluminum, while the monumental doors and framing products are 100% aluminum by weight, excluding fasteners and seals.

Aluminum recycling requires only 5% of the energy necessary to produce virgin aluminum—this is not the case for all recycled materials, where the energy required to source recycled materials can often exceed that required to use virgin materials.

Under normal circumstances, this credit should not apply to LEED-CI. In LEED-EB, this addressed in the Sustainable Purchasing requirement.

Material Reuse

MR Credit 3 Material Reuse 5%-10% (1-2 points)

There will be few opportunities to reuse an entrance system in a new facility. Due to its long life expectancy, a door that meets the general performance requirements for sustainability will be most able to be re-used after it is replaced or its building is decommissioned.

The same calculations are used to determine the total construction costs as for recycled materials. These credits exclude doors and windows to allow for energy efficiency gains. This credit should only apply to exterior doors for LEED-CI and LEED-EB if regular replacement is required.

Regional Materials
MR Credit 5 Regional Materials 10%-20% Extracted/Harvested, Processed & Manufactured Regionally (1-2 points)

Materials that are extracted or harvested, processed and manufactured within 500 miles of the installation site contribute to this credit. For the purpose of exterior doors, recycled steel or aluminum can contribute to this credit, as the smelting site is considered the point of extraction.

The same calculations are used to determine the total construction costs as for recycled materials.

Rapidly Renewable Materials/Certified Wood
MR Credit 6 Rapidly Renewable Materials
MR Credit 7 Certified Wood

The use of such materials is not recommended for exterior doors in an institutional environment.

Sustainable Purchasing/Solid Waste Management (LEED-EB only)
MR Prerequisite 1 Sustainable Purchasing Policy
MR Prerequisite 2 Solid Waste Management Policy
MR Credit 3 Sustainable Purchasing—Facility Alterations and Additions
MR Credit 6 Solid Waste Management—Waste Stream Audit
MR Credit 9 Solid Waste Management—Facility Alterations and Additions

These credits come into play in LEED-EB, which concerns facility management, if less than sustainable choices are initially made in the specification of exterior doors. There should not be a need to regularly purchase or dispose of exterior doors.

Indoor Environmental Quality

This is not an attribute commonly considered when specifying exterior doors, but the performance metrics proved that exterior doors do have a measurable effect. Like all building products, some exterior doors are manufactured with materials that will over time emit noxious fumes, pollutants or harmful volatile organic compounds. This can come from paint, adhesives and certain plastics, and can also be introduced during maintenance and cleaning.

Low-Emitting Materials
IEQ Credit 4.1 Low-Emitting Materials, Adhesives & Sealants
IEQ Credit 4.2 Low-Emitting Materials, Paints & Coatings
IEQ Credit 4.3 Low-Emitting Materials, Flooring Systems
IEQ Credit 4.4 Low-Emitting Materials-Composite Wood and Agrifiber Products

Exterior doors are not commonly considered for these credits, but as half of an exterior door is on the inside of a building, it only goes to reason that the product should answer to these considerations, even if it does not count toward any point calculations.

As these credits carry prescriptive requirements for various products, it is difficult to make a direct comparison to exterior doors. The IEQ impacts outlined in the Performance Metrics section provide a guide for how exterior doors will be affected, but as a general rule it is best to seek out products that have earned indoor air quality accreditations from a third-party verifier such as GREENGUARD or Scientific Certification Systems.

For *IEQ 4.4 Low-Emitting Materials-Composite Wood and Agrifiber Products*, interior door cores are one of the most often overlooked materials used to determine whether a project earns the credit. This credit forbids the use of wood or agrifiber components with added urea-formaldehyde. However, as discussed at length in the Performance Metrics section, wood and agrifiber components of any kind are not recommended when specifying an exterior door for sustainability as they are susceptible to weathering, decay and other damage. Avoid exterior doors made from wood or agrifiber components.

Indoor Chemical and Pollutant Source Control
IEQ Credit 5 Indoor Chemical and Pollutant Source Control

This credit is the only one in the standard that directly cites the entrance system. In order to reduce occupant exposure to particulates and chemical pollutants, entrance systems must be outfitted with a permanent entryway system, enclosed rooms must be fit with exhaust systems when hazardous gases or chemicals are present, and air filters must be used in all regularly occupied rooms. Obviously, the latter two requirements do not pertain to exterior doors.

The requirement that does pertain to entrance systems has generally been met with regularly changed roll-out mats. When selecting a door, it is wise to be aware of this credit, but understand that it will only affect the door itself in rare situations.

This applies to LEED-CI but not directly to LEED-EB as relevant to exterior doors.

It can be argued that this is a failure of the LEED-NC standard. By not expanding this credit to include the operational concerns associated with commonly used cleaning chemicals and repair or refinishing products, it creates a possibility that hazardous gases or chemicals will be regularly introduced to a structure regardless of mitigation investments. To better meet the intent of this credit, as opposed to its actual fulfillment, seek out product that can be maintained with environmentally sound products.

Green Cleaning (LEED-EB only)
Prerequisite 3 Green Cleaning Policy
IEQ Credit 3 Green Cleaning

The aforementioned cleaning and maintenance concerns are explicitly addressed and mandatory at the basic level for LEED-EB.

Thermal Comfort
IEQ 7.1 Thermal Comfort-Design
IEQ 7.2 Thermal Comfort-Verification

LEED encourages buildings to meet and maintain the thermal environment standards specified in ASHRAE Standard 55-2004. Thermal Efficiency was discussed at length in Performance Metrics. This also applies for LEED-CI.

Mold Prevention (LEED-Schools only)
IEQ Credit 10 Mold Prevention

Mold and Moisture Resistance was discussed at length in the Performance Metrics Section.

Daylight and Views
IEQ Credit 8.1 Daylight and Views, Daylight 75% of Space
IEQ Credit 8.2 Daylight and Views, Views for 90% of Space

As mentioned a number of times previously, sustainable design prefers daylight and views. These have been proved to have an effect on human health and productivity, and also to decrease the use of electricity for lighting purposes.

As stated previously, the use of entrance systems to meet this credit must be measured against its direct negative effect on thermal efficiency.

Other potential concerns

Heat Island Effect
SS Credit 7.1 Heat Island Effect, Non Roof

Heat Island Effect is the rise in temperatures in urban areas over their rural surroundings that is caused by the lack of vegetation and the absorption and retention of heat in pavement and buildings.

The general idea here is that darker exterior materials will have a warming effect on the surrounding environs. Think of asphalt in the summertime. This credit does not affect exterior doors, but it does suggest that selecting a lighter color will benefit the sustainable attributes of a facility.

Innovation in Design/Regional Priority

There are multiple credits available for innovative solutions to green building concerns that might not qualify for other green building credits. It is conceivable that an entrance system could be used to earn some of these credits under the right circumstances. There are also now bonus points available for various credits determined to be regional priorities, a recent addition to LEED as part of the 2009 update.

Recyclable Material

Interestingly, the eventual disposal of products is not directly addressed in any of the non-operations LEED standards. In the context of sustainability, both by performance and prescriptive metrics, the disposal of a door should not be a large priority. The more appropriate concern is whether or not disposal will become necessary. A truly sustainable door should be able to stay out of the waste stream indefinitely, albeit that may be an unattainable goal in the commercial and institutional environment.

When assessing an exterior door by life cycle concerns, it is readily apparent that most recyclable materials are poorly suited for use in the exterior environment. Non-recyclable materials such as FRP or urethane foam have been proven better options across every performance metric.

Special-Lite's aluminum framing and monumental doors are fully recyclable. As mentioned, the urethane foam core material and FRP and AMP face sheets are thermoset plastics and as such are not recyclable. These materials are essentially inert, so they can be safely disposed of at the end of their service life without adverse impacts on water, soil, or air quality.

Conclusion

In regard to operations and facility management, entrance systems have been shown to incur a disproportionate cost compared to the initial cost of the product and its installation. This can be measured both financially and environmentally, as discussed in this white paper.

The evolution of the LEED standard will eventually incorporate aspects of Life Cycle Assessment, which would provide a clearer understanding of all the sustainability concerns of a building product. To date there is no cost-effective way to do so on a consistent basis across all aspects of a structure. So for the time being, it is important to understand how exterior doors are relative to the prescriptive metrics of the LEED standard, but also the critical performance issues which will ultimately determine the sustainability of an exterior door.