

Reflective Foil Laminated Paper & Plastic Insulations and LEED White Paper

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Summary

The purpose of this white paper is to identify, develop and discuss specifics supporting “green” / “sustainable” energy strategies for reflective insulation and radiant barriers as related to the USGBC’s (US Green Building Council¹) LEED (Leadership in Energy & Environmental Design².) Rating System. The recommended information is based on research conducted through active participation in the USGBC, The National Institute of Building Science, AIA (American Institute of Architects), and CSI (The Construction Specifications Institute). The strategies proposed in this paper are intended to provide clarity about “Green”/”Sustainable” building products and potential point contributions for LEED credits specifically related to reflective insulation and radiant barriers. Supporting rationale presents information on energy efficiency programs, model code requirements, specification recommendations and scientific explanations of reflective insulation and radiant barriers and market acceptance of energy related industry initiatives.

Introduction

In the past decade there has been a great deal written about sustainable building and the need for better understanding about the science required for a properly designed building envelope. There has also been a movement for greater sensitivity of the environment and energy efficiency in construction. Even with this movement, the theory of “Green” building and “Sustainable” design has found few projects including this theory in the stated design intent.

As reported in *The Future of Green Developments in the A/E/C Industry* by Manar Shami and Thomas R. Dunn, Green buildings have been defined as systems that exist in harmony with the environment. Sustainability, in their report, is defined as the relationship between the dynamic human economic systems with the slower-changing ecological systems.

There has been much published about the benefits of increased insulation but there must be an understanding of the dynamics of the total efficiency of the building envelope and related systems. This holds true in concept to the entire building project and its relationship to community and environment.

The US Green Building Council is a nonprofit organization that is spearheading the effort to standardize the green building industry. It encompasses engineers, architects, specifiers, commissioning agents, facilities managers, code officials, specialty consultants and owners. It was founded in 1993 as a result of a lack of clear definition of “Green” building. One of the programs developed by the USGBC is the LEED Rating System which is gaining national and international attention as a baseline for developing “Green”/”Sustainable” building projects. In November of 2002, the USGBC held their first annual International Green Building Conference and Expo. Expected attendance was estimated at 1600 to 1800 but the final tally counted 4100 registered attendees. The 2003 November conference, to be held in Pittsburgh, is estimating 6,000 in attendance. The

USGBC along with organizations like the US EPA³ (Environmental Protection Agency), US DOE⁴ (Department of Energy), The Whole Building Design Institute⁴, and the Sustainable Buildings Industry Council⁵ are helping to promote greater energy efficiency with the goal of reducing energy loads and related environmental impacts.

Defining Insulation

The US DOE Insulation Fact Sheet⁶, developed by Building Envelop Research, Oak Ridge National laboratory, reports that heating and cooling account for 50 to 70% of the energy used in the average American home. Inadequate insulation and air leakage are leading causes of energy waste in most homes. Insulation is rated in terms of thermal resistance, called R-Value, which indicates resistance to heat flow. The higher the R-Value, the greater the insulating effectiveness. Traditional insulation materials include mass insulation (Cellulose or treated recycled newspaper and Glasswool or fiberglass), Polyester batts, Polystyrene foam boards, Rockwool, and Wool.

Defining Reflective Insulation and Radiant Barriers

RIMA – Reflective Insulation Manufacturers Association – supports the definitions, specification and use of reflective insulation as reported in the ASTM standards. ASTM C1224 defines the standard specification and testing of reflective insulation and ASTM C727 provides guidelines for the use and installation of reflective insulation. Reflective insulation differs from other insulating materials in the primary manner in which it retards heat transfer. Reflective insulation blocks radiant heat transfer between a heat-radiating surface and a heat-absorbing surface through the use of low emittance materials. The thermal performance or the reduction of radiant heat transfer is directly proportional to the surface emittance of the radiant barrier material. Emittance measurements of all materials range between zero (0), no radiant heat transfer, and one (1) that of a black surface or complete radiant heat transfer. Common building materials, such as wood, masonry, traditional insulation have surface emittances of approximately 0.85 and therefore have high radiant heat transfer rates. Products defined as reflective insulation and radiant barriers have one or more surface emittances less than or equal to 0.1 or low radiant heat transfer rates. Reflective insulation materials include paper, plastic, and aluminum foil or metalized aluminum substrates. In addition to reducing radiant heat transfer, reflective insulation functions by reducing convective heat transfer by trapping air or other gasses with multiple layers of these materials. This is the same principle that is used in high performance windows (for example a double paned low-e glazing). Types of reflective insulation include: expandable multi-layer with one or more aluminum layers, aluminum faced plastic bubble, and aluminum faced flexible foam. Products are available in solid form or perforated, which allow free passage of moisture.

ASTM C1313 defines the standard specification and testing and ASTM C1158 provides a guideline for use and installation of radiant barriers that function by reducing heat transfer by radiation. Typically radiant barriers are installed in areas of the building

envelope that are ventilated like attic spaces. Testing for R-values requires trapping or containing air or gases therefore R-values are not associated with the thermal performance of radiant barriers. Numerous studies have documented the benefits of this technology. State energy codes as well as thermal modeling (Eight Edition of Manual J) recognize the benefits of radiant barriers and their impact on building envelopes.

Beyond the energy efficiency of reflective insulation and radiant barriers, other benefits to consider include recycled content, environmental impact, cost, recyclability and geographical availability.

Defining “green” / “sustainable” building products.

“Green”, in the context of this paper, refers to “Green Building” as defined in ASTM E 2114-01 (Standard Terminology for Sustainability Relative to the Performance of Buildings): a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional and global ecosystems both during and after its construction and specified service life.

Following the ASTM definition is this discussion note: A green building optimizes efficiencies in resource management and operational performance; and, minimizes risks to human health and the environment.

Environmental Building News (<http://www.buildinggreen.com/>) in their Vol. 9 No.1 January 2000 edition published an article entitled Building Materials: What makes a product green? In the article there is a Summary of Product Standards for GreenSpec that gives us some additional clarification. This is a partial listing:

1. Products made from environmentally attractive materials
 - Products made with post-consumer/industrial content
2. Products that are green because of what isn't there
 - Alternatives to ozone-depleting substance
3. Products that reduce environmental impacts during construction, renovation or demolition
 - Products that reduce the impact of renovation
4. Products that reduce environmental impacts of building operation
 - Building components that reduce heating and cooling loads
 - Products with exceptional durability or low maintenance requirements
5. Products that contribute to a safe, healthy indoor environment
 - Products that don't release significant pollutants into the buildings

To further help in the assessment of “Green products”, ASTM E 2129 – 01 : Standard Practice for Data Collection for Sustainability Assessment of Building Products was developed in a joint effort between CSI and the USGBC. The scope of this standard states: 1.1 This practice offers a set of instructions for collecting data to be used in assessing the sustainability* of elements or products for use in both commercial and residential buildings. Specifiers may want to include this standard in project specifications to avoid “GreenWash” or unsubstantiated claims or positioning about “Green” products. Data areas reviewed include:

1. Materials
2. Manufacturing
 1. Process
3. Operational Performance of Installed Product
4. Indoor Air Quality
5. Corporate Environmental Policy.

Note: It is recommended to include these ASTM Standards in 3 Part CSI specification References found in Part 1. If this strategy is adopted, it will require filling out data sheet from ASTM E 2129 and having available upon request (if not available online).

Existing External Standards

Energy efficiency has primarily been driven by the code agencies and several government initiatives. These model codes represent the minimum required energy standards. The minimum standard is what is typically achieved on most projects based on construction costs. Certainly there are projects where investment in advanced energy performance strategies have resulted as part of stated design intent. Also some states, for example Florida and California, have more rigid energy and product standard requirements than others. Some of these include:

IBCO – International Building Code Officials
SBCCI – Southern Building Code Congress International
BOCA - Building Officials Code Administrators International
IBC - International Building Code

ASTM – American Society of Testing Materials

Federal Specification HH-I-1252B - Reflective, Thermal Cellulosic Fiber Insulating Board

American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

Note: It is highly recommended to have qualified company employees participate in as many industry associations and standards committees as possible. This will assist in

understanding industry trends and perceptions about radiant barriers and provide insights for business strategies.

What is LEED?

The U.S. Green Building Council (USGBC) is leading a national consensus for producing a new generation of buildings that deliver high performance inside and out. Council members work together to develop LEED™ products and resources, policy guidance, and educational and marketing tools that support the adoption of sustainable building. Members also forge strategic alliances with key industry and research organizations and federal, state and local government agencies to transform the built environment.

LEED™ was created to:

- define "green building" by establishing a common standard of measurement
- promote integrated, whole-building design practices
- recognize environmental leadership in the building industry
- stimulate green competition
- raise consumer awareness of green building benefits
- transform the building market

The LEED Rating System includes several key areas of opportunity for Radiant Foil insulation. There are a number of LEED project Rating Systems: New construction and major renovation LEED 2.1, Existing Building Operations LEED-EB, Commercial LEED-CL, Core and Shell and most recent is LEED for Retail. Additionally, there is a draft for a proposed LEED Residential rating system.

***Note:** Reflective insulation and radiant barriers have potential for contributing points for LEED credits in most of these systems.*

Potential Point Opportunities and Strategies for Radiant Foil Insulation LEED 2.1 Credits

Within each LEED Rating System there are “Categories of Concern” and each typically has Prerequisites as well as Credits. The five major categories include:

1. Sustainable Sites
2. Water Efficiency
3. Energy and Atmosphere
4. Materials and resources

5. Indoor Environmental Quality

Note: Energy and Atmosphere along with Materials and Resources are categories that may have point earning potential for LEED Credits as well as assisting in meeting prerequisite requirements.

Additional Commissioning

Intent

Verify and ensure that the entire building is designed, constructed and calibrated to operate as intended.

Requirements

In addition to the Fundamental Building Commissioning prerequisite, implement or have a contract in place to implement the following additional commissioning tasks:

1. A commissioning authority independent of the design team shall conduct a review of the design prior to the construction documents phase.
2. An independent commissioning authority **shall conduct a review of the construction documents** near completion of the construction document development **and prior to issuing the contract documents for construction.**
3. An independent commissioning authority shall review the contractor submittals relative to systems being commissioned.
4. Provide the owner with a single manual that contains the information required for re-commissioning building systems.
5. Have a contract in place to review building operation with O&M staff, including a plan for resolution of outstanding commissioning-related issues within one year after construction completion date.

Submittals

Provide the LEED Letter Template, signed by the owner or independent commissioning agent(s) as appropriate, confirming that the required additional commissioning tasks have been successfully executed or will be provided under existing contract(s).

Note: The strategy for this credit would be to identify LEED project “commissioning agents” and build a case as to the benefits, and advantages of reflective foil insulation.

Heat Islands Effect:

Roof Intent

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

Requirements

Use ENERGY STAR ® compliant (highly reflective) AND high emissivity roofing

(emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surface; OR install a “green” (vegetated) roof for at least 50% of the roof area. Combinations of high albedo and vegetated roof can be used providing they collectively cover 75% of the roof area.

Note: The ENERGY STAR roof program does not include insulation in consideration of making roofs more energy efficient. It is my opinion, that RIMA, and other insulation associations should be collectively lobbying this government program to be included as an integral component of a roof system. The science of the efficiency of a roof system cannot be based only on the reflectivity of the roofing membrane. This effort would provide greater opportunities for reflective insulation as a solution for greater roofing efficiency.

Required

Minimum Energy Performance

Intent

Establish the minimum level of energy efficiency for the base building and systems.

Requirements

Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments) or the local energy code, whichever is more stringent.

Note: Reflective Insulation and Radiant Barriers definitely contribute to compliance with model energy codes. It is also a very cost effective solution for increasing insulation efficiency and reducing the energy load on mechanical equipment.

Optimize Energy Performance

Intent

Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirements

Reduce design energy cost compared to the energy cost budget for energy systems regulated by ASHRAE/IESNA Standard 90.1-1999 (without amendments), as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11 of the Standard.

New Bldgs.	Existing Bldgs.	Points
15%	5%	1
20%	10%	2
25%	15%	3
30%	20%	4
35%	25%	5
40%	30%	6
45%	35%	7
50%	40%	8
55%	45%	9
60%	50%	10

Regulated energy systems include HVAC (heating, cooling, fans and pumps), service hot water and interior lighting. Non-regulated systems include plug loads, exterior lighting, garage ventilation and elevators (vertical transportation). Two methods may be used to separate energy consumption for regulated systems. The energy consumption for each fuel may be prorated according to the fraction of energy used by regulated and non-regulated energy. Alternatively, separate meters (accounting) may be created in the energy simulation program for regulated and non-regulated energy uses. If an analysis has been made comparing the proposed design to local energy standards and a defensible equivalency (at minimum) to ASHRAE/IESNA Standard 90.1-1999 has been established, then the comparison against the local code may be used in lieu of the ASHRAE Standard. Project teams are encouraged to apply for innovation credits if the energy consumption of non-regulated systems is also reduced.

Submittals

Complete the LEED Letter Template incorporating a quantitative summary table showing the energy saving strategies incorporated in the building design. Demonstrate via summary printout from energy simulation software that the design energy cost is less than the energy cost budget as defined in ASHRAE/IESNA 90.1-1999, Section 11.

Note: This is Fi-Foil's strongest case. By utilizing Fi-Foil radiant barrier or insulation, the energy efficiency of the building envelop can be increased with a low investment that contributes to reduced load requirements. Reduced load requirements have the potential for smaller mechanical units and less energy demand.

Recycled Content: Use 5% post-consumer or 10% post-consumer + post-industrial (*There is also a 50% program*)

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials.

Requirements

Use materials with recycled content such that post-consumer recycled content constitutes at least 5% of the total value of the materials in the project OR combined post-consumer and 1/2 post-industrial recycled content constitutes at least 10%. The value of the recycled content portion of a material or furnishing shall be determined by dividing the weight of recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total value of the item. Mechanical and electrical components shall not be included in this calculation. **Recycled content materials shall be defined in accordance with the Federal Trade Commission document, *Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e)*, available at www.ftc.gov/bcp/grnrule/guides980427.htm.**

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the

specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

Submittals

Provide the LEED Letter Template, signed by the architect, owner or other responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

Regional Materials: 20, 50% manufactured regionally

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation .

Requirements

Use a minimum of 20% of building materials and products that are manufactured* regionally within a radius of 500 miles.

Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesmen. For example, if the hardware comes from Dallas, Texas, the lumber from Vancouver, British Columbia, and the joist is assembled in Kent, Washington; then the location of the final assembly is Kent, Washington

Submittals

Provide the LEED Letter Template, signed by the architect or responsible party, declaring that the credit requirements have been met. Include calculations demonstrating that the project incorporates the required percentage of regional materials/products and showing their cost, percent-age of regional components, distance from project to manufacturer, and the total cost of all materials for the project.

Potential Technologies & Strategies

Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed and quantify the total percent-age of local materials installed.

***Note:** Beyond the obvious 500 mile radius factor for availability a case might be lobbied that because of the lightweight foil material can be shipped UPS, which also saves from the individual expense of a typical building material.*

Innovation in Design

Intent

To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED Green Building Rating

System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Requirements

Credit 1.1 (1 point) In writing; identify the **intent** of the proposed innovation credit, the proposed **requirement** for compliance, the proposed **submittals** to demonstrate compliance, and the **design approach** (strategies) that might be used to meet the requirements.

Credit 1.2 (1 point) Same as Credit 1.1

Credit 1.3 (1 point) Same as Credit 1.1

Credit 1.4 (1 point) Same as Credit 1.1

Submittals

Provide the proposal(s) within the LEED Letter Template (including in-tent, requirement, submittals and possible strategies) and relevant evidence of performance achieved.

Potential Technologies & Strategies

Substantially exceed a LEED performance credit such as energy performance or water efficiency. Apply strategies or measures that are not covered by LEED such as acoustic performance, education of occupants, community development or lifecycle analysis of material choices.

***Note:** This is a wild card category where innovation in design can be submitted for unique applications. As an example you could build a case for utilizing reflective insulating materials either exclusively or in conjunction with other insulating materials along with airtight building methods for maximum energy efficiency with low investment and good economical return on LEED credit investment.*

LEED Residential

LEED Residential is in DRAFT form at this time (see http://www.usgbc.org/Docs/LEEDdocs/LEEDresidential_DRAFT11-20-01.pdf)

This document has not been balloted by the US Green Building Council.

***Note:** Significant opportunities for Fi-Foil reflective insulation and radiant barrier products exist within this proposed program because of much of the criteria are found in LEED 2.1. However, one particular strength in the Residential LEED, is the acceptance of Energy Star energy program. Since Fi-Foil is already registered as an Energy Star material, this would be a sound inclusion*

Other Energy Efficient Initiative Influences

- DOE Energy Star Programs - <http://www.energystar.gov/default.shtml>
- ISO - <http://www.iso.ch/iso/en/ISOOnline.openpage>

- LEED – www.usgbc.org
- SBIC - Sustainable Buildings Industry Council - <http://www.sbicouncil.org/home/index.html>
- Whole Building Design Guide - <http://www.wbdg.org/>
- Building Product Pre-Approvable Program - <http://nibs.org/Bppap/>
- EEBA Energy and Environmental Building Association - <http://www.eeba.org/sites/organizations.htm>

Radiant barrier, Reflective Insulation Energy Efficiency Business Strategies

Arthur Gensler, Jr., Chairman and Founder of Gensler Architecture, Design and Planning Worldwide, said that opportunity in “Green” building is for those who move rapidly. Beyond the environmental sensitivity of Green Building there must be an economic based social and financial return.

Robert Hascall, Senior Associate Vice president, Facilities Management, at Emory University discussed how Emory already has 10 LEED Certified buildings with more scheduled. The cost issue for certification is upfront on every project. Emory University goes through an evaluation process analyzing the cost per credit to decide if a building should be considered for LEED certification. They conduct lifecycle cost studies on payback and base decisions on sound business logic. Bob and his team, clearly prefers to work with organizations, design professionals, contractors and suppliers who understand LEED programs and can make the process more efficient because of that knowledge. Even if Emory doesn’t decide to go for LEED Certification on a project it is used as a baseline for construction or remodeling.

LEED, “Green” and “Sustainable” Building design considerations are being driven by the government. GSA's Public Buildings Service (PBS) has committed to using the LEED rating system for all future construction projects, and they are working on revising their leases to include requirements that the spaces leased for customers be green. They are working with the latest buildings technology to make new Federal buildings as energy efficient as possible. They choose products with recycled content as one criteria in product selection. They are working in partnership with other government agencies to incorporate sustainable features in buildings.

Manufacturers, like Fi-Foil, have the opportunity to position for LEED projects as well as “Green” and “Sustainable” initiatives. A “Green” / “Sustainable” initiative does not have to LEED based. Some owner’s building criteria will determine the “cost-per-credit” not a sound economical return on investment for a given project. However, the energy

efficiency benefits of Fi-Foil products in cost analysis could be successfully marketed to this type of design criteria.

Federal Use of LEED

General Services Administration (GSA)

– LEED Certified by 2003

- **US Air Force**

– LEED Application Guide for Residential

- **US Army Corps of Engineers**

– Adoption of LEED (SPiRiT)

- **Department of State**

– LEED Certified Embassies

- **Department of Energy (DOE)**

- **Environmental Protection Agency (EPA)**

- **Federal Energy Management Program (FEMP)**

- **US Navy**

State & Local Use of LEED™

- New York

- New Jersey

- Pennsylvania

- Maryland

- Connecticut

- California

- Massachusetts

- Rhode Island

- Arlington, VA

- Austin, TX

- Santa Monica, CA

- Seattle, WA

- Portland, OR

- Chicago, IL

- Fairfax, VA

High Performance Buildings

- *U.S. Department of Energy's "High Performance Building Initiative"*

 - www.highperformancebuildings.gov

- **LEED**

- **Whole Building Design Guide**

 - www.wbdg.org

- **Sustainable Buildings Industry Council**

- **Building Product Pre-Approvable Program**

High Performance Schools

- Energy Smart Schools (DOE) Rebuild America
- Network of 100's of community based partnerships dedicated to saving energy, improving building performance
- National Best Practices Manual for Building High Performance Schools
 - Developed to promote energy efficiency and renewable energy

Recommended strategies and programs for building brand awareness and market position include:

Creating a niche where Fi-Foil can be recognized as first in radiant barriers and reflective foil insulation.

Look for active market opportunities

- Commercial
 - High Performance School initiatives
 - GSA/Government “Green” initiative projects
 - LEED projects
 - Niche Markets/Opportunities

Metal Buildings

- New construction
- Retrofit
- Residential
 - LEED projects
 - Energy Star initiatives

Joint venture opportunities as a system solution

- Wall systems
- Roof systems

Recommended information delivery programs include:

Article development and placement in industry related publications

Public Relations

Advertising

CEU Education Programs

Useful online information relating to various programs such as LEED

- Linking strategies to the many “Green” / “Sustainable” site
- Online advertising
- Email broadcasts/newsletters

Lobbying with various agencies

- USGBC
- Energy Star Roofs
- GSA
- State energy initiatives

Concluding Observations:

One of the perceptions in the built environment is that building green costs more than it is worth and design possibilities are restricted. The reality of “Green” building is that many firms and owners are just now beginning to understand the value of these design concepts. Through project information provided by the USGBC those beliefs are misstated. The following summary is from the USGBC’s brochure titled “Making The Business Case For High Performance Green Buildings”:

1. In the event up-front costs are higher for high performance green buildings – they can be recovered.
2. Integrated design lowers ongoing operating costs.
3. Better buildings equate to better employee productivity.
4. New technologies enhance health and well being.
5. Healthier buildings can reduce liability.
6. Tenant’s costs can be significantly reduced.
7. Property value will increase
8. Many financial incentive programs are available.
9. Communities will notice your efforts.
10. Using best practices yields more predictable results.

The green rating systems of the USGBC and LEED are evolving quickly and are becoming the standard for building “Green” / “Sustainable”. Based on articles in trade publications, industry conference topics, attendance at the USGBC conference and increasing number of LEED registered projects, “Green” building is becoming a larger part of projects design intent.

This accelerated interest in “green” building is the opportunity for reflective insulation and radiant barriers to gain market share. Projects utilizing the USGBC LEED Rating System program are a good baseline target for market expansion. It is important to remember that the goal of all of these “Green” and “Sustainable” programs is product and system integration for proper functioning of the building envelop in relationship to the environment. Insulation is not optional in meeting energy efficient requirements. Reflective foil and radiant barriers by Fi-Foil, properly positioned, have great potential as an integral component with advantages exceeding other types of insulation.