REFLECTIVE ROOFS RETURN MULTIPLE DIVIDENDS

The snowball effect: reduced cooling loads, lower energy bills and improved IAQ

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Many building owners are starting to realize the benefits of energy upgrades. Few, however, appreciate the potentially sizeable payback of reflective roofs. This applied roofing technology minimizes building heat gain and attacks energy waste in a critical area: interior cooling loads. It also is one of a number of effective strategies against the phenomenon of "urban heat islands" — a temperature increase in concentrated areas caused by radiant heat from dark surfaces, such as roofs and asphalt parking lots. This less-than-desirable condition indirectly impacts air quality and energy costs.

Though *it's often overlooked* by building owners, the roof is an ideal place to start reducing energy costs

"Building owners will consider wrapping pipes, putting reflective glazes on their windows, upgrading their lighting fixtures and even adding roof insulation — but most owners rarely look at the roof itself," says Sam Everett, director of corporate communications at Stevens Roofing.

Fortunately, owners are starting to look at reflective roofs as a way of reducing their energy costs.

The U.S. Environmental Protection Agency's ENERGY STAR® roofing program promotes reflective roofs, which are energy-efficient and environmentally friendly. The organization is also helping to educate building owners about the benefits of reflective roofs.

Owners have a few choices when it comes to reflective roofs: apply a reflective coating, install a reflective membrane or install a metal roof made of galvanized or other coated metal. Each option has its own benefits.

Coatings remain effective from five to 10 years, depending on how well they are maintained. Reflective membranes can last from 10 to more than 20 years when properly maintained. Metal roofs have a broad longevity range of 20 to 50 years. Their life span depends on the type of metal used to make the roof product, its thickness, whether or not it's coated and other variables that apply to all roof products, such as amount of weather exposure, foot traffic and maintenance.

A reflective roof can be installed or applied over almost any type of roof material.

No matter what method building owners use to make their roofs reflective, comparable overall benefits can be realized.

OPERATING COST SAVINGS

The concept is simple. Reducing the temperature of the roof reduces the building's interior temperature and reduces the running time of the air conditioning system. Also, lowering the temperature at or above the roof's surface means the air conditioning unit doesn't have to work as hard to cool down the make-up air. Cutting back on air conditioning use lowers a building's energy costs.

While most large buildings benefit financially from a reflective roof, those in the warmer states will see the most significant energy savings.

For whole building renovation projects, another benefit of reducing cooling loads is being able to install smaller, more efficient air conditioning units. Equipment runs more efficiently at full load, and downsized equipment runs at full load more often. Downsized equipment is also less expensive.

Heating costs can also be offset during winter months when a reflective roof is used with adequate insulation.

The correlation between insulation and reflective roofs has been examined for a while. Recently, ASHRAE Standard 90.1-1989 was revised to include information about reflective roofs. The new standard — 90.1-1999 — takes into account new developments in roofing technology and design.

Hashem Akbari, a researcher at the Lawrence Berkeley National Laboratory, worked with the committee to have reflective roofs included in the standard.

"Those buildings that have highly reflective roofs can actually reduce their levels of insulation," he says.

Even with an increase in heating costs, buildings in cooler climates can save on overall energy costs, Pat Downey of Merik Inc. explains: "Savings are based, in part, on fuel type. Since cooling units are generally electrical and heating units are generally gas, owners can save on electricity even

REFLECTIVE ROOFING TERMS

REFLECTIVITY (ALBEDO) **Amount of solar energy that is reflected away from a surface, usually given as a ratio.**

TYPICAL REFLECTANCE VALUES

White, reflective coating or membrane — 0.85
White paint — 0.60
Aluminized asphalt, weathered — 0.40
Concrete — 0.22
Bitumen (asphalt) — 0.09

EMISSIVITY **Amount of absorbed heat energy that is radiated from a surface.**

SOLAR REFLECTIVE INDEX (SRI) **The combined value of reflectivity and emissivity.**

R-VALUE **Measures the resistance to heat transmission through a material.**

ERS

Reflective roofs may reduce overall energy costs in cool climates *even if* heating costs increase slightly

if their heating costs increase slightly."

As electricity rates continue to increase and gas rates continue to decrease, these cooling cost savings should continue to rise.

Reflective roofs also reduce thermal shock, which occurs when cool rain hits a hot roof, causing a sharp drop in temperature.

During these temperature changes, a roof expands and contracts, causing unnecessary stress on the roof. This condition also degrades the seams, making them more susceptible to leakage, according to Jamie Moore, marketing specialist at Conklin. Reflective roofs maintain a more constant temperature, so thermal shock and associated problems are significantly reduced.

Cooling a roof may also prolong the life of roofing components, according to Jim Leonard, president of Elastomeric Roofing Systems.

"Everything on a roof ages at a faster rate when heated up," he says.

Others also speculate that reflective roofs slow down the rate of chemical reaction by keeping components cool, extending the lives of roofing materials.

ROOF PRODUCTS CRITERIA

ENERGY STAR

For a program that has been around for only one year, "ENERGY STAR® Roof Products" has created quite a following. More than 115 manufacturers currently participate in the program, which is sponsored by the U.S. Environmental Protection Agency and Department of Energy.

In order for manufacturers to use the ENERGY STAR label in association with a low-slope product, that product must have a solar reflectivity (albedo) of at least 0.65. This value indicates that 65 percent of the radiation is reflected away from the surface and 35 percent is absorbed.

The products have to be on a roof and field-aged for at least three years for consideration and must meet a reflectivity of at least 0.50 after five years. Manufacturers must submit test results from at least three buildings, one of which must be in a metropolitan area, that have the product installed or applied. Steep-slope roofs have different reflectivity standards because they are often shingled, and the reflectivity of asphalt granules isn't as high as it is with low-slope membranes. Products must meet reflectivity standards without compromising quality and performance.

Manufacturers voluntarily sign a Memorandum of Understanding with the EPA before they self-certify. Then they can use the label on any of their ENERGY STAR-compliant products.

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KARNAK

High-albedo treatments reduce the heat island effect because they can *reflect most of the sun's energy* away from a material's surface before it is converted into heat

ENVIRONMENTAL BENEFITS

Many building owners are looking for ways to make their facilities more cost-efficient, while also making them more environmentally friendly. Reflective roofing systems present a prime opportunity.

Dark-colored roofs and roadways can increase the overall temperature of a city. This phenomena is referred to as the urban heat island effect and it contributes to increased air conditioning demand in buildings, along with high levels of smog and other pollution.

Reflective roofs can help reduce this overall temperature and, therefore, the effects of heat islands.

"High-albedo treatments reduce the heat island effect because they can reflect most of the sun's energy away from a material's surface before it is converted into heat," says Downey at Merik Inc.

Albedo is a ratio that indicates the amount of solar energy reflected away from a surface.

MAINTENANCE

Reflective roofs require the same maintenance as non-reflective roofs, including semiannual inspections. Both types are affected by ultraviolet rays. With reflective roofs, the sun's influence is less pronounced, but dirt is still a major culprit. Though average rainfall generally prevents dirt build-up,

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building owners may want to consider washing their reflective roofs if they live in areas of low rainfall or their roofs have no slope.

"Cleaning helps maintain reflectivity, but also makes it easier to catch potential problems," says Roger Kyle, vice president of roof asset management at Integrated Roofing & Waterproofing Inc.

Reflectivity decreases the most during the first year of a roof's life, according to Leonard at Elastomeric Roofing Systems. After three years, the rate that reflectivity declines is typically less significant — it remains at a nearly constant value. Reflectivity loss will vary depending on the physical properties of the roof product, slope of the roof, environmental conditions and maintenance of the roof.

The loss caused by dirt is so minimal that some manufacturers don't think washing is worth the time and effort. Others think using an average garden hose once a year is enough to keep a reflective roof clean.

In areas of heavy environmental pollution, owners may not experience the full benefits of reflective roofs if they don't wash them occasionally, according to Eileen Dutton, technical director at Karnak. Industrial pollutants and biological growths, such as algae, can degrade a reflective roof over time, so they should be washed off according to the coating or membrane manufacturer's instructions.

UNITED COAT

Cooling costs **are an important factor in the new paradigm for roofing life-cycle costs**

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Owners should also consider the slopes of their roofs. "It is easier to keep a roof clean when water can run off nicely, as with a slope of ¼ inch or more," says Dick Gillenwater, manager of the thermoplastics group at Carlisle SynTec.

Reflective roofs, used in conjunction with other facility upgrades, have an enormous effect on overall operating costs and building efficiency.

"Building owners should understand their operating costs, as well as their maintenance costs," says Downey at Merik Inc. This will help determine potential savings.

VARIED BENEFITS

There is no doubt that different building owners will have varied outcomes after installing a reflective roof or applying a reflective coating. Several factors determine the amount of energy savings and other benefits.

One factor is the amount of insulation in the building. Typically, buildings with less insulation will benefit the most from a reflective roof.

Savings also depend on the building's function, according to Andre Desjarlais at Oak Ridge National Laboratory. For example, an office building with computer equipment must be kept cool at all times to prevent damage to the computers. Air conditioning use may not be reduced significantly with a reflective roof.

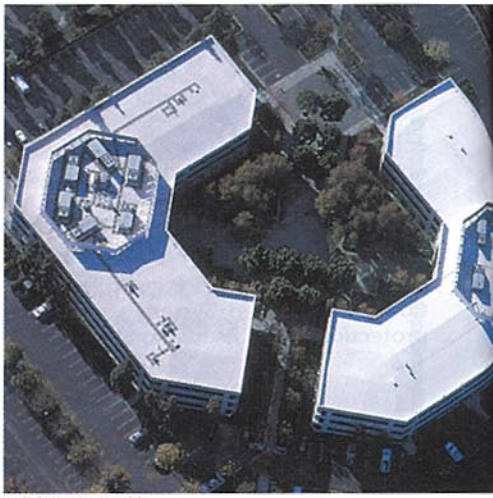
Even with this building, though, a reflective roof will help reduce the overall outdoor air temperature that perpetuates urban heat islands.

The best candidates for energy savings are one-story, air-conditioned buildings that have large roof surface areas compared to the overall size of the facility and more cooling-degree days than heating-degree days.

"This is because the roof on this type of building will represent a majority of the heat gain into the building if the roof absorbs most of the solar radiation that hits it," says Kevin Foley, national accounts manager at Sarnafil Inc.

Older buildings are also good candidates, according to Randy Rugg, marketing manager at United Coatings.

"This is due, in part, to the fact that older buildings don't normally have adequate insulation levels or the benefit of newer, more efficient air conditioning units and building techniques. At



NATIONAL COATINGS

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the same time, the roofs have already had years to degrade."

Energy savings are often difficult to evaluate, according to Perry Smith, production manager at Hydro-Stop. Although a reflective roof generally only affects the cooling portion of the utility bill, which is difficult to quantify, the bill will be reduced, nonetheless.

WHY START WITH THE ROOF?

"Few people realize that the roof can be such a big part of reducing building cooling loads," says Lisa Gartland, owner of PositivEnergy.

But it's not just cooling loads that building owners are interested in. They also are becoming more concerned with life-cycle costs.

"Under the new paradigm in roofing, which the ENERGY STAR program is helping to define, roof system selection will be made with more awareness to the roof's entire life-cycle cost, taking into account energy and environmental savings and maintenance expenses," says Foley at Sarnafil.

Looking beyond initial roofing costs allows building owners to focus on ways of improving the overall, long-term performance of their facilities.

The cost to install a reflective roof or apply a reflective coating compares favorably with other energy efficiency options. According to Butch Lockhart,

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A roof's primary function is to ***keep a building dry.*** After that, building owners should ask themselves what else it can do for them

VIRGINIA SCHOOL LIGHTENS ITS LOAD

Jefferson Elementary School in Alexandria, Va., had a typical, black built-up roof with no insulation prior to 1994. The school board tracked energy use for the single-story, 83,000-square-foot building before and after installation of a white, reflective roofing system. Yearly cost analyses of energy expenses showed that costs for the school were $123,000 in 1991, $120,000 in 1992 and $121,000 in 1993. In 1994, after installation of a 60 mil reflective roofing system, along with the installation of polystyrene insulation, the school's electric utility bill dropped to $90,000.

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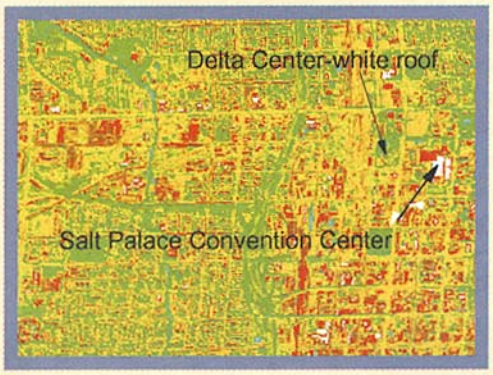

NASA

SALT LAKE CITY COOLS OFF

The Advanced Thermal and Land Applications Sensor (ATLAS) is used by NASA to detect visible and thermal wavelengths. These thermal images of Salt Lake City were taken at 16,500 feet from the ATLAS scanner, which was mounted from a Lear jet. Green areas are the coolest; white areas are the hottest. "The reflective roofs just blended in," says Jeff Luvall, senior research scientist at NASA's Marshall Space Flight Center. "The black rooftops and other hot areas stood out like a sore thumb." The convention center's black, EPDM roof has an albedo of approximately 0.05. The Delta Center's reflective roof has an albedo of 0.63. The project was sponsored by NASA and the EPA.

ATLANTA HEATS UP

ATLAS also took thermal images of downtown Atlanta — specifically, of Georgia State University — in 1972 and again in 1993. During that time, two distinct heat islands were formed while two existing islands grew. The four islands were approximately six to eight degrees warmer than the surrounding areas, which consisted of more trees and grass, and fewer buildings and roadways. ATLAS meaured roof temperatures at 10 GSU buildings with different types of roofs, including built-up, EPDM and modified bitumen. On-site rooftop temperatures were also taken. According to Amy Apprill at the University of San Diego, "The preliminary results determined that increased vegetation on or near rooftops, covering rooftops with lighter colored materials and maintaining the surfacing on older rooftops are ways to decrease temperature and, therefore, contribution to the urban heat island." Marty Waterfill, Patrick Downey, and the Global Hydrology and Climate Center conducted the research. The project was funded by NASA and the Universities Space Research Association.

Georgia, by amending ASHRAE 90.1, was the first state to codify the benefits of white roofs. The amendment recognizes four climate zones where insulation can be reduced when a reflective roof is used. "With the new amendment, building owners can save on insulation, while reaping the benefits of reflective roofs," says Downey.

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chief operating officer at Integrated Roofing, cost to install a retrofit roof can range from $1 to $4 per square foot, depending on existing roof type, building height, number of roof sections and other variables. Installing a roof with reflective qualities doesn't increase this cost significantly and it's a small price for something that will last for years if properly maintained and possibly pay for itself through energy savings.

"A roof's primary function is to keep a building dry," says Lockhart. "After that, building owners should ask themselves what else it can do for them."

Can it save energy? Can it help improve air quality?

"A customer who's been educated and is aware of long-term investment will look more closely at the roof as a way of saving energy," says Mike Debenedetto, regional manager at DC Taylor.

Energy savings and environmental benefits aside, reflective roofs are also aesthetically pleasing to some building owners.

Increasingly, the roof is becoming an integral part of a building's architecture. White, reflective roofs provide a different look from the typical, black rooftops.

As far as Randall Thompson, vice president at Evercrete International Inc., is concerned, the only argument for not having a reflective roof is if it didn't fit in with local architectural styles. For example, mission-style roofs are defined by their red color, so reflective roofs wouldn't be suitable.

MAKING THE DECISION

While most product decisions for a facility are difficult, choosing a reflective roof is one of the easier ones.

Building owners just need to decide which type of reflec-

TEXAS BUSINESS REDUCES ENERGY COSTS BY 42 PERCENT

With a built-up roof that was only 30 percent reflective, a 6,678-square-foot commercial building in Burton, Texas, certainly had room for improvement in the area of energy efficiency. Its owner, Ted Malloy, was looking for a low-maintenance, energy-saving roof that he wouldn't have to replace every seven to eight years.

After installation of 1-½ inches of polyurethane foam insulation, a roofing foam and reflective coating, the reflectivity jumped to 85 percent. After three years, the roof maintained a reflectivity of 55 percent.

According to Malloy, energy costs dropped 42 percent after the installation of the coating.

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tive roof will create the best results for their particular buildings based on the size, age and use of the buildings, level of insulation and amount of money they want to invest.

The benefits of reflective roofs — lower cooling costs, reduction of heat islands, increased comfort for occupants — often outweigh any higher first costs. And aside from the same semiannual inspections and occasional maintenance that have to be performed on non-reflective roofs, not much time and money have to be invested in reflective roofs after initial installations.

As far as quality, reflective roofs must meet the same standards as non-reflective roofs in order to qualify for the ENERGY STAR label.

"Owners shouldn't feel like they're trading one benefit (quality) for another (reflectivity)," says Dan Varvais, regional manager at National Coatings Corp. BoM

E-mail comments and questions to nicole.sturdevant@tradepress.com

A reflective roof requires little if any more maintenance than any roof *after initial installation*

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