White paper: Roofing, Energy and the Environment

Nov. 24, 2003

Dear Member,

Following is a newly developed white paper created by NRCA's Energy Conservation and Environmental Issues Task Force. The white paper discusses issues related to roofing, energy and the environment. We hope you find it useful and interesting.

The white paper was developed, in part, to enable the industry to participate in dialogue about these important issues in a way that is fair and balanced. Our intent is not to be "for" or "against" any approach to energy conservation or environmental protection but rather to welcome a discussion of the advantages and limitations of the many approaches available to homeowners, building owners and government agencies.

As the white paper suggests, the matter of optimizing energy savings and improving the nearby environment through roof system design and application is a complicated one. The best solution for a roof system in Phoenix may be quite different from one in Minneapolis for reasons that may or may not be immediately obvious. What is important, however, is for homeowners and building owners to be equipped with the right kind of information to make good decisions.

The white paper also suggests the roofing industry can and should play a significant role in our national energy programs and efforts to improve our environment. Sophisticated owners and government officials understand that, but we have much more to do to tell our story.

The Energy Conservation and Environmental Issues Task Force welcomes your comments on the enclosed white paper. The task force is especially interested in knowing if you find it helpful and how you intend to use it.

NRCA members can feel free to photocopy the document for their use. If you prefer, we'll be happy to provide additional copies on NRCA letterhead for a modest fee. Contact Alison LaValley at our office if you are interested.

Sincerely,

William A. Good, CAE
Executive Vice President

Roofing, Energy and the Environment

Homeowners and building owners face a complex array of decisions when considering installing or replacing roof systems. What type of material will work best? How will the roof be used? If appearance matters, what style and color will suit the home or building? And which manufacturers, contractors, designers and consultants should be considered for the project?

Today, these questions become even more complex when the roof system's role is fully understood with regard to its potential for conserving energy and contributing to a healthier environment. Good roofs, those that are well-designed, constructed with quality materials and properly maintained can save a significant amount of energy. And many roof systems, depending on the materials used and local climate, can help reduce ambient temperatures and environmental hazards.

Unfortunately, however, there are no simple answers to the question: "What roof system is best for me?" Instead, the ability to answer that question requires a deeper understanding of all the issues involved.

Understanding Roof Systems

Virtually all roof systems are composed of several different components. First, there is the weatherproofing component. For built-up roofing, organic materials, such as asphalt and coal tar, are used. For single-ply roofing, thermoplastic (such as polyvinyl choloride [PVC]) and thermoset (such as ethylene propylene diene monomer [EPDM]) materials are most typical. Metal and spray polyurethane foam-based roof systems also are commonly used. Coatings often are used as surfacings for roof systems and can contribute to roof systems' waterproofing characteristics, as well as protect roof coverings.

In addition, most roof systems incorporate thermal insulation, typically rigid board stock installed under the weatherproofing element. The insulation, of course, adds thermal efficiency to a roof system and also can provide a supporting substrate, helping to ensure proper roof system application.

For steep-slope applications, asphalt shingles are the most commonly used material, but even an asphalt shingle roof is thought of as a system because it includes an underlayment, flashing materials and some method of attachment. Other steep-slope materials include slate, concrete or clay tile, wood shingles and shakes, and metal shingles.

All roof systems require a method for being attached to buildings; they are either mechanically attached, fully adhered or ballasted. Aggregate surfaces can also help keep a roof system's surface cool.

Energy Efficiency Considerations

One of the most important attributes of a well-designed and constructed roof system is its ability to conserve energy. Consider a typical one-story building; for example, a school. If the building is 15

feet high, 50 feet wide and 200 feet long, it will have a total of 7,500 square feet of exterior wall space where insulation typically will be added. But that same building will have 10,000 square feet of roof area where heat is much more likely to infiltrate or escape without a well-insulated roof system because hot air rises.

Adding thermal insulation to a roof system often is an obvious and easy first step in contributing to energy savings. Many organizations, such as Oak Ridge National Laboratories and the National Roofing Contractors Association (NRCA), have developed software programs to enable building owners to calculate energy savings through the use of roof insulation and the ensuing cost payback periods. In addition, building codes now require minimum thermal resistance for new roof systems, an indication that properly insulated roof systems now are widely recognized as a primary source of energy conservation. Also, thermal resistance can be added to an existing roof system without a complete replacement, provided the roof deck's structural capability is sufficient and the existing components are both sound and compatible with the new materials.

Another way for roof systems to reduce energy consumption is to incorporate materials that reflect ultraviolet rays, keeping the roof surface cooler. Some roofing materials are inherently reflective: metal roofs, depending on their color, may reflect a great deal of heat, as do some white- or light-colored weatherproofing membranes. Coatings and surfacings also can contribute to reflectivity and should be considered if the roof surface is not inherently highly reflective.

Another important characteristic of roofing materials is emissivity, which is the ability to emit residual heat during the cool evening hours. Materials have various initial rates of reflectivity and emissivity, and different rates of diminishing capability even when properly installed and maintained. (In those regions of the United States where homes and buildings require substantial heating, reflecting the sun's energy may not necessarily be appropriate.)

Other technology is emerging that one day may provide more energy savings by using a building's roof. Roof-mounted solar collectors or panels, for example, already have enjoyed limited success. And new roof systems are being developed that incorporate photovoltaic cells sources of energy that are renewed by exposure to the sun.

Still, the most important way to ensure a roof system's long-term energy performance may very well be to design a system that can be expected to perform for a long time. For example, a single leak in a roof system with thermal insulation has the potential to reduce significantly the thermal efficiency of the roof system: wet insulation loses much of its thermal value. This is one of the reasons NRCA recommends roof maintenance be performed twice per year and after significant weather events.

Environmental Considerations

There is some emerging science suggesting that if roof systems in urban areas can reflect enough heat, they have the potential to reduce the area's ambient temperature and thereby reduce levels of smog. Although the science is not yet definitive, reflective and emissive roof surfaces may help

buildings cool in the summer, especially those without adequate amounts of insulation, and have proved to be valuable for energy-saving purposes in warmer climates.

Still, reflective and emissive roof surfaces are much more likely to be of value in warm, sunny climates, such as Arizona, than in cooler climates, such as Minnesota, where snow can provide its own reflective surfacing for a portion of the year and heating a building is likely to be much more important than cooling it.

"Green" Roof Systems

A good deal of attention has been given in recent years to roof systems that literally are green, that is, they incorporate a vegetation system as part of the surfacing. Typically, green roof systems include a waterproofing element, filter material, insulation, a growth medium and plant systems appropriate for this type of use. (Generally, plants used with green roof systems should not require a great deal of maintenance and should not have extensive root systems.)

Green roof systems can reduce heat absorption during summer (cooling) months but have a lesser effect on heat loss during winter (heating) months. Properly designed, green roof systems can effectively help to control storm-water runoff and help reduce greenhouse gases in the adjacent area, thus improving air quality.

Not all buildings, of course, are suited to green roof systems, because they add considerably more weight than conventional roof systems. An owners considering installing a green roof system needs to consult with a structural engineer to ensure the building can adequately support the weight of a green roof system.

Green roof systems are also relatively expensive to install. And finding and repairing leaks in green roof systems also can be problematic, so having proper design and application become even more important than with other types of roof systems. Owners and designers should be certain green roof systems meet the required fire ratings, as well.

Disposal Issues

It has been estimated that as much as 5 percent of the nation's landfill space is occupied by torn-off roofing materials. The principal reason for this is traditional roofing materials are difficult and expensive to reuse or recycle; asphalt shingles, for example, have mineral granules imbedded into them, making them difficult to recycle. Disposal becomes the most economic and sometimes the only alternative for homeowners and building owners when they are replacing roof systems.

Some roofing materials, especially newer ones, can be recycled, and designers and owners should ask roofing professionals about these products when making their buying decisions. There also are "sustainable" roof systems in use today, such as coated roof systems, that can be recoated to extend the roof system's life and delay removal and replacement.

Building codes generally allow for one new roof system to be applied over one existing roof (for a total of two roofs), provided the structural capability of the roof deck will allow such an application and the existing roof is suitable to be recovered. The installation of a new, recyclable roof system can therefore avoid or at least delay the removal and disposal of aged roofing materials that may not be environmentally friendly.
Again, however, the most important consideration for a designer or owner should be the durability of the roof system. A roof system that lasts for 20 years will, obviously, only need to be disposed of once in 20 years. An energy-efficient and environmentally friendly roof system that fails after 10 years may take up more landfill space, may lose thermal efficiency as it begins to fail and may not achieve the results that were expected when it was first installed.

The Importance of Maintenance

No roof system should be expected to perform satisfactorily for an extended period of time without regular, scheduled maintenance twice per year, at a minimum. This always has been true, but it takes on even more significance when energy and environmental considerations are taken into account.

Regular rooftop inspections may reveal potential leak sources: worn flashings that have pulled away from the wall or seams that have become separated, for example. Inspections also can reveal damage caused by storms, debris or other trades working on the roof. Generally, the best times to inspect roof systems are in the spring and fall or after a significant weather event.

Roof systems also should be inspected to determine whether they have lost any thermal efficiency. Infrared scans or other methods for moisture detection should be included in routine maintenance programs.

Roof systems that have reflective surfaces should be inspected, maintained and cleaned to maximize their reflective values. For example, a roof system with a white surfacing, installed in an urban environment will not maintain its initial reflectively without appropriate cleaning and maintenance.

Taking It All Into Account

It is commonly understood in the roofing industry that a good roof system requires the following four elements to perform successfully:

Proper design
Quality materials
Good application
Regular maintenance

As roof systems are called on to do more save energy and be sensitive to the environment these elements take on added importance. And having a roof system with a long service life may very

well be as important as having the right amount of insulation or an appropriate amount of reflectivity and emissivity.

Homeowners and building owners must take a number of considerations into account when making a decision about a new roof system. There is neither a simple formula to use nor any complex mathematical model to follow. The climate, location, type of building structure and the building's intended use all come into play. For many buildings, the single most important energy-saving step an owner can take is be to be sure the roof system contains an appropriate amount of insulation. For other buildings, it may be to have a reflective surface that is kept clean and leak-free. For still others, it may be to have an aesthetically pleasing roof system.

As always, the best advice is to gather as much information as possible and consult with roofing professionals at every step of the way. The appendix that follows includes a list of sources of information about roof design, application, and energy and environmental issues.

Sources of Additional Information

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
1791 Tullie Circle Northeast
Atlanta, GA 30329
(404) 636-8400
www.ashrae.org

ASHRAE's mission is to advance the arts and sciences of heating, ventilation, air conditioning, refrigeration and related human services.

Asphalt Roofing Manufacturers Association (ARMA)
1156 15th Street, N.W., Suite 900
Washington, DC 20005
(202) 207-0927
www.asphaltroofing.org

ARMA represents the majority of North America's asphalt roofing manufacturing companies, as well as their raw material suppliers. ARMA includes almost 90 percent of the nation's bituminous-based roofing products.

Cool Roof Rating Council
1738 Excelsior Avenue
Oakland, CA 94602
(866) 465-2523
www.coolroofs.org

The Cool Roof Rating Council was created in 1998 to develop accurate and credible methods for evaluating and labeling the solar reflectance and thermal emittance (radiative properties) of roofing products and to disseminate the information to all interested parties.

Energy Star Program
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
(888) STAR-YES
www.energystar.gov

Energy Star is a government-backed program designed to protect the environment through superior energy efficiency.

EPDM Roofing Association
515 King Street, Suite 420
Alexandria, VA 22314
(703) 684-5020
www.epdmroofs.org

The EPDM Roofing Association (ERA) is the trade association representing the manufacturers of EPDM roofing products and their leading suppliers. ERA provides technical and research support to the public and the construction industry and communicates the attributes and value proposition of EPDM rubber membrane roofing materials.

Heat Island Group
Building 90, Room 2000
Berkeley Lab
Berkeley, CA 94720
(510) 486-7437
eande.lbl.gov

The Heat Island Group conducts research and provides information pertaining to urban heat island effects and remedies.

National Roofing Contractors Association
10255 W. Higgins Road, Suite 600
Rosemont, IL 60018
(847) 299-9070
www.nrca.net

Established in 1886, NRCA has 5,000 members in all 50 states and 55 foreign countries. NRCA produces the NRCA Roofing and Waterproofing Manual, which contains design and application recommendations for most roof systems, and RoofWise, an energy calculator for use with low-slope roof systems.

Oak Ridge National Laboratories
P.O. Box 2008
Oak Ridge, TN 37831
www.ornl.gov

Oak Ridge National Laboratories is managed for the U.S. Department of Energy by UT-Battelle LLC. Oak Ridge conducts research for conserving energy, protecting the environment and providing homeland security. ORNL has developed the DOE Cool Roof Calculator for Low-slope or Flat Roofs, available on its Web site.

Polyisocyanurate Insulation Manufacturers Association
515 King Street, Suite 420
Alexandria, VA 22314
(703) 684-6048
www.pima.org

PIMA is the national trade association that advances the use of polyiso-insulation. PIMA's efforts focus on product education, partnering with the government, environmental responsibility and energy efficiency advocacy.

Roof Coating Manufacturers Association
1156 15th Street, N.W., Suite 900
Washington, DC 20005
(202) 207-0919
www.roofcoatings.org

RCMA is the national trade association representing the manufacturers of cold-applied coatings and cements used for roofing and waterproofing.

Roof Consultants Institute
1500 Sunday Drive, Suite 204
Raleigh, NC 27607
(919) 859-0742
www.rci-online.org

The Roof Consultants Institute (RCI) is an international, nonprofit association of professional roof consultants, architects and engineers who specialize in the specification and design of roof systems.

SPRI Inc.
77 Rumford Avenue, Suite 3B
Waltham, MA 02453
(781) 647-7222
www.spri.org

SPRI represents sheet membrane and component suppliers to the commercial roofing industry.

Spray Polyurethane Foam Alliance
1300 Wilson Blvd.
Arlington, VA 22209
(800) 523-6154
www.sprayfoam.org

The Spray Polyurethane Foam Alliance is the voice, educational and technical resource for the spray polyurethane foam industry.