ENERGY EFFICIENCY:

MORE THAN A SIMPLE BLACK-AND-WHITE ISSUE

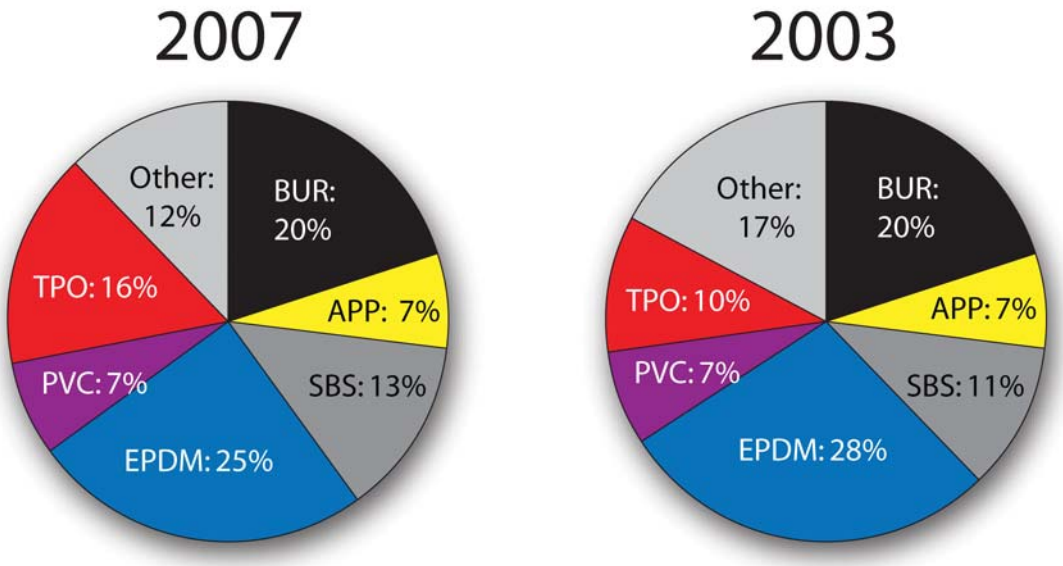
BY TONY MATTER

The days when heating and cooling costs were a relatively insignificant line item on a building owner's budget are long gone. Oil prices, though blessedly lower at this writing, remain extremely unstable. Natural gas and coal prices are also on the rise. All of these increases and instability have led to higher heating and cooling costs, and property owners are doing all they can to keep such costs in check through the use of energy-efficient building materials.

An argument can be made that the focus on energy efficiency has impacted the roofing industry more than most other segments within the construction market. Numerous codes have been developed, organizations formed, and regulations established – all in the interest of addressing the issue of energy-efficient roofing. Over the past decade, energy efficiency within the roofing market has been focused on cool roofing, which utilizes light-colored materials such as thermoplastic polyolefin (TPO) to reflect sunlight and solar energy away from a building and keep it cooler.

In 2003, TPO accounted for just 10 percent of the commercial roofing market, but by 2007, its share had reached nearly 17 percent (see pie chart, below). At the same time, EPDM saw its share within the market drop by nearly four percent. While the shifts may appear small, the numbers are significant when one considers the amount of roofing materials that are installed throughout the country every year, and they paint a detailed picture of where the industry is headed, highlighting the increased emphasis that has been placed on reflectivity.

The growth in reflective materials has occurred for several reasons. First, thermoplastic roofing manufacturers' marketing efforts touting the energy-efficient benefits of these reflective materials have been incredibly successful. When TPO first burst onto the roofing scene in the early-to-mid 1990s, the primary goal for manufacturers was to gain market share for this relatively new material. From a marketing and communications standpoint, reflectivity and energy efficiency were the two attributes that made the most sense, because they spoke to people in a language that mattered most – dollars and cents. At the same time that TPO was getting its foot in the door, manufacturers of PVC membranes were continuing to promote the reflective benefits of their materials, using their popularity in Europe as a basis to establish what was



Market share, from 2007 NRCA survey.

Charleston WV
4632 HDD 903 CDD

Energy Cost Comparison

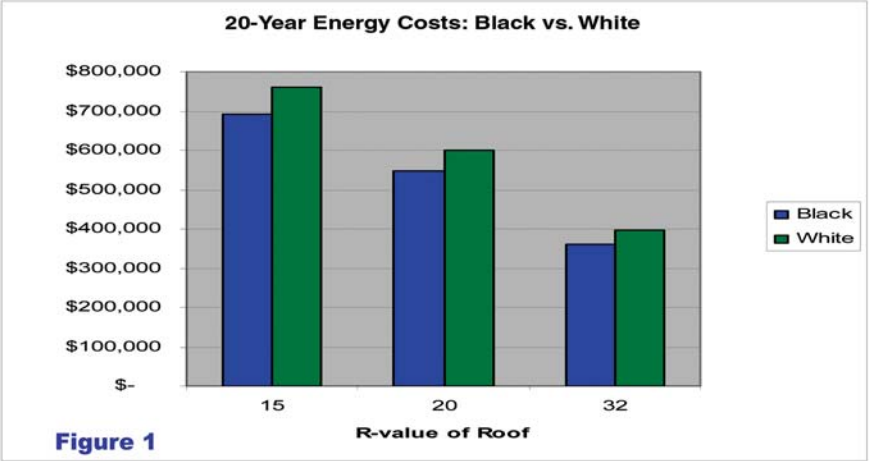


Figure 1

Carbon Potential Comparison

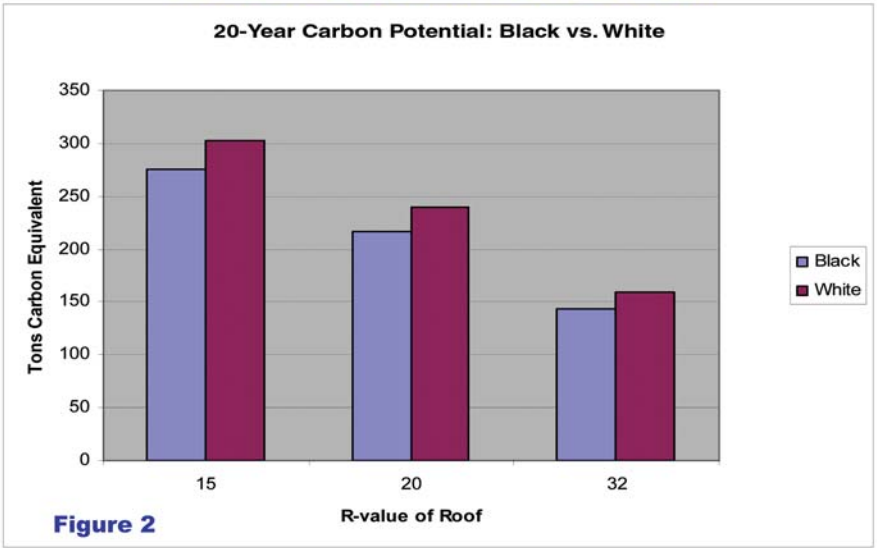


Figure 2

becoming a respectable share of the U.S. low-slope roofing market.

It has been proven through numerous studies that, under some circumstances, a building's air conditioning-related energy consumption can be reduced through the use of reflective roofing materials. These studies have helped create a perception within the roofing industry that reflectivity is the best option for reducing energy consumption.

But there is a catch with that philosophy, and caution must be used when specifying cool-roof systems. The energy savings that buildings experience due to the use of reflective roofing materials are most often realized in warm, southern climates where Cooling Degree Days (CDD) outnumber Heating Degree Days (HDD) and air conditioning is more prevalent than heating.

To help reduce heating-related energy demands, which are greater than air conditioning demands in northern regions, dark-colored materials such as EPDM membranes are most often beneficial. That is because materials like EPDM absorb heat and transfer exterior solar energy into a building, causing interior temperatures to rise and helping to alleviate the demands placed on heating systems.

Unfortunately, there continues to be a misconception throughout much of the industry that reflective roofing is the panacea for all our buildings' energy woes, regardless of geographical location. This could not be further from the truth. If examined strictly from an energy-efficiency perspective, research and data prove that materials like EPDM can provide energy savings that are the same or better than light-colored alternatives in many locations.

Table 7.4 of the 2007 *Buildings Energy Data Book*, published by The Building Technologies Program within the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy, outlines energy use intensity in various commercial building types, comparing heating and cooling as a percentage of total energy consumed. The average results show that heating accounts for 29 percent of the energy consumed within a building, while cooling totals a mere 6 percent. The statistics are even more compelling when broken into specific building segments, such as healthcare and educational facilities, which feature 55 percent to 10 percent and 33 percent to 5 percent heating-to-cooling ratios, respectively.

These numbers indicate that the move toward reflective roofing in many parts of the country may be unwarranted and, in fact, counterproductive to the goal of minimizing overall energy consumption. The numbers also suggest that there should be more focus on cutting heating costs and not cooling costs, an idea that makes dark-colored membranes such as EPDM an important asset in the push for energy efficiency.

The DOE, in conjunction with its research wing, Oak Ridge National Laboratory (ORNL), has developed a Cool Roof Calculator to help consultants, architects, contractors, and building owners determine the most efficient and cost-effective roof system for any given project. Accessible through the DOE Web site, the calculator simulates building energy consumption based on the type of membrane and amount of insulation that is installed.

Users can pinpoint the analysis within DOE's calculator based on the ZIP code of their project, resulting in direct, head-to-head comparisons of various assemblies. In most instances, dark-colored membranes will prove to be more energy efficient than light-colored materials for projects located in cooler climates.

The Cool Roof Calculator was recently used to help the School Building Authority (SBA) of West Virginia develop its *Quality and Performance Standards*, a document that outlines specific products and minimum-performance qualifications for state-

funded school construction and renovation projects. The group formed a committee to create the standards in January 2007, and in its original draft, reflective materials were identified as a mandatory specification for all statewide roofing projects.

According to David Sneed, chief of architectural services for the West Virginia SBA, reflective roofing materials were chosen initially because the board believed they would help the state's school districts cut their annual energy costs. Thanks, in large part, to the aforementioned marketing campaigns, this perception is becoming fairly typical. When the standards were sent out for review, many local roofing professionals began to question the use of reflective materials.

Ed Smith, manufacturer's representative with North Coast Commercial Roofing Systems in Huntington, WV, was one of the first industry experts to raise concerns over the potential use of reflective roofing materials in a state that features far more Heating Degree Days (HDD) than Cooling Degree Days (CDD).

"I've been in the roofing business in West Virginia for nearly 30 years," said Smith. "This state has a long and successful history with dark-colored membranes, especially EPDM. I know reflective roofing is gaining in popularity, but it simply does not produce the energy savings in West Virginia that many would expect."

So, Smith contacted Carlisle SynTec, a commercial roofing manufacturer, to help him show the SBA that it would actually lose money if it opted to mandate reflective roofing on the state's schools. Carlisle turned to Randy Koller, a certified energy manager for 28 years, who simulated a number of scenarios at various locations throughout West Virginia using the DOE's Cool Roof Calculator. Koller compared 60-mil reinforced TPO and EPDM membranes to determine what effects both materials would have on energy costs and the resulting carbon emissions.

His scenarios included assemblies with R-values of 15, 20, and 30 for each membrane at every location (*Figures 2* and *3*). In every scenario Koller ran, the EPDM roof system proved to be at least 10 percent more energy efficient per year than the TPO. Smith took those results back to Sneed and the SBA board to show them what could happen if it mandated reflective roofing materials throughout the state.

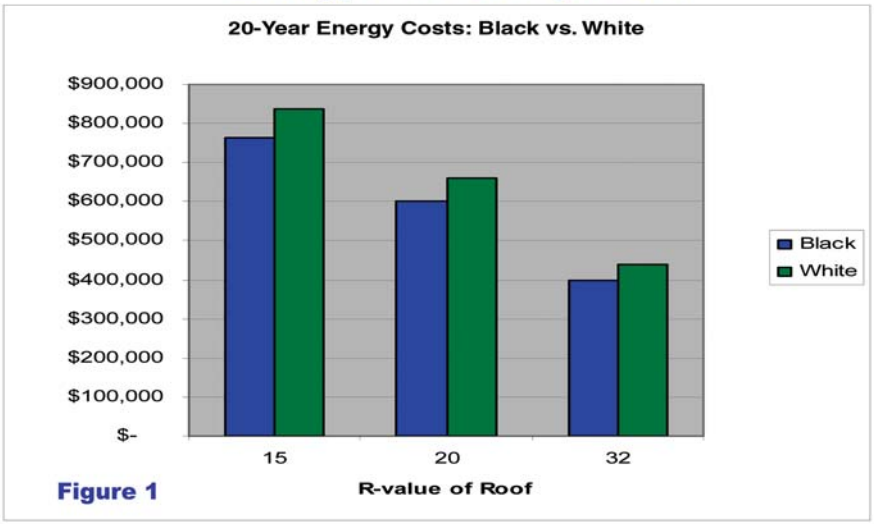
Upon reviewing the data that was compiled, the board developed a new roofing specification that called for 60-mil EPDM and at least two layers of staggered polyiso insulation. Thomas Worlledge, area manager at the architectural firm McKinley & Associates in Charleston, WV, commended the SBA for switching its original specification.

"White roofing is simply not beneficial in West Virginia," said Worlledge. "Furthermore, most schools are closed during the summer months, when peak air conditioning demand is at its highest. Installing a white roof to help cut air conditioning costs makes no sense if there is no need for air conditioning in the first place."

While Koller's findings certainly prove that black membranes are more beneficial in cooler climates, what was truly interesting was the importance that insulation played on the overall energy demand for all of his simulations, regardless of membrane color. When he ran the analysis on R-32 roofs, the energy savings attributable to membrane color were dramatically lower than those with an insulation value of R-15, and, more importantly, the difference in energy costs of the white and black roofs began to shrink as the R-value increased.

Martinsburg WV
5174 HDD 815 CDD

Energy Cost Comparison



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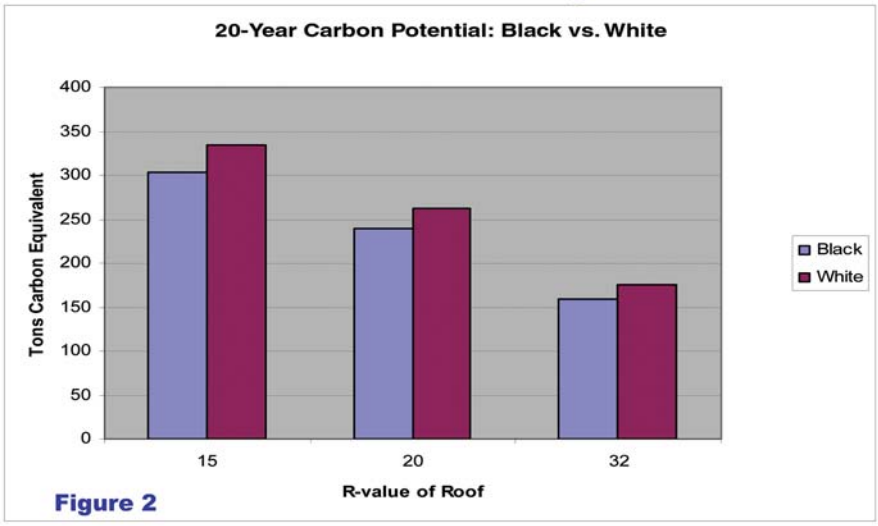


Figure 2

"Research shows that from an energy perspective, insulation often negates membrane color," said André Desjarlais, group leader for building envelope research at ORNL. "Reflective roofing should not take the place of quality design, of which insulation is a key factor."

A superior option for most low-sloped roofing, white or black, is to utilize two layers of fully adhered insulation. This option minimizes the effect of thermal escapes at the joints of the insulation and through the fasteners, resulting in a more efficient assembly.

"White membranes throughout the northern part of the U.S. may be a tool by which heat island concerns could be addressed, but they do not deliver energy savings, nor do they contribute to lower carbon emissions," stated Carlisle SynTec's Director of Design Services Samir Ibrahim. "The key factor should always be the amount of insulation utilized in the assembly, which has been demonstrated as the most influential component by which sustainability can be achieved."

Even as more evidence that refutes the benefits of reflective roofing in many instances surfaces, there is a large and influential movement that continues to push for the usage of these products. Independent organizations and government agencies such as the Cool Roof Rating Council (CRRC), the Environmental Protection Agency's EnergyStar® program, and Leadership in Energy and Environmental Design (LEED®) are all recognizable within the roofing industry, and all three promote reflective roofing without consideration for insulation or climate zone.

Worlledge, West Virginia's first LEED®-accredited architect, said that LEED®, while great in many ways, is part of the problem that has caused the reflective roofing movement to infiltrate areas where it doesn't truly belong. "Just because a building receives LEED® certification does not mean that it is a great building," said Worlledge. "Too many people do not understand the program's complexities, and, instead, they use it as a checklist."

LEED®, officially called the Leadership in Energy and Environmental Design Green Building Rating System™, is arguably the most prestigious and influential green building program in the United States. In it, one LEED® point is awarded to any building that utilizes a reflective roof system, regardless of its location. So, while not required for LEED® certification, reflective roofing is certainly promoted and often used by designers as a way to easily garner one more elusive point.

Ibrahim said that Koller's findings and the SBA's flip-flop are crucial first steps in validating EPDM's position as an environmentally friendly and energy-efficient roofing material.[1]

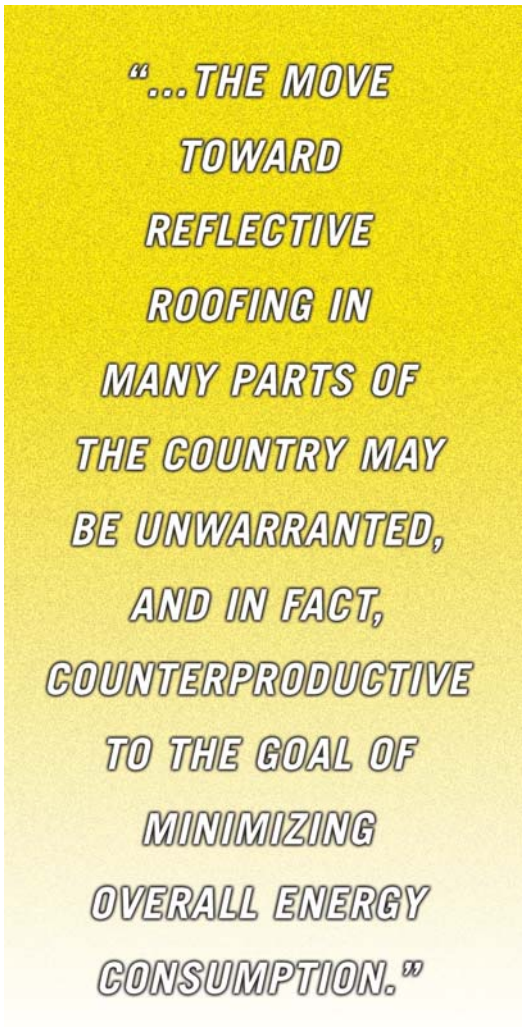
"The design community has always emphasized sustainability and energy efficiency; however, the reflective roofing movement seems to have blurred many people's vision as to how to reach those goals," said Ibrahim. "EPDM has been an effective roofing solution for decades, and we always knew that it was more beneficial in cold, northern regions. The energy analysis tools available today are helping us counteract some of the misconceptions that are out there."

Desjarlais has been researching and testing the effects of reflective roofing since 1988, when he published the industry's first report on the energy costs associated with white and black roofing materials. At the time, there was little interest in his paper because U.S. energy costs were low; however, he continued to study and he is now recognized as one of the foremost authorities on energy-efficient roofing.

"Cool roofing is the most contentious issue in the roofing industry since the introduction of single-ply membranes more than 40 years ago," said Desjarlais. "Just like

when single plies were introduced, cool roofing has changed the landscape of the market, and whether it is perceived as positive or negative, people are getting excited."

Desjarlais is quick to point out the benefits of reflective roofing in warm, southern regions, but he does not believe they should be used in cooler climates in most instances. "There are many ways to make roofs energy efficient," he said. "Cool roofs are one of them, but they are not the only option."



One of those other options that Desjarlais spoke about was EPDM ballasted roof systems, the oldest and most time-tested single-ply roofing systems available. Ballasted systems were extremely popular when EPDM first entered the roofing scene in the early 1960s, because they provided low-cost, easy installations. In ballasted systems, insulation and membrane are loose-laid onto roof decks and secured in place with stones or pavers of various shapes, sizes, and weights.

Considered by many today as antiquated, ballasted systems have been given new life. In May of 2008, the Single-Ply Roofing Industry (SPRI) released a report on a joint study with the DOE and EPDM Roofing Association (ERA) entitled, "Evaluating the Energy Performance of Ballasted Roof Systems." The study shows that ballasted systems can save as much energy as reflective roofing membranes.

Desjarlais, who headed the research, admitted that he was surprised by the results. "To think that these very low-tech roofs that have been out there for so long were achieving energy savings equal to the newer white roof membranes! The adobe method of construction used 600 to 700 years ago all makes sense."

The cool-roof benefits of ballast may make such roofs an ideal alternative to the growing number of reflective systems that are being installed in northern cities where HDDs outnumber CDDs by more than a five-to-one ratio. Many northern cities are looking to reflective roofing to help counteract the formation of urban heat islands, which can cause city temperatures to be as much as five or six degrees higher than the ambient temperature.

Chicago's latest energy code, which goes into effect on January 1, 2009, mandates reflective roofing on all low-sloped buildings within the city limits. Tom Hutchinson, principal with the roof consulting firm Hutchinson Design Group in Barrington, IL, is concerned with the city's newest code, as well as the growing number of codes across the country that are mandating reflective roofing.

"Reflective materials are seen by many groups as energy efficient, and that's it," said Hutchinson. "Most proponents, such as the EPA, LEED®, and CRRC, as well as designers and owners, often fail to consider the potential side effects of installing a light-colored rooftop in a northern climate such as Chicago, especially with mechanically fastened systems. The disconcerting aspect of this is that those who push cool roofing as a panacea for environmental concern, such as the EPA, LBL, and LEED®, have no investment in the industry and thus have no part in fixing any problems if they do occur. When was the last time you heard of the EPA

paying for a roof replacement because it failed due to the EPA's single-component roof solution? Perhaps if these associations and proponents were held monetarily responsible for their known and obviously incorrect assumptions, a more balanced approach could be achieved. Unfortunately, in the meantime, city officials are adopting and mandating changes in roofing that often lead to unintended results."

Hutchinson said he believes dark-colored membranes like EPDM, which have proven themselves for decades, are more economical and logical materials for Chicago and other northern cities, and he wasn't just speaking about energy efficiency. Because light-colored membranes remain cooler than their dark-colored counterparts, the contrast between warm interior temperatures and the cooler ones outside is much greater. This can lead to the development of condensation within the roof assembly that may appear to be a leak when in fact it is not. "People will be looking for that leak forever, but they're not going to find it," said Hutchinson. "Eventually, they'll tear off the roof system and install a new one. If it's another white roof, the same thing could happen."

Besides condensation and leakage issues, mold formation on the insulation facers is a common concern when condensation occurs. Algae growth on top of the cooler membrane surfaces is another common problem associated with light-colored roofs that are installed in both northern and southern climates. In many instances, the light-colored material never gets warm enough to dry off, and surface mold or algae will form eventually. A common area for this growth is on the rooftop near mechanical equipment, because this location is dark and cool. The growth becomes an environmental hazard for building occupants, as air intakes are often located on the roof. White surfaces also become soiled over time and, in urban areas, can become downright dark; this result is ironic, because cities such as Chicago are endorsing reflective materials because it is believed that they can help alleviate the negative environmental impacts associated with urban heat islands.

It is highly unlikely that a consensus will ever be reached within the roofing industry as to what constitutes the best system in any given location. There are too many interests and too much money involved. Manufacturers of strictly white roofing will continue to tout its benefits nationwide. The same goes for those that only manufacture dark-colored materials.

Luckily, the emergence of energy and life cycle analysis programs such as the DOE's Cool Roof Calculator will help validate or refute the claims that are being thrown around by all sides. One thing is for certain: EPDM has proven to be a long-lasting and dependable roofing option for the past 45 years. It has lost share to reflective roofs over the past decade, notably in warmer, sunnier climates; however, it is unlikely that its proponents will sit idly by and watch it lose out strictly because of its color. Reflective roofing materials have a place within the industry; but so, too, does EPDM.

"No roof system should be shoved down people's throats," said Desjarlais. "I'd like to see the availability of all options and let people choose based on what is the most economical and efficient for their needs."

References

1 The specification is for a fully adhered, .060 fire-rated (FR) EPDM. Where reflectivity is desired or needed, .060 fully adhered white FR EPDM will be installed. Assemblies must include 20-psi polyiso of a thickness required to comply with the latest IECC and/or ASHRAE 90.1. There must be two layers with staggered joints and achieve an R-32. All seams must feature 6-in, factory-applied seam tape, and a 16-hour puncture repair warranty is required. See the document at **www.wvs.state.wv.us/wvsba/hottopix/quality.pdf**.

Tony Matter

Tony Matter has been writing for the roofing industry for three years, and he previously worked as a freelance reporter for *The Patriot News* in Harrisburg, PA. He earned a bachelor's degree in public policy from Pennsylvania State University. Matter has worked in the construction industry for nearly 10 years and currently serves as the marketing communications manager for Carlisle SynTec.