Cool roofs:

Assuming a higher profile in key building codes and standards

Elastomeric acrylic cool roof coating is applied by roller to low slope roof. Photo courtesy Rohm and Haas

Report from experts at Lawrence Berkeley Laboratory offers evidence of technology's emerging significance

By Joe Maty, JAC Editor

If any lingering doubts persist in the design and building professions regarding the level of interest in cool-roof technologies, this perception can be quickly dispelled by reviewing a forthcoming paper by experts on the subject from Lawrence Berkeley National Laboratory.

The paper, titled "Status of cool-roof standards in the United States," tracks the development of various cool-roof initiatives, their evolution into more expansive measures, and moves by states and other jurisdictions and agencies to adopt programs aimed at fostering greater use of cool-roof technologies. The heightened level of activity in the launch of these initiatives serves as a barometer of interest in these green-building strategies.

The authors of the paper are Hashem Akbari and Ronnen Levinson of the Heat Island Group at Lawrence Berkeley Laboratory. Akbari heads the group, which has carried out groundbreaking research on building design and materials technologies that reduce energy demand and mitigate the urban heat-island effect. The paper is scheduled for presentation at the Second PALENC (Passive and Low-Energy Cooling) Conference, scheduled for Sept. 27-28 in Crete.

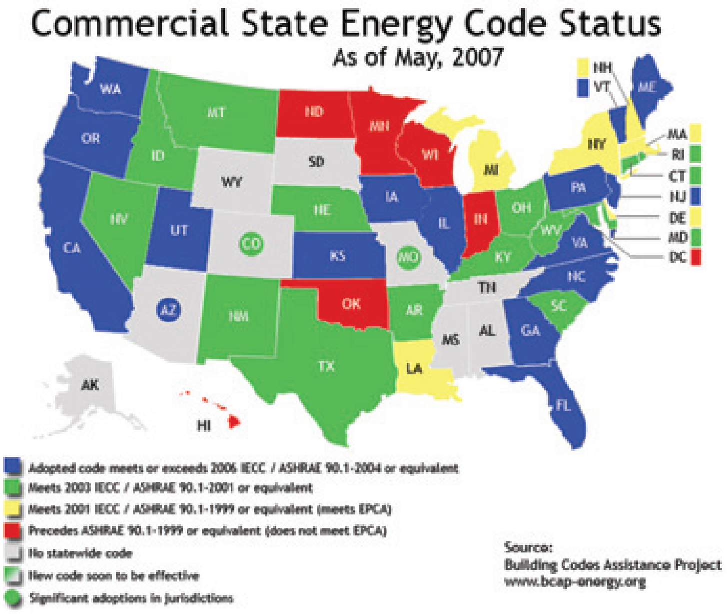
The paper reviews the technical development of cool-roof provisions in the ASHRAE 90.1 and 90.2 standards and

California Title 24 standards, and gives some attention to the EPA Energy Star program and the U.S. Green Building Councilís LEED (Leadership in Energy and Environmental Design) green-building rating system, both of which address cool-roof systems.

Making the case for the cool roof

In acknowledging the significance of cool-roof technologies as an effective means to reduce the impact of solar radiation on roof heat transfer in warm climates, the authors cite research showing that cool roofs used in warm climates such as California, Texas, and Florida have typically yielded summertime daily air-conditioning savings and peak energy demand reductions of 10% to 30%.

Roof coatings figure prominently in the cool-roof marketplace, with technologies that are seeing extensive use in both factory- and field-applied materials. These chemistries include a variety of solar-reflective, pigmented coatings based on resins such as acrylics, silicones, polyurethanes, and polyurea hybrids.



(See *JAC*, June/July 2000). Coatings suppliers in recent years also have introduced high-performance, fluoropolymer coatings used as factory-applied finishes for metal roofs. Coatings colored with conventional light-colored pigments cann provide high solar reflectance (over 0.7). Novel dark coatings colored with special pigments that minimize absorption of near-infared sunlight can yield dark surfaces with medium solar reflectance (about 0.4).

Cool-roof standards: A dynamic situation

In reviewing existing standards, the report by Akbari and Levinson points out that the current ASHRAE 90.1 standard includes credits for cool roofs, which are defined as possessing a minimum initial solar reflectance of 0.70 and a minimum thermal emittance of 0.75. The authors also provide some detail on other specifics of ASHRAE 90.1 and 90.2, including the addition of thermal transmittance multipliers for climate zones in the U.S., and revisions related to the effect of cool-roof technologies on the thermal transmittance of the roof assembly as a whole.

Turning their attention to California, a hotbed of green-building ideology, Akbari and Levinson discuss the addition of cool-roof credits to Californiaís Title 24 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. The standards were expanded in 2005 to include prescriptive requirements for cool surfaces on many low-slope, nonresidential roofs. In addition, the California Energy Commission is currently considering the addition of cool-roof requirements for other buildings to new standards to be issued in 2008.

In defining prescriptive as opposed to mandatory requirements of building energy-efficiency standards, the authors state that mandatory requirements, such as practices for proper installation of insulation, must be implemented in all buildings covered by the given standard. A prescriptive requirement typically specifies the characteristics or performance of a single component of the building (e.g., the thermal resistance of duct insulation) or of a group of components (e.g., the thermal transmittance of a roof assembly).

Currently, cool-roof credits under California Title 24 duplicate the cool-roof provisions of ASHRAE, setting the bar for nonresidential-building roofs at an initial solar reflectance of at least 0.70 and a thermal emittance of at least 0.75, with an exception for tile roofs, where the initial solar reflectance requirement is 0.40. The Berkeley Laboratory Heat Island Group in 2005 began to investigate the merits of adding cool-roof requirements for all other types of buildings, including low-slope and steep-slope residential and nonresidential roofs. Akbari and Levinson state that the Heat Island Group simulated the energy use of a prototypical building with conventional and cool versions of three different steep-sloped roofs: fiberglass asphalt shingle, concrete tile, and polymer-coated metal. Each conventional product possessed a solar reflectance of 0.10. By contrast, the cool-shingle roof's solar reflectance was 0.25, while the solar reflectance of the cool-tile and cool-metal products was pegged at 0.40. All products were assigned a thermal emittance of 0.90.

Based on the simulation study, the Heat Island Group concluded that the expansion of cool-roof requirements for steep-slope nonresidential roofs under Title 24 would prove to be cost-effective throughout the state's highly diverse climate zones, which total 16. A cool-roof requirement for steep-slope residen-

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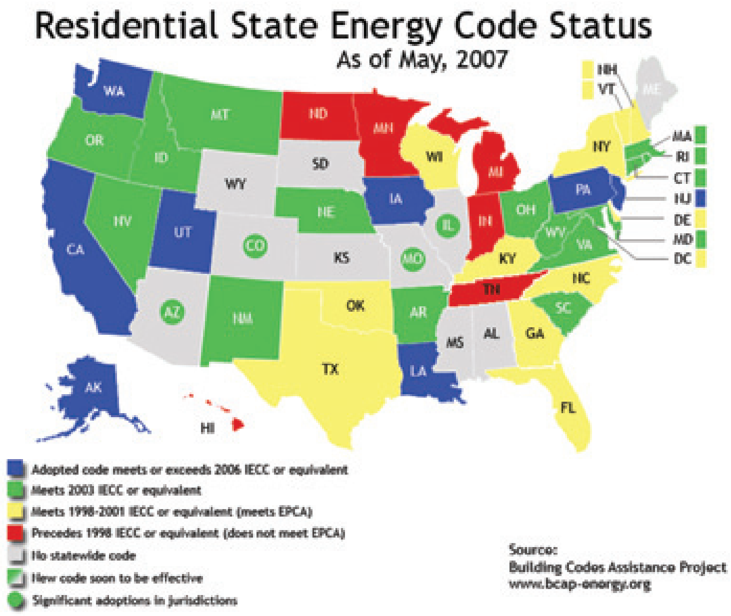

tial roofs would be cost-effective in some of the climate zones, the study determined.

As part of its plans to expand cool-roof code requirements in Title 24, the California Energy Commission is considering the inclusion of a prescriptive cool-roof requirement for nonresidential buildings with steep-sloped roofs in all climate zones. The state is also weighing the inclusion of a prescriptive cool-roof requirement for residential buildings with low-slope and steep-slope roofs in the very warm and sunny Central Valley climate.

Other programs and standards

Assessing the status of cool-roof initiatives elsewhere in the country, Akbari and Levinson indicate that many states have adopted building codes established by ASHRAE Standard 90.1 or the International Energy Conservation Code (IECC). Other U.S. cities, states, and territories have developed customized provisions for cool roofs in their energy codes. These include Atlanta, GA; Chicago, IL; Florida; Georgia; Guam; and Hawaii. Cool-roof requirements have also been developed by several voluntary energy-efficiency programs, including the EPA's Energy Star"™ label, the LEED rating system, and the cool-roof rebate programs offered by the state of California and its utilities.

The accompanying maps, above and on the previous page, provide a glance at the adoption, as of May 2007, of IECC and/or ASHRAE standards by individual U.S. states.

Akbari and Levinson report that the 2003 IECC does not explicitly address the use of cool roofs; however, IECC compliance can be achieved by meeting the requirements of ASHRAE Standard 90.1, which in turn offers cool-roof credits. There are neither direct nor indirect cool-roof credits for residential buildings under current IECC codes. The 2006 IECC retains the link to ASHRAE Standard 90.1 for commercial buildings, and explicitly offers cool-roof credits for residential buildings through performance compliance.

To qualify for its Energy Star™ label, the U.S. EPA currently requires that low-slope roofing products possess initial and three-year aged solar reflectances of at least 0.65 and 0.50, respectively. Steep-slope roofing products must possess initial and three-year-aged solar reflectances of at least 0.25 and 0.15, respectively (EPA 2007).

The LEED Green Building Rating System assigns one rating point for the use of a cool roof, in credit 7.2. The current version of LEED (2.2) uses the solar reflectance index (SRI) measure to qualify a non-vegetated cool roof. SRI is a relative index of the steady-state temperature of a roof's surface under standard summer-afternoon conditions, as defined in ASTM Standard 1980. SRI is defined to be 0 for a clean black roof (solar reflectance 0.05, thermal emittance 0.90), and 100 for a clean white roof (solar reflectance 0.80, thermal emittance 0.90). The LEED system also spells out other specific requirements needed to earn the cool-roof credit.

In their report, Akbari and Levinson offer compelling evidence that cool roofs are assuming a higher profile in the building-code and green-building domains. Their assessment would suggest that the market for cool-roof technologies, including solar-reflective coatings, is destined to heat up as a way to keep energy costs down and the urban heat island in check.

More information on the report "Status of Cool-Roof Standards in the United States" is available from Hashem Akbari, Lawrence Berkeley National Laboratory Heat Island Group, by sending an email to H_Akbari@LBL.gov. Information on the programs and activities of the Heat Island group is available online at http://www.HeatIsland.LBL.gov and http://CoolColors.LBL.gov.

More information on the PALENC (Passive and Low-Energy Cooling) Conference is available from the website located at www.palenc2007.conference.gr.

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