


they do not have measured values from the roofing manufacturer. The default solar reflectance value for any other type of metal roof without measured values would be 0.08, which is equivalent to the reference material (composition shingle), meaning there would be no advantage noted in the energy rating.

The amendment was posted for public comment in May before being adopted into the new set of procedures.

NEW TASK FORCE

RESNET is appointing a task force to establish a National Standard for Energy Audits of Existing Homes. This has been done in order to satisfy the growing need and interest in energy audits. With spiraling costs of home heating and cooling, the need for such audits is also spiraling, resulting in the need for a national standard. For additional information on this task force, it's make up and mission, go to [www.resnet.us/hotnews/taskforce/Energy Audit Framework. pdf](http://www.resnet.us/hotnews/taskforce/Energy%20Audit%20Framework.pdf)

MARK YOUR CALENDAR

The 2008 annual RESNET Building Performance Conference has been announced for February 18-20, 2008, in San Diego, CA. With the challenges of spiraling energy costs, climate change and energy efficiency catching the attention of popular media, corporate leaders, utilities, Congress and State Governments, RESNET has scheduled its annual conference to address these issues. This presents opportunity for the building products and building performance industries. 

More than ever, the American public, the housing industry, corporations, utilities, financial institutions and policy makers are looking for solutions.



Credit: Corus Building Systems

[ABOVE-SHEATHING VENTILATION FOR METAL ROOFS]

Providing an air space above the sheathing of a roof deck offers thermal benefits for stone-coated or standing seam metal roofs that yield energy savings in the summer and winter while also helping to remove unwanted moisture.



ORNL "Test Farms" for various roofing products

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Figure 1: Batten and counter-batten system used to mount stone-coated metal roofs.

Stone-coated shake roofs are often offset mounted from the roof deck using a batten and counter-batten system. Here counter-battens (1" x 4") are nailed to the roof deck from soffit to ridge, and battens (2" x 2") are placed above the counter-battens and nailed to the deck (Fig. 1). The batten and counter-batten construction provides a unique inclined air channel running from soffit to ridge. The bottom surface of the channel is formed by the

sheathing. The top surface is created by the underside of the stone-coated metal and is broken at regular intervals by the 2" x 2" batten wood furring strip (into which the shakes are fastened). The batten and counter-batten and similar systems provide an air space wherein the solar irradiance absorbed by the metal roof heats the air within the space and induces a natural convection airflow, which we define as above-sheathing ventilation.

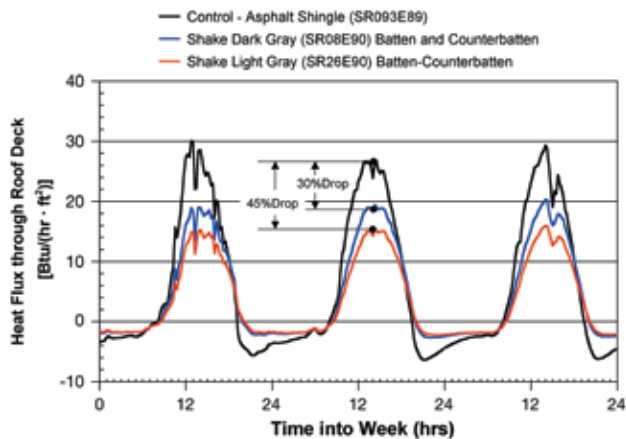


Figure 2: The effect of solar reflectance and above-sheathing ventilation for dark gray (SR08E90 indicates a solar reflectance of 0.08 and an emissivity of 0.90) and light gray (SR26E90) stone-coated metal shake roofs as compared to a direct nailed shingle roof (solar reflectance 0.093).

To examine the effects of above-sheathing ventilation, a steep-slope roof assembly was constructed for field testing and documenting the energy savings of several stone-coated and standing seam metal roofs (Miller 2006). A commercially available asphalt shingle with a solar reflectance of 0.093 and a thermal emittance of 0.89 (SR093E89) was selected as the control for comparing the thermal performance of the metal roof systems. A conventional shake, a dark-gray stone-coated metal (SR08E90), was also field tested. This shake has a solar reflectance and a thermal emittance very similar to that of the control asphalt shingle. The asphalt shingle, however, was directly nailed to the roof deck, with no air space along its underside, while the dark-gray shake was attached to the batten and counter-batten arrangement. Both assemblies were equipped with attic ventilation through soffit and ridge vents. Thus, a comparison of the two test roofs can provide insight into the effects of above-sheathing ventilation. The light-gray stone-coated shake (SR26E90) had the same batten and counter-batten construction as the dark-gray shake. However, the light gray shake has a solar reflectance of 0.26 and thermal emittance of 0.90; its unpainted underside has a thermal emittance of 0.35. A comparison of the two stone-coated roofs reveals the benefits of high solar reflectance in combination with above-sheathing ventilation.

Summer Field Exposure

A clear, cloudless summer day was selected to display the separate and combined effects of high solar reflectance and above-sheathing ventilation as compared to the asphalt

[A 45% reduction in heat flow can occur from both above-sheathing ventilation and increased solar reflectance.]

shingle roof. Venting the underside of the dark-gray stone-coated metal shake caused significant reductions in the heat flow crossing the deck during solar noon, as seen in Figure 2. The dark-gray stone-coated metal shake and the asphalt shingle have almost identical reflectance and emittance characteristics, yet the heat flow crossing the roof deck of the dark-gray shake is just 70% of the heat flow crossing the roof deck of the asphalt control shingle. The 30% reduction in heat flow is due to above-sheathing ventilation. Note that the air space was closed to the soffit to eliminate wind effects.

The light-gray shake (SR26E90) and the dark-gray shake (SR08E90) have identical batten and counter-batten constructions and low underside emittance values ($E=0.35$). Both have soffit and ridge vents supporting attic ventilation. The 0.17 increase in the solar reflectance caused the heat flow crossing the roof deck of the light-gray shake to be less than the heat flow crossing the roof deck of the dark-gray stone-coated shake. The reduction is about 15% of the heat crossing the deck of the control shingle roof (Fig. 2). The 30% reduction due to above-sheathing ventilation of the dark stone-coated shake can be added to the 15% reduction due to increased solar reflectance to yield a total 45% reduction in heat flow due to both above-sheathing ventilation and increased solar reflectance. The combined results (Fig. 2) shows that ventilating the deck is just as important as is increasing solar reflectance and may be the stronger player in reducing heat gain into the attic. It should also be noted that the heat flow due to above-sheathing ventilation of the hotter dark-gray shake is more than double the amount of heat flow swept away from the deck of the light-gray shake. The hotter dark-gray shake causes greater buoyancy-induced airflows, and therefore above-sheathing ventilation is somewhat self-regulating and offsets the effect of the darker, less reflective color.

Winter Field Exposure

Cool roofs have received much positive trade press where comfort cooling is the dominant building energy load. In mixed climates with both significant heating and cooling loads, the wintertime effect reduces the energy benefit because the desirable roof heat gain in winter is diminished somewhat by the higher solar reflectance of the roof. The Achilles heel of all cool roof systems continues to be the heating penalty that offsets the energy and cost savings associated with the cooling benefit of the reflective roof system. The colder the climate the greater the penalty, and the trade-off between climate and reflective roofs limits their penetration into predominantly heating load climates. However, field data for the stone-coated metal roofs tested in east Tennessee's moderate climate are showing that the metal's above-sheathing ventilation negates the heating penalty associated with cool roofs having high solar reflectance.

Data for a January week with clear skies, shown in Figure 3, illustrate the wintertime thermal performance of stone-coated metal roofs compared with that of a dark, heat-absorbing asphalt shingle roof. The ridge vents for these test sections were open, and both attic and above-sheathing ventilation were observed for this week of January, which had an average daytime ambient air temperature of 36°F. At solar noon for each of the seven days, the attic assembly with asphalt shingles (SR093E89) absorbed more

solar radiation than either of the two more reflective stone-coated metal roofs (18 vs. 10 Btu/hr·ft²; see Figure 3). However, the nighttime losses for the direct-nailed asphalt shingle roof were significantly larger than losses for the attics with above-sheathing ventilation of the shake roofs (the abscissa in Figure 3 shows midnight as multiples of 24). The heat loss from the shingle roof at night was roughly twice that escaping from the two light-gray roofs or from the dark-gray shake roof, all with batten and counter-batten construction. The underside of a second light-gray stone-coated metal was painted to show the effect of thermal emittance, which increased from 0.34 (unpainted) to 0.85 (when painted). The higher underside emittance resulted in larger nighttime heat losses from the roof deck.

Therefore, the air gap appears to be serving as an insulating layer that reduces radiative and convective heat transfer from the roof deck to the metal roof's underside, as compared with the direct conduction path through relatively highly conductive solids in the case of the asphalt shingle roof. From about 8:00 p.m. through about 6:00 a.m. all the stone-coated metal roofs lose less heat to the night sky than does the asphalt shingle roof. The temperature of the stone-coated metal is colder at night than that of the shingle, yet the

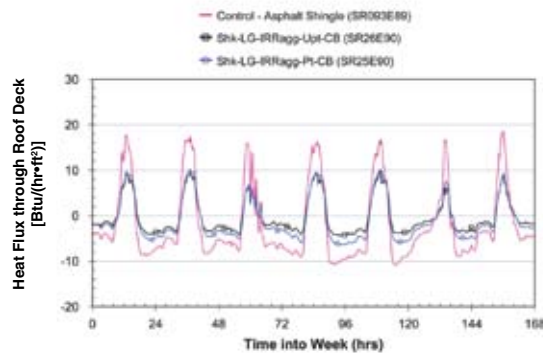


Figure 3: Heat flow measured through the roof deck for stone-coated metal shake and asphalt shingle roof during a week in January 2005. The one light-gray stone-coated metal roof [Shk-LG-IRRagg-Pt-CB(SR26E90)] has a painted underside to show the effect of thermal emittance within the air gap.

deck temperature for the stone-coated metal roof (with above-sheathing ventilation) is warmer than the deck temperature for the direct-nailed shingle roof.

Results integrated over the week of January data shown in Figure 3 indicate that the above-sheathing ventilation of the stone-coated metal roofs counterbalances the heating penalty associated with cool roofing for the moderate climate of Tennessee (Table 1). The asphalt shingle roof gains through its deck about 476 Btu/ft² of attic floor during the daylight hours for the week of January data. The light-gray stone-coated metal roofs gain only half as much heat because of their higher solar reflectance (0.25 vs. 0.09). During the evening hours, however, the heat lost through radiative cooling of the roof decks for the stone-

coated metal roofs is 50% less than that lost from the asphalt shingle roof. In fact, during the evening hours the insulation air layer reduced the heat loss from the stone-coated metal roofs to the point that the heat loss from the attic floor was less than the loss from that of the control shingle (-562 Btu/ft² of attic floor for the shingle roof vs. -453 and -429 Btu/ft² for the stone-coated metal roofs). These data represent a very important finding because they show that stone-coated metal roofs negate the heating penalty associated with a cool roof in Tennessee's moderate climate (3662 HDD65 and 1366 CDD65).

Summary

The improved summer performance coupled with the reduced heat losses



A cool metal roof can save a home owner up to 25% in cooling energy costs compared to a dark- gray asphalt shingle.

(ORNL, FSEC)



during the winter show that high solar reflectance metal roofs negate the heating penalty associated with a cool roof. Offset mounting a stone-coated metal roof provides a seasonal synergistic effect (improved cooling performance and reduced winter heat losses) that the metal roof industry should exploit for marketing its products in predominately cold climates.

Future articles will address: (1) how above-sheathing ventilation affects moisture removal; (2) does increased

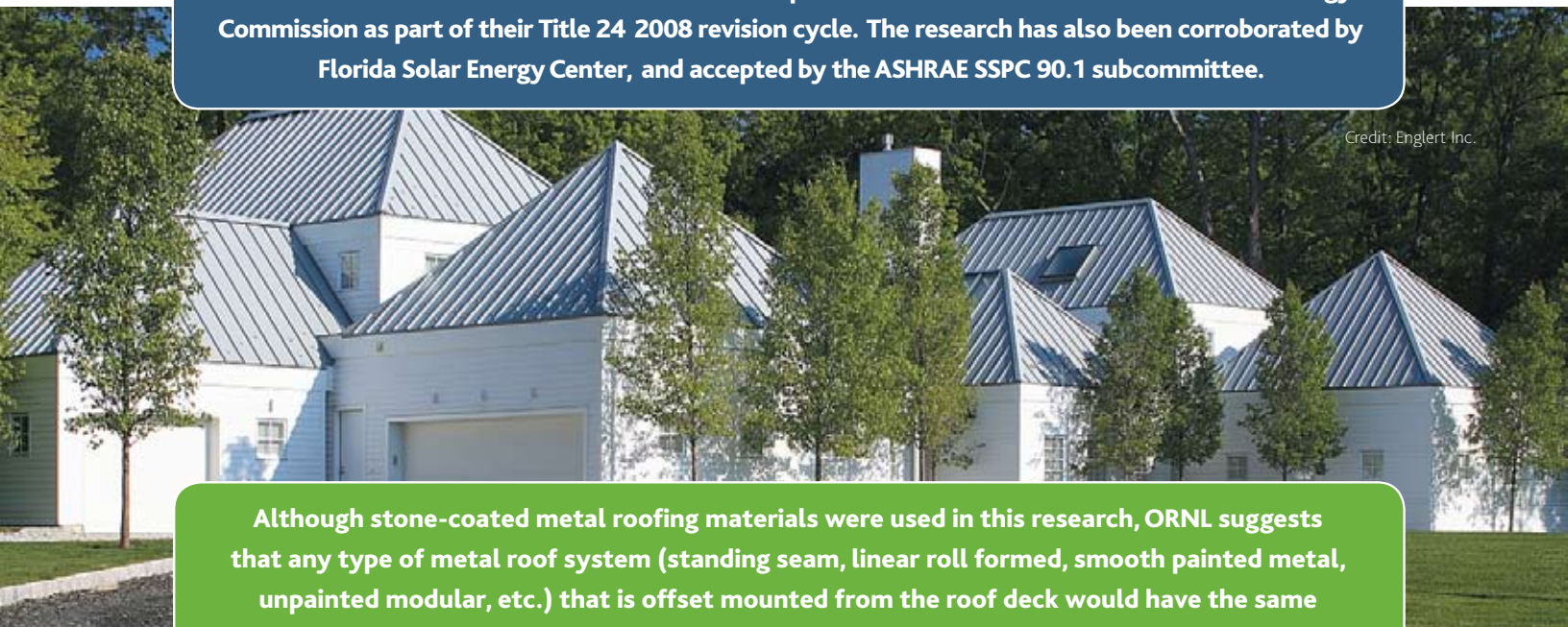
spacing of the air gap improve thermal performance; (3) does above-sheathing ventilation help retard ice damming; and, (4) what are the seasonal benefits of above-sheathing ventilation.

Acknowledgements

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Achilles Karagiozis, all of ORNL's Buildings Envelope Program. The Metal Construction Association and its affiliate members provided the stone-coated shake and S-mission roofs used in testing. Metro Roof Products constructed the attic assemblies and provided valuable assistance in installing the roofs on the steep-slope assemblies. The financial support of the Metal Construction Association, the Cool Metal Roofing Coalition and the guidance of Metro Roof Products are greatly appreciated. [cmrf](#)

The results from the ORNL research project and subsequent modeling in various climate zones formed the basis for a Measured Information Template that was submitted to the California Energy Commission as part of their Title 24 2008 revision cycle. The research has also been corroborated by Florida Solar Energy Center, and accepted by the ASHRAE SSPC 90.1 subcommittee.



Although stone-coated metal roofing materials were used in this research, ORNL suggests that any type of metal roof system (standing seam, linear roll formed, smooth painted metal, unpainted modular, etc.) that is offset mounted from the roof deck would have the same advantages from above-sheathing ventilation due to the creation of an air space.