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2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.4 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above cooled conditioned spaces ~~in *Climate Zones* 0 through 3~~ shall comply with one or more of the options in Table C402.4.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.4:

1. Portions of the roof that include or are covered by the following:
   - 1.1. Photovoltaic systems or components.
   - 1.2. Solar air or water-heating systems or components.
   - 1.3. Vegetative roofs or landscaped roofs.
   - 1.4. Above-roof decks or walkways.
   - 1.5. Skylights.
   - 1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.
5. Roofs in Climate Zone 6 that are in a jurisdiction with a population of less than 50,000.

TABLE C402.4 MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS[a]

Climate Zone	0-6	7-8
Three-year-aged solar reflectance[b] / ~~of 055 and~~ 3-year aged thermal emittance[c] ~~of 0.75~~	0.63/0.75	NR
Three-year-aged solar reflectance index[d]	~~of 64~~ 75	NR

a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for either solar reflectance or thermal emittance shall be assigned both a 3-year-aged solar reflectance in accordance with Section C402.4.1 and a 3-year-aged thermal emittance of 0.90.

b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903, ASTM E1918 or CRRC-S100.

c. Aged thermal emittance tested in accordance with ASTM C1371, ASTM E408 or CRRC-S100.

d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft^2 × °F (12 W/m^2 × K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance.

Reason: The 2024 International Energy Conservation Code (IECC) should extend the requirements of section C402.4 on roof solar reflectance and thermal emittance standards to include Climate Zones 4, 5, and cities in Climate Zone 6. This modification is cost-effective and will provide benefits felt by building owners, occupants, and the energy system. This code update would save building owners and occupants money, reduce overall energy consumption and GHG emissions, mitigate and adapt to climate change, address longstanding environmental justice issues, and improve health outcomes by reducing the risk of summer heat deaths.

The Smart Surfaces Coalition (SSC) strongly supports the update to code C402.4 in the 2024 IECC. SSC, a 501(c)(3), is a coalition of 40+ industry-leading organizations including the American Institute of Architects (AIA), the National League of Cities (NLC), the American Council for an Energy-Efficient Economy (ACEEE), the Alliance to Save Energy, the American Public Health Association (APHA), the American Planning Association (APA), and many other organizations. What unites the coalition is the dedication to support cities in adopting cost-effective reflective, green, and porous surfaces and solutions that help combat climate change. This statement reflects the entire coalition's stance on the necessary changes to the 2024 IECC.

The beneficiaries of expanding reflective roof requirements to Climate Zones 4, 5, and cities in Zone 6 include property owners, occupants, and the Climate Zone's respective populations at large. The changes would improve people's health and wellbeing, lower their energy bills, deliver environmental justice, and strengthen the economies of cities, and industries such as tourism. The only consistent opposition to the expansion of reflective roof requirements are dark roofing manufacturers and their industry groups. For example, a 2016 roofing industry review discusses these "erroneous, claims against cool roofs despite the science supporting their general benefits… The success of … cool roof technologies has created an anxiety among the manufacturers of 'non-cool' roofs. They have initiated a campaign through the ERA to discredit, or at least cast doubt, on the fundamental science behind cool roofing [1]."

In a more recent example, in Spring 2022 two roofing materials industry groups: the Asphalt Roofing Manufacturers Association (ARMA) and the EPDM Roofing Association (ERA) submitted a document to the Baltimore City Council opposing a new roof ordinance to increase roof reflectivity. These organizations sought to raise doubts about the legitimacy and benefit of increasing the use of reflective/cool surfaces in Baltimore. The objections made in Baltimore by these two groups which have been persuasively rebutted by other roofing industry organizations are discussed and dismissed again below.

The 2024 International Energy Conservation Code (IECC) should extend the requirements of section C402.4 on roof solar reflectance and thermal emittance standards to Climate Zones 4, 5, and cities in Climate Zone 6. Cities and non-rural areas in Climate Zone 6 should incorporate reflective roof requirements because in dense urban environments reflective roofs not only cool their respective building but also provide city-wide cooling to a city.

The benefit-cost value of reflective roofs is greater in cities than in rural areas because of the secondary cooling, energy-cost saving, climate health, and equity benefits that are shared throughout a city. For Zone 6, roofs in jurisdictions of at least 50,000 people, qualifying as a small city according to the National League of Cities definition should be subject to reflective requirements [2].

Many major cities already require the use of reflective roofs. Those cities include Chicago, Dallas, Denver, Houston, Los Angeles, Miami Beach, New York City, Philadelphia, and Washington, D.C. New York, and Chicago are cities in Zones 4 and 5, respectively, demonstrating the value of commercial reflective roof requirements in these climate zones.

A. Energy and Heat Reduction

Cool or reflective roofs reflect far more sunlight back into the atmosphere than a conventional, dark roof, which absorbs roughly 80 - 95% of incoming sunlight. Asphalt and EPDM-based materials are examples of these dark, lower-cost roofing options. These dark roofs heat buildings, worsen city-wide urban heat, increase air conditioning demand, aggravate smog and air pollution, and impose large economic and equity burdens. As a result of such costs, these types of dark roofs are increasingly being rejected by cities and by national and international energy codes in favor of reflective roofs. In contrast to their dark counterparts, reflective roofs reduce heat in buildings and across the city, thereby reducing air conditioning demand and unwanted outside heat, smog, energy bills, and a range of health costs and risks [3]. The US Cool Roof Rating Council lists a variety of commercially available roofing products and paints that are highly reflective on their roof product directory. These products are applied nationally, including in zones in climate zones 4, 5, and 6, demonstrating the value and effectiveness of reflective roof strategies in these climate zones.

For almost all the U.S., including Climate Zones 4, 5, and cities in Zone 6, the cool roof summer cooling benefit far outweighs the winter heating penalty. For example, a Concordia University study done to test the impact of reflective roofs on new and older commercial buildings in Anchorage, Milwaukee, Montreal, and Toronto. The study which factored in snow cover concluded that "cool roofs for the simulated buildings resulted in annual energy expenditure savings in all cold climates [4]." In most northern locations, winter solar irradiance–a major factor impacting energy savings–is only about 20% of what is experienced in the summer months, because winter days are shorter with lower-angle sunlight (so the sun provides far less heat in the winter months) [5]. Since days are shorter, sunlight is at a lower angle (so it's not as hot), and there are more clouds, the already small winter heating penalty of reflective roofs is shrinking. Global warming is making cities hotter and winters warmer, making reflective roofs even more cost-effective [6]. Also, many commercial buildings require space cooling all year due to heat from human activity and equipment, so they generally don't benefit from heat from the sun.

It should also be noted that buildings in northern climates often have high levels of roof insulation. There is a common misconception that higher insulation levels reduce or negate the energy-saving impact of cool roofs. A study of black and white roof membranes over various levels of insulation by the Princeton Plasma Physics Lab showed that the relationship between roof reflectivity and insulation was not a tradeoff. This means that for a building owner to have a roof that minimizes heat gain in the summer and heat loss in the winter, both insulation and reflectivity are necessary [7].

Given climate projections from the Intergovernmental Panel on Climate Change (IPCC), city-wide cooling strategies like reflective roofs are moving from optional to essential to protect city livability [8]. Over the last two decades, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has found that heating degree days have dropped 15% while cooling degree days have increased by about 15%. These findings were drawn from out-of-date data. Given accelerated global warming, the shift from heating to cooling degree days is substantially larger than the ASHRAE estimations indicate [9]. Given the reality of global warming and the decrease in heating degree days, reflective roofs are a strong and suitable solution across climate zones.

B. Health

Reflective roofs can reduce urban heat, smog, heat deaths, and costs, building a strong public health argument for their deployment in Climate Zones 4, 5, and cities in Zone 6. Heat deaths typically occur on the top floor of a building as a direct result of the heating of dark roofs [10]. For example, a Chicago multi-day heat event in 1995 killed 793 people [11]. With the value of a statistical life at about $10 million, the deaths alone quantify this tragedy at $800 million [12]. This is without any attempt to quantify the cost of the larger number of people who suffered from, though survived the heat event. Chicago is in Zone 5, but on the cusp of Zone 6, illustrating that with the increased severity and frequency of heat events across Climate Zones, reflective roofs should be included in updated codes for all of Zone 5, and urban roofs in Zone 6 as well.

More generally, reflective roofs can improve health outcomes with the health benefits that come with reducing indoor and outdoor extreme heat. The impacts of excess urban heat are large and complex including increased risk of chronic diseases, obesity, occupational accidents, and reduced work capacity [13]. Reflective roofs measurably reduce urban temperature, protecting the lives and health of populations.*C. Moisture* Cool roofs reduce energy demand, mitigate urban heat islands, and can be built without the presence of moisture. Moisture and condensation risks on cool roofs can be easily eliminated by using a variety of commercially available products or roof designs. In colder climates, warm, humid air travels upward in a building during the cold winter months and can infiltrate the roof assembly from the bottom. In a paper presented to the 2011 NRCA International Roofing Symposium, the Single Ply Roofing Industry (SPRI) reported on a field survey and modeling studies to verify whether cool roofs were susceptible to condensation buildup. SPRI found that though moisture was observed on the underside of the membrane on three roofs, researchers noted "no detrimental effects due to moisture in any of the roofs [14]." In all cases, the minimal moisture build-up detected in the winter months dried up by the summer. Moreover, condensation risk for low-slope roofs can be easily reduced by applying spray products or using a vapor retardant layer under the roof [15]. These design tactics and products are well-understood and commonly used in the roofing community.

The Smart Surfaces Coalition has worked with multiple cities to undertake city-wide cost-benefit analysis of Smart Surfaces including reflective commercial roofs. For example, in 2021, the Smart Surfaces Coalition conducted a 248-page analysis with/for the city of Baltimore and a range of partners such as the American Institute of Architects, the National League of Cities, and the American Public Health Association that demonstrated how reflective roofs are both cost-effective (with a benefit-cost ratio greater than 9:1) and provide broad benefits including in the areas of health, employment, risk reduction, reduced energy bills and improved resilience. The report quantified the benefits that reflective roofs deliver including reduced heat, better air quality, lower energy bills, reduced risk of summer heat deaths, and improved urban structural inequality, and large health benefits.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will increase the cost of construction.
SSC's agrees with the broad roofing and building industry consensus on the cost-effectiveness of reflective roofs. The leading industry publication, Roofing Magazine, for example, asserts that "decades of real-world examples from the marketplace indicate that reflective roofs are an effective net energy (and money) saver even in our coldest cities." If examined from just a surface life-extension perspective, implementing cool roof requirements in Climate Zones 4, 5, and cities in Zone 6 is the cost-effective choice. [16]. Reflective roof requirements would help remove the cost burden of dark roofs from home and property owners by guiding them to make the more cost-effective choice.

Additionally, with rapidly rising market demand and the desire to respond to climate change, roofing manufacturers are increasingly investing in more reflective roofing products. Reflective roofs not only reduce unwanted heat and cut pollution, energy bills, smog, and GHG emissions but also commonly command larger profit margins for roofing product companies. This dynamic makes cool roofs more desirable for both manufacturers and consumers in most cities.

The Smart Surfaces Coalition has worked with multiple cities to undertake city-wide cost-benefit analysis of Smart Surfaces including reflective commercial roofs. For example, in 2021, the Smart Surfaces Coalition conducted a 248-page analysis with/for the city of Baltimore and a range of partners such as AIA, the National League of Cities, and the American Public Health Association demonstrating that reflective roofs are very cost-effective, with a benefit-cost ratio of over 9:1.

Clearly, there is broad documentation and consensus – with the exception of dark roof companies and their industry groups – that reflective roofs are cost-effective and important design elements across the country including in Zones 4 and 5. The higher heat in cities (called the urban heat island effect) means that in cities in Zone 6 reflective roofs are also very cost-effective and provide a broad range of health, energy bill, economic and resilience, and climate benefits. The case for extending reflective surface requirements in IECC is clear and compelling.

Bibliography: [1] FiberTite Blog "A Cool Roof Myth" https://www.fibertite.com/blog/a-cool-roof-myth[2] National League of Cities "Small: 50K" https://www.nlc.org/resources/city-size/small-50k/[3] US Department of Energy "Cool Roofs" https://www.energy.gov/energysaver/cool-roofs
[4] Energy and Buildings "Effect of cool roofs on commercial buildings energy use in cold climates" https://www.sciencedirect.com/science/article/abs/pii/S0378778815300256

[5] Office of Energy Efficiency & Renewable Energy "Solar Radiation Basics" https://www.energy.gov/eere/solar/solar-radiation-basics

[6] Environmental Protection Agency "Climate Change Indicators; Heating and Cooling Degree Days" https://www.epa.gov/climate-indicators/climate-change-indicators-heating-and-cooling-degree-days

[7] Princeton University "The joint influence of albedo and insulation on roof performance: A modeling study" https://www.osti.gov/servlets/purl/1254734

[8] States at Risk https://statesatrisk.org/

[9] Building Services Engineering Research and Technology “A method to estimate the heating and cooling degree-days for different climatic zones of Saudi Arabia” 2016 https://www.researchgate.net/publication/311238888_A_method_to_estimate_the_heating_and_cooling_degree-days_for_different_climatic_zones_of_Saudi_Arabia

[10] The New England Journal of Medicine “Heat-Related Deaths during the July 1995 Heat Wave in Chicago” 1996.https://www.nejm.org/doi/full/10.1056/nejm199607113350203

[11] EPA “Chicago, IL Adapts to Improve Extreme Heat Preparedness” 2022. https://www.epa.gov/arc-x/chicago-il-adapts-improve-extreme-heat-preparedness

[12] EPA “Mortality Risk Evaluation” 2022. https://www.epa.gov/environmental-economics/mortality-risk-valuation

[13] Annual Review of Public Health “Heat, Human Performance, and Occupational Health: A Key Issue for the Assessment of Global Climate Change Impacts” 2016. https://www.annualreviews.org/doi/abs/10.1146/annurev-publhealth-032315-021740

[14] Concordia University “Hygrothermal behavior of flat cool and standard roofs on residential and commercial buildings in North America” https://spectrum.library.concordia.ca/id/eprint/974482/

[15] RCI International Convention and Trade Show “Avoiding Condensation in Low Slope Roofing Assemblies” https://www.abbae.com/wp-content/uploads/2020/04/RCI_33rd_Houston_TX_Trade-Show-AVOIDING-CONDENSATION-IN-LOW-SLOPED-ROOFING-ASSEMBLIES.pdf

[16] Cool Roof Rating Council “CA Title 24” https://coolroofs.org/resources/california-title-24

II.

Some Resources

Below are several directly relevant rigorous industry resources/studies documenting that/why/where reflective/cool roofs are cost-effective. These generally include analysis of the cost-effectiveness and value of reflective roofs, including in Climate Zones 4, 5, and 6.

Cool Roofs in the US: The Impact of Roof Reflectivity, Insulation and Attachment Method on Annual Energy Cost. Athanasios Tzempelikos and Seungjae Lee. 2021

Effect of cool roofs on commercial buildings energy use in cold climates. Mirata Hosseini and Hashem Akbari. 2015

The joint influence of albedo and insulation on roof performance: An observational study P. Ramamurthy, T. Sun, K. Rule, and E. Bou-Zeid. 2015

The joint influence of albedo and insulation on roof performance: A modeling study P. Ramamurthy, T. Sun, K. Rule, and E. Bou-Zeid. 2015

Hygrothermal behavior of flat cool and standard roofs on residential and commercial buildings in North America. Moghaddaszadeh Ahrab, Mohammad Ali. 2012

Cool Roofs and Thermal Insulation: Energy Savings and Peak Demand Reduction. Marcus Bianchi, Andre Desjarlais, William Miller, and Thomas Petrie. 2007

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/684/1711/files/download/358/

Workgroup Recommendation