Manual provides thermal analysis guidelines

The NRCA Energy Manual offers information for determining a roof system's thermal efficiency

by **Mark S. Graham**

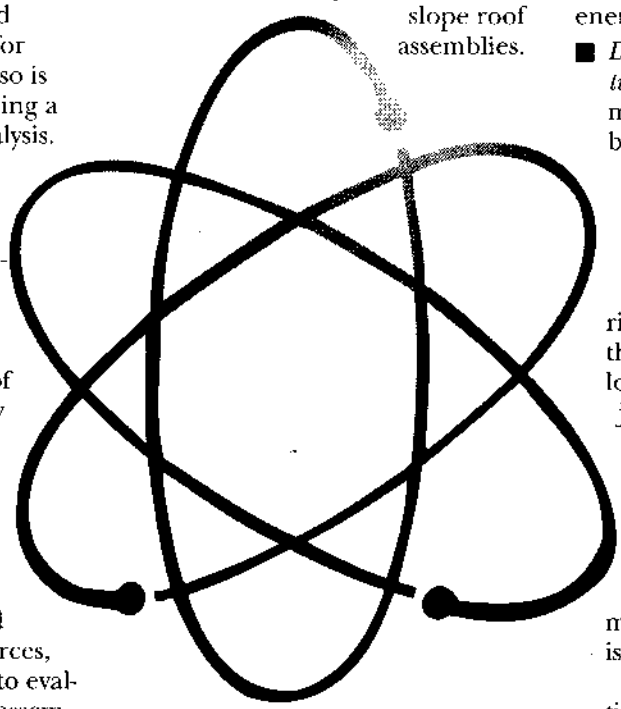
The NRCA Energy Manual was published to help roofing professionals analyze the thermal performances of new and existing low-slope roof assemblies. Thermal efficiency analysis is important for determining the payback in reduced heating and/or cooling costs for added thermal insulation; it also is a consideration when performing a roof system's life-cycle cost analysis.

Background

Before the 1970s, there was little concern for energy-efficient buildings and roof system thermal performance. This primarily was because of the seemingly endless supply of energy resources and relatively low cost of fuel and electricity used to heat, cool and operate buildings.

After the 1973 energy crisis, concern for energy efficiency grew dramatically. Substantial increases in fuel costs, coupled with diminishing energy resources, caused many building owners to evaluate their buildings' and roof assemblies' energy efficiencies.

During the mid-1970s, NRCA established its Energy Task Force, which drafted the first edition of *The NRCA Energy Manual.* Published in 1977, the manual provided a way to determine a roof system's thermal resistance (R-value) and approximate the heating and cooling cost savings associated with using thermal insulation within a roof assembly. The manual marked a milestone in the roofing industry—it was the first widespread acknowledgment of thermal insulation's importance to low-slope roof assemblies.



The latest edition

In 1982, 1986 and 1989, NRCA published revised and updated editions of the energy manual; the manual's latest edition was published in 1996 with the release of *The NRCA Roofing and Waterproofing Manual, Fourth Edition.* Although previous editions of the energy manual were available only as stand-alone documents, the 1996 edition is a separate section within *The NRCA Roofing and Waterproofing Manual;* however, it still is available as a stand-alone document.

Following is a brief overview of the energy manual's various sections:

- *Design and installation considerations.* This section provides information about specific roof assembly design and installation considerations that can substantially impact overall roof system thermal performance.

  For low-slope roof assemblies, designs using a double layer of rigid insulation are preferred—they reduce thermal bridging and losses through insulation board joints. Using a double layer also reduces the potential for membrane buckling, ridging and splitting. (In addition, the manual provides guidelines for calculating the reduction of a roof assembly's thermal performance if only one insulation layer is used.)

  When a double layer of insulation is used and the insulation is to be mechanically attached, the manual encourages designs where the insulation's bottom layer is mechanically attached to the substrate and subsequent layer(s) are adhered ("screw one, mop one"). If mechanical attachment through the full thickness of insulation is

necessary, the manual provides guidelines for calculating the reduction of a roof assembly's thermal performance.

For roof systems using tapered insulation, careful consideration is necessary because R-values vary between nontapered and tapered insulation. The manual provides equations for designers to use when analyzing the thermal performances of roof systems using tapered insulation.

- *Heat transfer.* Ways to determine a roof system's overall R-value and thermal transmittance also are described. Simplified calculation procedures using these variables are given for determining heating and cooling costs based on a roof system's design. If cost savings are to be determined, calculations should be run in parallel for comparison (e.g., existing roof system vs. new design).

Detailed tables within the manual provide the variables to use in the calculations, as well as design climatic data for 882 U.S. cities. Either these default values or those derived from local data and manufacturers' product literature can be used to customize calculations to situations and locales.

Numerous examples are provided to assist roofing professionals in following and understanding the calculation processes.

- *Minimum insulation requirements.* Most of today's building codes, and many state energy usage codes, require minimum thermal insulation requirements for roof systems and other building components.

These minimums are mandated by the National Energy Policy Act (EPAct), which former President Bush signed into law in 1992. The act mandates compliance with the currently recognized energy-efficiency standards for buildings. The American Society for Heating, Refrigerating and Air Conditioning Engineers Inc./Illuminating Engineering Society of North America Standard 90.1-1989 (ASHRAE/IES 90.1-1989)—"Energy Efficient Design for New Buildings Except Low-Rise Residential Buildings"—is the current recognized standard. The standard's requirements may vary from city to city.

The manual will be particularly helpful for those advising building owners about how to make technically and economically sound purchasing decisions of thermally efficient roof systems.

This section also provides calculation procedures and examples (based on ASHRAE/IES 90.1-1989) to determine minimum insulation requirements for roof systems. In many situations, the minimum mandated amounts of thermal insulation are more than what most roof system designers are accustomed to providing in their designs.

For more detailed information about EPAct and ASHRAE/IES 90.1-1989 readers should refer to *Professional Roofing*, May 1996 issue, page 26.

- *Vapor retarders.* The manual also explains how to determine relative humidity and vapor pressure drive, as well as a roof assembly's permeance and dew point temperature, to assess the need for a vapor retarder within a roof system. Although some consider these fundamental moisture-control concepts to be complex, the concepts actually are straightforward.

There are several possible methods of determining whether a vapor retarder is needed for a low-slope roof system. The following methods are explained in the manual:

1. For many years, and in previous editions of the manual, NRCA has suggested a vapor retarder be used if the outside average January temperature is below 40 F (4 C) and expected interior winter humidity is 45 percent or more.

2. The U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (CRREL) also has a method for determining the need for a vapor retarder—it depends on where a building is located and its interior temperature. NRCA has recognized CRREL's guidelines as viable, useful information for the roofing industry.

3. ASHRAE also has criteria for determining the need for a vapor retarder. Its method, which is considerably more conservative than CRREL's or NRCA's guidelines, hinges upon dew-point temperature calculations.

It should be noted that NRCA considers it the roof system designer's responsibility to determine whether a vapor retarder is needed. The manual's guidelines are meant to assist roof system designers in making this decision.

A discussion of common vapor retarder membrane materials and installation procedures can be found in the low-slope roofing section of *The NRCA Roofing and Waterproofing Manual, Fourth Edition.*

In closing

The NRCA Energy Manual provides guidelines for analyzing the thermal performances of low-slope roof assemblies. Determining these will help roofing professionals figure out the paybacks for added roof insulation and perform life-cycle cost analyses.

Roofing professionals are encouraged to familiarize themselves with and use the manual's concepts. The manual will be particularly helpful for those advising building owners about how to make technically and economically sound purchasing decisions of thermally efficient roof systems. PR

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