Codes now mandate minimum requirements for thermal insulation

The amount of thermal insulation employed in roof systems used to be determined by budget; now it's dictated by codes

by **Mark S. Graham**

Less than 25 years ago, the use of thermal insulation in roof systems was the exception rather than the rule. In more recent years, even after the need for energy-efficient roof system design was recognized, some building owners still chose to use only minimal thermal insulation to keep initial roofing costs low. However, the trade-off was higher heating and cooling costs over the roof system's life.

Today, recognizing that building energy accounts for more than 35 percent of the total energy used in the United States, federal and state governments are mandating minimum requirements for thermal insulation in buildings and roof systems. In many instances, these minimums require using considerably more thermal insulation than roofing professionals were accustomed to several years ago.

This article addresses the background, development, implementation and enforcement of code requirements that dictate the minimum amount of thermal insulation for roof systems.

Background

Prior to the early 1970s, there was only minimal concern for energy-efficient buildings and the thermal performance of roof systems. This primarily was due to the seemingly endless supply of energy resources and relatively low costs for fuels and electricity used to heat, cool and operate buildings.

As a result of the 1973 energy crisis, concern for energy efficiency grew dramatically. Substantial increases in fuel costs, coupled with the realization that the United States relies heavily on foreign energy resources, caused many building owners to evaluate their buildings' and roof systems' energy efficiencies.

It became apparent that if buildings' exterior constructions could retard heating and cooling losses, the overall cost to operate them could be decreased significantly. Because a roof system often is the largest single component of many buildings' exteriors, improving roof systems' thermal performances became an important part of reducing heating and cooling costs.

Then, during the mid- to late 1970s and early 1980s, the development of modern thermal insulation materials made it possible for roofing professionals to design and construct relatively energy-efficient roof systems with high overall thermal resistances (R-values) compared to those from several years before.

Energy code development

The origin and development of the modern U.S. building energy-efficiency codes can be traced back to the early 1970s.

During this period, based on concern for conserving energy, the National Conference of States on Building Codes and Standards (NCS/BCS) continued ongoing work at the National Bureau of Standards (NBS, now the National Institute of Standards and Technology) regarding building-related energy conservation. In 1974, NBS published the NBS Interim Report 74-452, which provided preliminary evaluation criteria for energy-conservation design in buildings.

The American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE) accepted responsibility for developing a voluntary consensus standard based on the NBS criteria. In 1975, the standard was published as ASHRAE Standard 90-75, "Energy Conservation in New Building Design." This was the first modern energy-efficiency standard applicable to buildings in the United States.

In 1977, NCS/BCS, the Building Officials and Code Administrators International Inc. (BOCA), International Conference of Building Officials (ICBO) and Southern Building Code Congress International Inc. (SBCCI) published

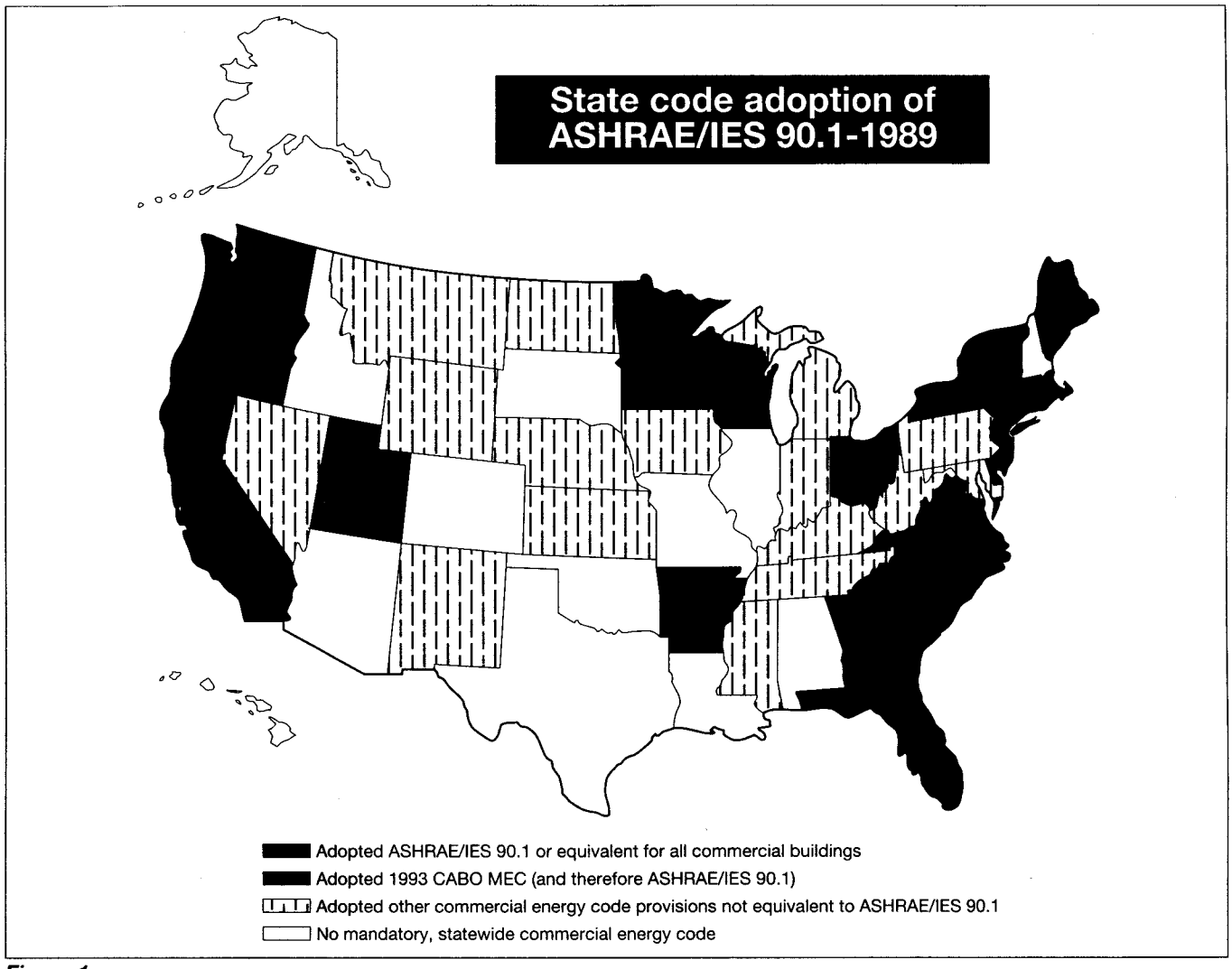


Figure 1

"Code for Energy Conservation in New Building Construction." This code was based on Standard 90. During the next 10 years, all 50 U.S. states adopted energy conservation regulations for buildings, based partly on this standard.

In 1980, ASHRAE 90-75 was superseded by the ASHRAE, American National Standards Institute, Illuminating Engineering Society of North America (IES) Standard 90A-80, "Energy Conservation in New Building Design."

ASHRAE/IES 90.1-1989

During the 1980s, the U.S. Department of Energy (DOE) performed extensive research on energy conservation in buildings. This research was not limited only to buildings' exteriors; it included other important aspects, such as building orientation, equipment and lighting. The results demonstrated that significant, cost-effective improvements could be made to the 1980 version of Standard 90.

Standard 90-1980 was updated and revised and, in 1989, published as ASHRAE/IES 90.1-1989, "Energy Efficient Design for New Buildings Except Low-Rise Residential Buildings." This standard serves as the technical basis for many current building energy-efficiency codes.

As it applies to buildings' roof systems, ASHRAE/IES 90.1-1989 provides requirements for the maximum overall thermal transmittance value (U_{OR})—or minimum thermal resistance (R-value)—for roof assemblies. The requirements are based on calculations that take into account the climatic data for a building's location (i.e., city). Considerations also are made for whether the building is heated and/or air-conditioned.

An explanation of the calculation, including the necessary climatic data, is provided in the *NRCA Energy Manual*, which is part of *The NRCA Roofing and Waterproofing Manual, Fourth Edition.*

For example, the minimum required overall thermal resistance value for a Chicago, Ill., low-rise commercial building's roof assembly is 18.52 F•ft²•h/Btu (3.26 m²•K/W). For a similar building in Billings, Mont., the minimum required overall thermal resistance for the building's roof assembly is 22.19 F•ft²•h/Btu (3.91 m²•K/W).

These examples illustrate the magnitude of thermal insulation required to comply with the standard. In many instances, the minimum amount of thermal insulation necessary is far more than many building owners and roofing professionals are accustomed.

Energy Policy Act

In 1992, then-President Bush signed the Energy Policy Act of 1992 (EPAct) into law. In effect, EPAct mandates compliance with the currently recognized energy-efficiency standards for buildings. Actual implementation and enforcement of EPAct generally is the responsibility of individual states. DOE is responsible for certain implementation procedures and overseeing states' deadlines.

For commercial buildings (i.e., generally all buildings except low-rise residential, manufactured housing and federally owned), EPAct required that each state review its commercial building code regarding energy efficiency and, if necessary, upgrade its code to meet or exceed the requirements of ASHRAE/IES 90.1-1989 by Oct. 24, 1994. Current states' code compliance with ASHRAE/IES 90.1-1989 is shown in Figure 1.

EPAct also requires that, within one year of any subsequent revision of ASHRAE/IES Standard 90.1, DOE review the revision to determine whether it would generally improve commercial buildings' energy efficiencies. Once that determination is made, states have up to two years to review and update the applicable portions of their codes relating to buildings' energy efficiencies.

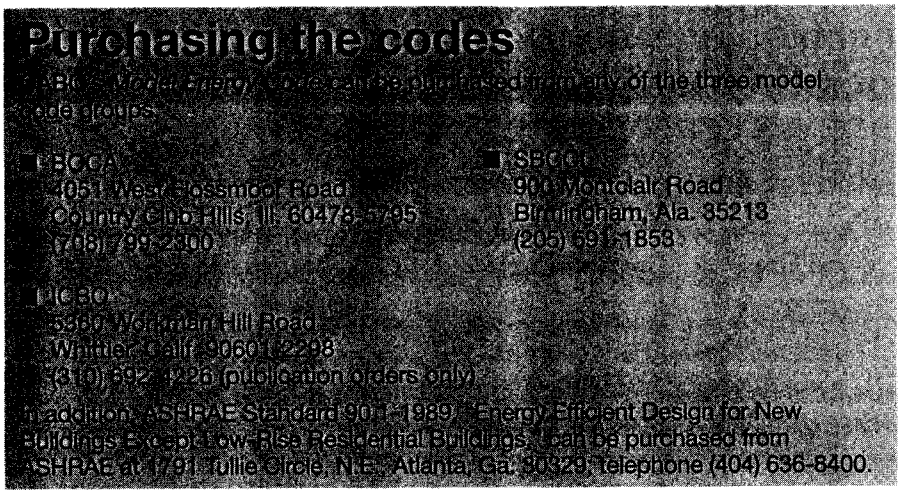
To date, ASHRAE/IES 90.1-1989 still is the version of the standard applicable to EPAct for commercial buildings.

For residential buildings (e.g., low-rise residential), EPAct required that each state review its residential building code regarding energy efficiency and report to DOE by Oct. 24, 1994, whether it was appropriate to revise its code to meet or exceed the Council of American Building Officials' (CABO's) *Model Energy Code*, 1992 Edition. EPAct does not mandate that states' residential building codes comply with the *Model Energy Code*. However, if a state's code does not meet or exceed the *Model Energy Code*, the state must publish its reasons for noncompliance.

Also, similar to ASHRAE/IES 90.1-1989 for commercial buildings, when an updated version of CABO's *Model Energy Code* is published, DOE must review it and determine if it would improve residential buildings' energy efficiencies. States then have up to two years to repeat the review and certification process.

Since EPAct was adopted in 1992, two subsequent editions of CABO's *Model Energy Code* (the 1993 and 1995 editions) have been published and made available for adoption. The 1993 and 1995 editions are considered more stringent than the 1992 edition. Both also adopt the requirements of ASHRAE/IES 90.1-1989 by reference for certain building types.

By July 15, states must certify whether it is appropriate to revise their residential codes to comply with the 1993 edition of the *Model Energy Code* or publish their reasons for noncompliance.



Code enforcement

Similar to enforcement of other building code requirements, local jurisdiction (e.g., municipality) enforcement of state provisions for energy efficiency varies widely. Reportedly, some jurisdictions are vigorously requiring compliance with the state's energy code, while others are more relaxed in their enforcement.

Roofing professionals should be aware of the energy-efficiency code requirements applicable in their areas. In some local jurisdictions, the local government has modified the state's requirements for energy efficiency.

In addition, it is suggested that roofing professionals encourage building owners to comply with the applicable energy-efficiency codes when making roof system purchasing decisions.

Closing comments

Several years ago, building owners' budgets determined the amount of thermal insulation used in roof systems; today, the determination often is dictated by state or local codes. In many cases, the minimum amount of thermal insulation required for buildings is considerably more than roofing professionals were accustomed to providing several years ago.

Roofing professionals should refer to the *NRCA Energy Manual* for information on calculating insulation requirements and estimating heating and cooling cost savings.

References

1. *The NRCA Roofing and Waterproofing Manual, Fourth Edition*, NRCA, 1996.
2. ASHRAE Standard 90.1-1989, "Energy Efficient Design for New Buildings Except Low-Rise Residential Buildings," ASHRAE and IES, 1989.
3. "Energy Policy Act Establishes Efficiency Requirements," *Codes Forum* magazine, January-February 1996. PR

Mark S. Graham is NRCA's associate executive director of technical services.