Chapter

6

Building Codes, Associated Standards, and Regulations

Building standards and model codes that address the energy-efficient design of residential buildings have been around for over 30 years. It was the energy crisis of the 1970s, however, that launched a plethora of federal regulations, testing standards, and guidelines have now been developed not only to provide more energy-efficient home construction but also to help provide consumer safety, eliminate fraud, and even assist in home mortgage financing.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is an international organization with over 50,000 members and numerous chapters located throughout the world. ASHRAE writes standards and guidelines to guide industry in the delivery of goods and services to the public. These standards and guidelines include uniform methods of testing for rating purposes, recommended practices in designing and installing equipment, and provide other industry-related information.

The original ASHRAE Standard 90-1975, "Energy Conservation in New Building Design," was first published in 1975. The scope of this document covered both residential and commercial buildings and became the historical and technical basis for most current model codes and standards for residential construction. Two

significant modifications to Standard 90 were 90A and 90B, published in 1980. These original ASHRAE standards served as the basis for ASHRAE Standard 90.2-1993 and the *Model Code for Energy Conservation,* published in 1977. This became known as the *Model Energy Code* (MEC) of the Council of American Building Officials (CABO) throughout the 1980s and 1990s. The *Model Energy Code* is now published as the *International Energy Conservation Code* (IECC) by the International Code Council (ICC).[1]

ASHRAE Standard 90.2, "Energy-Efficient Design of New Low-Rise Residential Buildings," was first published in 1993. This standard was specifically created to provide design requirements for the efficient use of energy for new residential dwellings that are three stories or less above grade. These include single houses, multifamily structures (of three stories or fewer above grade), and manufactured houses (both mobile homes and modular homes).

This standard deals with the building envelope, heating equipment and systems, air-conditioning equipment and systems, domestic water-heating equipment and systems, and provisions for overall building design alternatives and tradeoffs. Compliance can be calculated using the prescriptive requirements method and the annual energy cost method (systems-analysis approach). Standard 90.2 has been modified since its publication by several published addenda and continues to be under "continuous maintenance" per ASHRAE procedures.

International Energy Conservation Code

The *International Energy Conservation Code* (IECC), formerly known as the *Model Energy Code* (MEC), is a voluntary code that sets energy-efficiency standards for furnaces, air conditioners, windows, and insulation for commercial and residential construction. The *Model Energy Code* (MEC) was developed jointly by Building Officials and Code Administrators International, Inc. (BOCA), the International Conference of Building Officials (ICBO), the National Conference of States on Building Codes and Standards (NCSBCS), and Southern Building Code Conference International, Inc. (SBCCI), under a contract funded by the United States Department of Energy (DOE). First published in 1983, subsequent full editions of the MEC were published in 1986, 1989, 1992, 1993, and 1995.

The MEC was first referenced in the National Affordable Housing Act of 1990, and then in the Energy Policy Act (EPAct) of 1992. EPAct was signed into law by President Bush in 1992 and

referenced the 1992 MEC as the energy-efficiency standard to be used for new residential construction. Additionally, EPAct required federal mortgage lenders to ensure that homes using their products also comply with the 1992 MEC as a minimum standard. Subsequently, the DOE determined that the 1993 MEC and later the 1995 MEC provided greater energy efficiency for residential buildings and required states to consider adopting the later version. In concurrence with EPAct, the U.S. Department of Housing and Urban Development (HUD) required compliance with the 1992 MEC as part of its minimum property standards. HUD currently has a final rule pending to upgrade its minimum property standards to the 1995 MEC level. Whether a state has adopted it or not, the MEC applies to houses financed through the Federal Housing Administration (FHA), the Department of Veterans Affairs (VA), and the Rural Economic and Community Development (RECD, formerly Farmers' Home Administration). Loans received from or guaranteed by these agencies require that the financed house comply with the MEC.

The International Code Council (ICC) was formed in late 1994 by BOCA, ICBO, and SBCCI with the objective of developing a comprehensive set of U.S. model building codes, known as the *International Building Code* (IBC). The IBC is a synthesis of the building codes of the three regional model code organizations. These are BOCA's *National Building Code,* SBCCI's *Standard Building Code,* and ICBO's *Uniform Building Code.*

The MEC had been maintained until 1998 as an activity of the Council of American Building Officials (CABO) and incorporated by reference in each of the three regional model building codes: BOCA's *National Building Code* (in Chap. 13), SBCCI's *Standard Building Code* (in an appendix), and ICBO's *Uniform Building Code* (in an appendix). The ICC has assumed responsibility from the CABO for maintenance of the CABO *One- and Two-Family Dwelling Code* and the *Model Energy Code* to provide proper interfaces with the international codes. States will have a time window in which to adopt the new ICC model codes.

The 1998 version of the MEC was published as the first *International Energy Conservation Code* (IECC). The current 2000 IECC addresses the design of energy-efficient building envelopes and the installation of energy-efficient mechanical, lighting, and power systems through requirements emphasizing performance. This comprehensive code establishes minimum regulations for energy-efficient buildings using prescriptive and performance-

related provisions. It makes possible the use of new materials and innovative techniques that conserve energy. This second edition incorporates the provisions of the 1998 IECC and its approved changes. Preliminary review of the 2000 IECC seems to indicate that it is more "user-friendly."

The *International Residential Code* (IRC), released in 2000, replaces the CABO *One- and Two-Family Dwelling Code.* A chapter in the IRC addresses energy efficiency but looks significantly different from the IECC. Intended to be a simplified prescriptive approach to achieving equivalent compliance with the "performance" requirements of the IECC, the IRC energy chapter is a table of prescriptive insulation and window requirements.

Most states have adopted some version of the MEC. In states that do not have a statewide energy code, the MEC has also been adopted by individual counties and cities. With continuously changing regulations, as well as the introduction of the IRC in 2000, the status of most states will most likely change. It is important to check with the local building officials or the state energy office for current requirements.

Most states have adopted a version of the MEC or a similar equivalent energy code. Only six states, Arizona, Illinois, Louisiana, Missouri, South Dakota, Hawaii, and Texas, do not have any statewide mandatory energy codes for low-rise residential construction.[2] (Hawaii and Louisiana have statewide mandated codes for low-rise multifamily construction.)

Currently, the 1992 MEC has been adopted by Indiana, Iowa, Kentucky, New Mexico, and Tennessee, whereas the 1993 MEC has been adopted by Delaware, Kansas, Montana, and North Dakota. States that have adopted the 1995 MEC are as follows: Connecticut, Georgia, Maryland, Massachusetts, Ohio, Oklahoma, Rhode Island, South Carolina, Utah, Virginia, and Washington, D.C. Nevada still enforces the 1986 MEC, whereas Nebraska uses the 1983 MEC.[2]

Alabama, Alaska, Arkansas, California, Florida, Minnesota, New York, North Carolina, Oregon, Vermont, Washington, and Wisconsin have adopted a state-developed code that exceeds or meets MEC requirements, whereas Colorado, Idaho, and Maine have adopted a state-developed code that is less stringent than the MEC. Mississippi, New Hampshire, and Wyoming still reference ASHRAE 90-1975, whereas Michigan, New Jersey, and West Virginia reference ASHRAE 90A-1980. Pennsylvania has officially adopted the IECC as a state-mandated energy code.[2]

Requirements

The IECC and the MEC allow designers a variety of calculation methods to comply with code requirements. The prescriptive approach, the simplest of the three approaches, allows builders or designers to select from various combinations of energy-conservation measures based on "climate zone" location. Each combination or "package" specifies insulation levels, glazing areas, glazing U-values (thermal performance), and sometimes heating and cooling equipment efficiency. By locating the correct climate zone and looking up the appropriate table of packages, builders and officials can ensure that their projects meet or exceed one of the packages listed for that zone.[3] Few calculations are required.

The tradeoff worksheet approach enables builders to vary insulation levels in the ceilings, walls, floors, basement walls, slab edges, and crawl spaces; glazing and door areas; and glazing and door U-values. Based on the proposed plans and specifications, the builder enters simple information on a worksheet and then hand-calculates a total U-value for the project. By comparing the project's U-value with the value required for the climate zone, the builder can determine if the project passes the energy code requirements. The impact of this approach is that as window area increases, the thermal performance of the windows must be improved (lowering U-value) or the insulation must be increased in the opaque portion (raising the R-value) in order to satisfy the overall U-value requirement. If the project does not pass, the builder can use the worksheet to examine a different combination of insulation levels, window or door products, and areas for compliance. The worksheet is suitable for use during the plan check and field inspection phases of a project.[3]

Simplified software products that allow tradeoffs and demonstrate compliance may offer the best combination of simplicity and flexibility. The software approach does the same calculations as the tradeoff worksheet but automates the procedure using a computer. Special features allow builders to trade off heating and air-conditioning equipment efficiency, as well as windows and insulation. The software generates a report that is suitable for plan checking and field inspection.[3] The "rules" for the assumptions or standard conditions to be used when performing such analyses have been revised substantially in the IECC over those in the MEC.[1] Finally, many state energy code offices also provide quantitative R-value standards for the specific locale in order to simplify residential design energy calculations. It is important to consult with local

building officials to determine which energy code has been adopted and the calculation methods available.

In addition to the insulation and window requirements, there are basic criteria that must be met regardless of which envelope compliance approach is used. These include the following: sealing the building envelope to restrict air leakage (caulking, sealing, and weatherstripping at all penetrations and joints); installing vapor retarders in most climates; identifying materials used for energy code compliance (such as insulation R-values) on plans, specifications, and/or directly on materials in the residence; and insulating and sealing ducts in unconditioned spaces as well as insulating pipes for hydronic heating and circulating hot water systems. Tightly sealed structures also can prevent the proper exchange of the minimum ventilation needed for the physiologic needs of people. Makeup air, usually through a means of mechanical ventilation, can be implemented to guarantee the proper number of air changes in a home.

Model Energy Code compliance assistance

The DOE has developed a number of resources to guide architects, builders, designers, plan checkers, and field inspectors in meeting the requirements of the MEC and the newer IECC. The *MECcheck Manual* is a clear and comprehensive compliance guide that describes the basic requirements of the code for building envelopes, heating and cooling, electrical systems, materials, and equipment. Included are three approaches for attaining compliance, guidance for plan checkers and field inspectors, and several forms and checklists. The *MECcheck Software* calculates tradeoffs between all building envelope components and heating and cooling equipment efficiencies. The software is capable of generating reports that can be used to document code compliance. *MECcheck Prescriptive Packages* instruct design and construction professionals on how to select a package of insulation and window requirements based on the specific climate zone in which their building is located. Each climate zone package lists all compliance standards for insulation, glazing areas, glazing U-values, and heating and cooling efficiency.

Miscellaneous Building Codes

There are many energy-related provisions, guidelines, and standards that are referenced throughout the new IBC as well as all previous model building codes. Thermal and sound insulating

materials, vapor retarder requirements, foam plastic and loose-fill cellulose insulation restrictions, and flame spread ratings are but a few of the issues referenced.

Home Energy Rating System Council Guidelines

The Home Energy Rating Systems Council (HERSC) is a nonprofit association whose focus is to promote residential energy efficiency nationwide by linking home energy rating programs with financing for energy-efficiency improvements. The council maintains that once the linkage between home energy ratings and energy-efficiency financing is established, energy-efficient homes will become more available and affordable.

The council draws its members from the full spectrum of the housing industry and financial community. These include individuals from the appraisal industry, builders, certified raters, consumer groups, contractors/retrofitters, energy and environmental groups, state and local governments, mortgage companies, product and equipment manufacturers, real estate professionals, and utilities.

Home energy rating systems (HERS) measure and rate the relative energy efficiency of any house, regardless of its age, location, construction type, or fuel use. The rating evaluates the performance of the thermal envelope; glazing strategies; siting; the heating, ventilation, and air-condition (HVAC) system; and other criteria and is obtained by onsite inspection. HERS calculations include estimates of annual energy performance and costs and can provide insight into cost-effective, energy-efficiency improvements. Under the voluntary guidelines, homes would receive an energy performance rating of one to five-plus stars. The guidelines spell out the minimum appropriate procedures for assigning energy ratings to homes and encourage consistency with a uniform plan for energy-efficiency financing.

Federal Trade Commission

The Federal Trade Commission (FTC) home insulation regulation (16 CFR Part 460) requires the seller of a new home to provide information on the type, thickness, and R-value of the insulation that will be installed in each part of the house in every sales contract. Commonly known as the *R-Value Rule,* it is intended to eliminate dishonest or misleading insulation marketing claims and to ensure publication of accurate R-value and coverage data.

American Society for Testing and Materials

Organized in 1898, the American Society for Testing and Materials (ASTM) is a not-for-profit organization and one of the largest voluntary standards development organizations in the world. More than 32,000 members representing producers, users, ultimate consumers, and representatives of government and academia from over 100 countries develop documents that serve as a basis for manufacturing, procurement, and regulatory activities.

ASTM provides a forum for the development and publication of voluntary consensus standards for materials, products, systems, and services. These standards are documents that have been developed and established within the consensus principles of the society and meet the approval requirements of ASTM procedures and regulations. ASTM standards are developed and used voluntarily. They become legally binding only when a government body makes them so or when they are cited in a contract. ASTM headquarters has no technical research or testing facilities; such work is done voluntarily by the ASTM members located throughout the world.

The following is a list of many of the ASTM standards that are referenced in many of the building and energy codes with respect to building insulation:

C208-95, "Standard Specification for Cellulosic Fiber Insulating Board"

C209-98, "Standard Test Methods for Cellulosic Fiber Insulating Board"

C665-98, "Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing"

C687-96, "Standard Practice for Determination of Thermal Resistance of Loose-Fill Building Insulation"

C727-90(1996)e1, "Standard Practice for Installation and Use of Reflective Insulation in Building Constructions"

C755-97, "Standard Practice for Selection of Vapor Retarders for Thermal Insulation"

C976-90(1996)e, "Standard Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box"

C1015-84(1995)e1, "Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation"

C1049-85(1995)e1, "Standard Practice for Installation of Granular Loose-Fill Thermal Insulation"

C1058-97, "Standard Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation"

C1224-99, "Standard Specification for Reflective Insulation for Building Applications"

C1373-98, "Standard Practice for Determination of Thermal Resistance of Attic Insulation Systems under Simulated Winter Conditions"

C1374-97, "Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation"

E84-99, "Standard Test Method for Surface Burning Characteristics of Building Materials"

E1574-98, "Standard Test Method for Measurement of Sound in Residential Spaces"

U.S. Consumer Product Safety Commission

The U.S. Consumer Product Safety Commission (CPSC) is an independent federal regulatory agency that was created in 1972 by Congress in the Consumer Product Safety Act. The agency's mission, as directed by Congress, is to "protect the public against unreasonable risks of injuries and deaths associated with consumer products."

The CPSC has jurisdiction affecting 15,000 types of consumer products, from automatic-drip coffee makers to toys to lawn mowers. There a number of standards under CPSC Standard 16 CFR (*Code of Federal Regulations*) that deal with the labeling and advertising of home insulation as well as the installation and handling of cellulose insulation.

Appendix

ASHRAE Headquarters
1791 Tullie Circle, N.E.
Atlanta, GA 30329-2305

800-527-4723
http://www.ashrae.org/

American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken,
Pennsylvania, USA 19428-2959
http://www.astm.org/index.html

U.S. Department of Energy
Building Research and Technology Office
Stephen Turchen
http://www.eren.doe.gov/buildings/

Federal Trade Commission
CRC-240
Washington, D.C. 20580
1-877-FTC-HELP (382-4357)

Home Energy Rating Systems (HERS) Council
Ms. Cynthia Gardstein, Executive Director
1331 H Street N.W., Suite 1000
Washington, DC 20005 USA
202-638-3700
Fax: 202-393-5043

International Code Council
5203 Leesburg Pike, Suite 708
Falls Church, VA 22041
703-931-4533
Fax: 703-379-1546
http://www.intlcode.org/

U.S. Consumer Product Safety Commission
Washington, D.C. 20207-0001
1-800-638-2772
http://www.cpsc.gov

References

1. "The Latest and Greatest on Energy Efficiency in Residential Building Codes and Standards," presented by Stephen Turchen, U.S. Department of Energy, Office of Codes and Standards, Energy Efficient Building Association, October 1998.
2. Building Codes Assistance Project Web site: *http://solstice.crest.org/efficiency/bcap/update.html*.
3. United States Department of Energy Building Standards and Guidelines Program (BSGP): *http://www.energycodes.org/*