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Energy Codes and the Roof

Overview: History and Why It's Important to Understand

Following the energy crisis in 1973, the United States began developing energy codes. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) created the first standard, published in 1975: Standard 90 -75 Energy Conservation in New Building Design.

However, the biggest impact came via the Energy Policy Act of 1992. This act required the Department of Energy (DOE) to be "actively involved in the development and deployment of building energy codes, with close collaborations with states, local governments, and building code communities." (12)

The DOE is also tasked with determining whether new versions of model energy codes save energy. ASHRAE Standard 90.1 serves as the basis for these determinations for commercial and high-rise multi-family residential buildings. The same act also lists the Council of America Building Officials (CABO) Model Energy Code (MEC) of 1992 as the basis for the DOE's formal determinations of energy savings for low-rise residential buildings.

Since the early 1990s, the topic of efficient energy usage in the construction industry has become a staple in all building construction where specific codes must be followed. The subsequent paragraphs in this whitepaper will provide you an understanding of the influencers along with an overview of the codes and how they affect the roofing industry.

Influencers for Energy Code

There are four main influencers when it comes to writing building code, and we're about to dive into the reasons why they've been chosen.

United States Department of Energy (DOE)

The U.S. Department of Energy is a cabinet-level subdivision of the U.S. Government. The DOE's mission is to "ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions." In response to the 1973 oil crisis, U.S. Congress created an all-encompassing approach to federal energy policy: The Energy Policy and Conservation Act of 1975 (EPCA). (9)

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International Code Council (ICC)

The International Code Council, established in 1994, is a nonprofit association providing a vast variety of building safety solutions, including “product evaluation, accreditation, certification, codification, and training.” The council develops model codes and standards to construct safe, sustainable, affordable, and resilient structures across the globe.

The International Code Council’s primary goal was to develop a single set of national model construction codes. The result was a combined effort from three different organizations that had developed three separate sets of model codes throughout the U.S.: Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO) and Southern Building Code Congress International, Inc. (SBCCI). (10)

American National Standards Institute (ANSI)

The American National Standards Institute (ANSI) is a “private, not-for-profit organization that supports the U.S. voluntary standards and conformity assessment system.” The Institute represents diverse interests of more than 270,000 companies and 30 million professionals worldwide. (5)

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE is a “global society advancing human well-being through sustainable technology for the built environment.” Its focus is on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability within the industry. Through research, standards writing, and continuing education, ASHRAE helps shape tomorrow’s environment today.

ASHRAE was formed as the American Society of Heating, Refrigerating and Air-Conditioning Engineers in 1959 by the merger of the American Society of Heating and Air-Conditioning Engineers (ASHAE) and The American Society of Refrigerating Engineers (ASRE).

More than 57,000 members from over 132 nations make ASHRAE an extremely diverse organization that is dedicated to “advancing the arts and sciences of heating, ventilation, air conditioning, and refrigeration to serve humanity and promote a sustainable world.” (6)

International Building Code Energy Standards

There are numerous specific standards which architects and consultants must follow, according to the International Building Code (IBC). The 2021 IBC addresses energy efficiency in Chapter 13, stating that “buildings shall be designed and constructed in accordance with the International Energy Conservation Code.” (1)

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IECC Overview

America's model energy code — the International Energy Conservation Code (IECC) — "sets out minimum efficiency standards for new construction for a structure's walls, floors, ceilings, lighting, windows, doors, duct leakage, and air leakage."

The IECC is referred to as America's model energy code. In the United States, building codes are state laws and there is no national building energy code. Therefore, the IECC is the go-to source for states adopting an energy code. An ICC code is in use or adopted in all 50 U.S. states and beyond. (4)

Chapter four of the 2021 IECC speaks specifically of energy efficiency for commercial buildings. (2)

SECTION C401
GENERAL

C401.1 Scope.
The provisions in this chapter are applicable to commercial *buildings* and their *building sites*.

C401.2 Application.
Commercial buildings shall comply with Section C401.2.1 or C401.2.2.

C401.2.1 International Energy Conservation Code.
Commercial buildings shall comply with one of the following:

1. Prescriptive Compliance. The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
2. Total Building Performance. The Total Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

C401.2.2 ASHRAE 90.1.
Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1.

C401.3 Thermal envelope certificate.
A permanent thermal envelope certificate shall be completed by an *approved* party. Such certificate shall be posted on a wall in the space where the space conditioning equipment is located, a utility room or other *approved* location. If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. A copy of the certificate shall also be included in the construction files for the project. The certificate shall include the following:

1. *R*-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, *basement walls*, crawl space walls and floors and ducts outside *conditioned spaces*.
2. *U*-factors and *solar heat gain coefficients* (SHGC) of fenestrations.
3. Results from any *building* envelope air leakage testing performed on the *building*.

Where there is more than one value for any component of the building envelope, the certificate shall indicate the area-weighted average value where available. If the area-weighted average is not available, the certificate shall list each value that applies to 10 percent or more of the total component area.

The IECC regulates minimum energy-conservation requirements for new buildings via prescriptive and performance provisions; the IECC also addresses energy-conservation

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requirements for both commercial and residential construction. It provides requirements for all types of building energy uses, including:

- Heating and ventilating
- Air-conditioning
- Electrical lighting
- Water heating
- Power usage for appliances and building systems

Energy conservation codes, typically adopted by individual states, are applicable to all buildings within said state. Most energy codes in the United States have adopted one of several editions of the IECC as their technical basis. Individual states or other jurisdictions may modify the IECC to address specific regional or local issues. (11)

IECC and the Roof

The IECC provides minimum requirements for building envelope and building systems insulation, including:

- Wall and roof insulation
- Windows and doors
- Mechanical system duct insulation
- Water distribution system insulation

A building's roof assembly serves an important role in controlling a building's overall energy efficiency and the owners' heating/cooling costs. In fact, codes “mandate minimum thermal insulation requirements for the energy efficiency of most buildings.” (11)

IECC states that you are allowed to use ANSI/ASHRAE/IES Standard 90.1 as an alternative option, but you must choose one single path to create your design, either IECC or ASHRAE 90.1. Yes, they’re similar, but there are differences depending on the requirements of a particular project. (3)

ANSI/ASHRAE/IES Standard 90.1 Overview

ASHRAE 90.1 is an energy code compliance option for commercial buildings in most places throughout the United States. It contains mandatory requirements and offers a choice between performance- or prescriptive-based criteria.

Performance-Based

This approach involves analyzing the entire building and determining projected annual energy costs. This style is commonly used in complex projects, atypical buildings, or when a designer

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wants to use a trade-off approach (e.g., making up shortcomings in one area by exceeding in others).

Prescriptive-Based

In this approach, the information needed to determine the minimum R-value and other requirements is listed in the standard. This saves time, money, and resources. For these reasons, the information that follows is based on complying with roofing-related mandatory and prescriptive requirements. (3)

Standard 90.1 is a global benchmark to set minimum energy performance standards (MEPS) and energy codes that provides minimum requirements for energy-efficient design (sans low-rise residential buildings). Standard 90.1 includes detailed minimum energy efficiency requirements and criteria for determining compliance with these requirements.

The 90.1 User's Manual provides detailed instruction to ensure compliance with ANSI/ASHRAE/IES Standard 90.1-2019. It contains dimensions and calculations in I-P and SI units, example calculations, application cases, forms to validate compliance, along with additional resources. (7)

ASHRAE and the Roof

Most information relevant to roof system designers is listed in Section 5: Building Envelope.

The “building envelope” are elements that “form a barrier between the exteriors of buildings and the conditioned space on the inside of buildings” (e.g., skylights act as barriers and are therefore subject to the provisions in ASHRAE 90.1. (3)

Differences between IECC and ASHRAE

Minimum R-Value

Tapered Insulation

Tapered insulation is the most common process for creating a slope on a low-slope roof; unfortunately, neither code addresses tapered systems.

While neither code permits average R-values as a substitute for meeting specific requirements, they differ in when and where a minimum R-value is required. IECC recognizes that a tapered system benefits from having thinner insulation in some parts, such as the drain. Hence the reason the 2021 version allows minimum thickness of insulation to be one inch less at the low point in the system (commonly where a drain or a scupper would be located). On the other hand, 90.1 requires systems to meet the minimum right up to the edge of the drain.

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Semi-Heated Spaces

90.1 classifies as “semi-heated,” like a warehouse with baseboard heating that’s conditioned just enough not to be too frigid during the winter. Semi-heated spaces don’t require as high of an R-value as regular occupied spaces do, so if you have a choice between the two codes on your next re-roofing project that includes a significant amount of warehouse space, you might opt to follow 90.1 instead of IECC.

Cool Roofing

Buildings in climate zones 1-3 (and slopes under 2/12 pitch) are mandated to meet minimum requirements for roof solar reflectance. IECC permits a couple of options for roof materials:

- Install with a three-year aged Solar Reflectance Index (SRI) of 64
- Opt for an aged SRI of 55 combined with an aged thermal emittance of 0.75 OR

Typically, 75% of a roof meets exception criteria, which includes:

- Roofs with vegetation, walkways, skylights, solar air or water heating, or PV systems
- Shaded areas and ballasted systems
- Areas that are heating-only

ASHRAE requires cool roofs for buildings with slopes under 2:12. Exemptions are made for semi-heated spaces, conditioned spaces that aren’t cooled, and metal buildings/asphaltic membranes in climate zones 0 or 1.

ASHRAE requires use of material with a thermal reflectance of 0.55 and thermal emittance of 0.75. Alternatively, a product with a three-year aged SRI of 64 can be used. (8)

Green Building and LEED

International Green Construction Code (IGCC)

In 2012, the IGCC was added to the I-Code® family of model codes. IGCC is intended to be an extension of other ICC codes such as the International Building Code (IBC) and International Energy Conservation Code (IECC).

IGCC is used by code officials to enforce the adoption of green and sustainable building design. It allows jurisdictions to “tailor the code to address local environmental concerns and advance local agendas.” IGCC applies to the “construction of high-performance commercial buildings, structures and systems, including existing buildings subject to alterations and additions, utilizing traditional and innovative construction practices.” (11)

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The U.S. Green Building Council (USGBC)

Founded in 1993, the U.S. Green Building Council is committed to a sustainable, prosperous future through LEED, the leading program for green buildings and communities worldwide.

Its mission is to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life (13)

The most common rating system for green buildings is Leadership in Energy and Environmental Design (LEED). LEED provides a framework for highly efficient, cost-saving green buildings and is used for every building type and phase, including new construction.

A LEED certification is globally recognized as a symbol of achievement and leadership in the world of sustainability. (14)

Sources:

1. https://codes.iccsafe.org/content/IBC2021P2/chapter-13-energy-efficiency
2. https://codes.iccsafe.org/content/IECC2021P2/chapter-4-ce-commercial-energy-efficiency
3. http://docserver.nrca.net/technical/10174.pdf
4. https://energyefficientcodes.org/iecc/
5. https://www.ansi.org/
6. https://www.ashrae.org/
7. https://www.ashrae.org/technical-resources/bookstore/90-1-portal
8. https://www.buildings.com/news/industry-news/articleid/21469/title/3-must-know-differences-in-roofing-codes
9. https://www.energy.gov/about-us
10. https://www.iccsafe.org/
11. https://www.nrca.net/technical/guidelines-resources/codes-standards
12. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-17979.pdf
13. https://www.usgbc.org/
14. https://www.usgbc.org/help/what-leed

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