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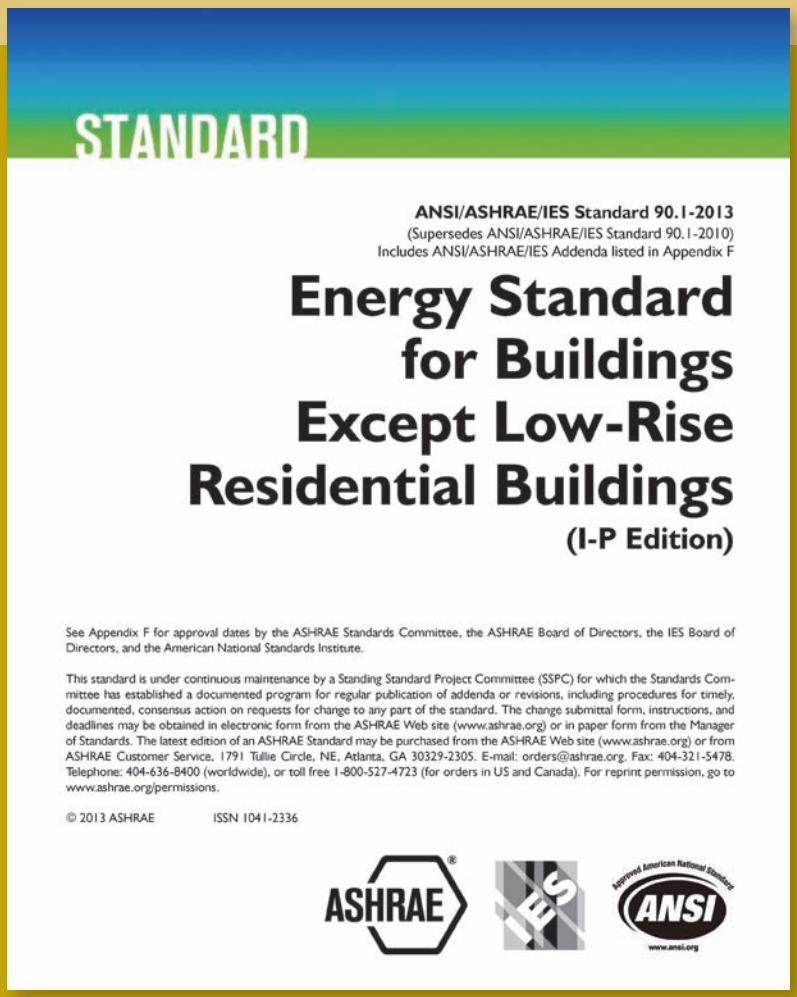
Technical Brief

Insulation and Air Sealing Compliance in ASHRAE 90.1


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2013
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2010)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard for Buildings Except Low-Rise Residential Buildings
(I-P Edition)

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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After the Energy Crisis of the 1970s, the federal government desired national minimum energy efficiency building codes. Ultimately, for commercial construction, the technical society now known as ASHRAE was tasked with maintaining Standard 90.1, which provides requirements for non-process loads in conditioned spaces of buildings other than low-rise residential construction.

continued

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ASHRAE 90.1: the model code

Background

Having gone through many revisions —and ongoing improvement under a continuous maintenance process—90.1 is the most commonly used model for jurisdictions. Please note: ASHRAE 90.1 is a model code; your jurisdiction might have modifications, addenda or normative appendices that will differ from the standard model year versions. Also, because of the continuous maintenance process, the requirements of a particular year/version of 90.1 can change over time if your jurisdiction has adopted the standard with addenda.[1]

Though designing for building performance—not just energy efficiency —is a holistic endeavor, this document will address only the evolution of requirements for thermal insulation and air sealing in the building envelope. See the appendix for individual climate zone insulation requirements.

TABLE 3.1 Heated Space Criteria

Heating Output (Btu/hr*ft²)	Climate Zone
5	1 and 2
10	3
15	4 and 5
20	6 and 7
25	8

Table 1: Heating energy limits to qualify for semiheated space

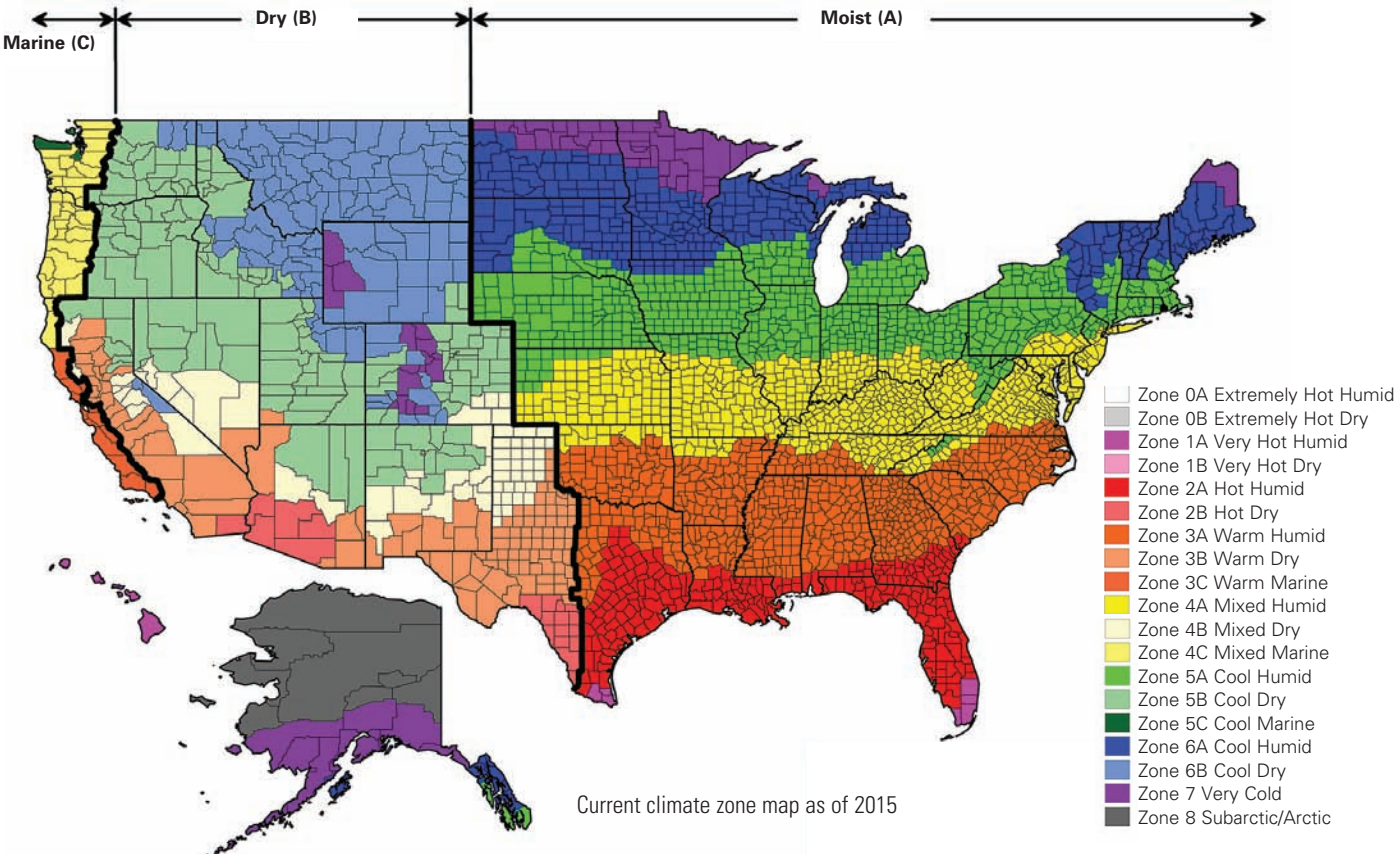
Applicability

First, it is necessary to determine whether the proposed building falls within the scope of Standard 90.1 and, if so, how. As noted, 90.1 does not apply to low-rise residential buildings.

Low-rise residential buildings: single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes) and manufactured houses (modular).

Strictly commercial buildings complying under the prescriptive path use "nonresidential" thermal insulation values in Table 5.5-6. High-rise residential complies under "residential." Mixed use buildings comply space by space according to each occupancy's respective requirements. The "semiheated" category generally is limited to warehouses and similar occupancies, with requirements defined in Table 3.1. It cannot apply to cooled spaces. The building official must approve semiheated or unconditioned space determinations.

[1] The Online Code Environment and Advocacy Network has code statuses by jurisdiction: http://energycodesocean.org/code-status-commercial



Current climate zone map as of 2015

Thermal Insulation

Within Standard 90.1, there are multiple compliance paths: prescriptive, building envelope trade-off option, and energy cost budget method. Here we will cover only the prescriptive provisions. Note: There are mandatory provisions that apply to all compliance paths, and the air leakage requirements are mandatory provisions.

All envelope thermal insulation requirements in 90.1 are climate zone-specific. Standard 169 determines which counties are included in each climate zone. 169 has been updated, but that change may or may not affect your particular jurisdiction, depending on how/when the national model codes and standards were adopted. See the revised map on page 2. A county-by-county listing can be found in 90.1 Appendix B, or the heating degree days / cooling degree hours defining the climate zone can be found in Standard 169.

Air Sealing

High building envelope air leakage often is the primary energy efficiency failure in modern construction. While conductive, convective and radiative heat loss/gain can be considerable, mass transfer of unconditioned air in a poorly sealed envelope will overwhelm them all. There are unique challenges to sealing various assemblies and materials properly, but all can be equally air tight. In general, the more joints, gaps and penetrations in an assembly, the worse its performance is likely to be. The requirements for air sealing have changed more dramatically than those for thermal insulation in the modern codes era.

Across the versions of Standard 90.1, the air leakage requirements cover the opaque envelope, fenestration, vestibules and loading docks. The 2004 version required only the sealing of actual gaps within or between envelope components. For our purposes here, 2007 did not change.

TABLE 5.5-6 Building Envelope Requirements for Climate Zone 6 (A, B)*

	Nonresidential		Residential		Semiheated	
Opaque Elements	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Walls, Above-Grade						
Mass	U-0.080	R-13.3 c.i.	U-0.071	R-15.2 c.i.	U-0.151[a]	R-5.7 c.i [a]
Metal Building	U-0.069	R-13.0 + R-7.5 c.i.	U-0.069	R-13.0 + R-5.6 c.i.	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.051	R-13.0 + R-7.5 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0

Table 2: Sample of prescriptive envelope table from 90.1-2010, here showing climate zone 6 walls

* The following definitions apply: c.i. = continuous insulation

[a] Exception to Section 5.5.3.2 applies for mass walls above grade.

In Standard 90.1, both U-factors and R-values are given for opaque elements under the prescriptive building envelope option. The requirement is the assembly maximum U-factor given in Table 5.5-X. The insulation minimum R-value is the most cost-effective complying assembly construction as determined by ASHRAE's cost efficacy model. The insulation minimum R-value is not the requirement, and certainly is not the only compliant technology/construction allowed. It is one of an infinite combination of materials that can be approved by the code official. Appendix A of 90.1 lists the thermal insulation performance of a sampling of the most common assemblies. As seen in the above example from Table 5.5-6 in 90.1-2010, assemblies constructed using different materials are subject to different performance requirements. Each version of Standard 90.1 for your climate zone at the end of this document shows the progression of requirements as illustrated for mass walls. For some zones, there is little to no change. Others have changed more significantly.

A major change came in section 5.4.3.1 of the 2010 edition: "The entire building envelope shall be designed and constructed with a continuous air barrier."

Continuous air barrier: the combination of interconnected materials, assemblies and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope.

The sealing list was replaced by three sections: design, installation, and materials and assemblies. The first two sections are straightforward, describing appropriate detailing on plans and standard instructions saying to seal whole buildings—similar to the previous versions' language. Essentially the third section is subdivided into deemed-to-comply materials and assemblies pressure-tested according to an ASTM standard. Examples of the former include 3/8" plywood, 1/2" cement board, cast-in-place and precast concrete. The 2013 version of the standard retained the 2010 language.

At the 2015 fall meeting for 90.1, an addendum was approved that allowed for a whole building air leakage testing compliance option. While the air leakage section appears to have seen great change, the basics from 2010/2013 still are there. This option allows no more than 0.4 cmf/ft^2 @ 75 Pa, or, for now, 0.6 cfm/ft^2 utilizing a "training wheels" exception. This language will be carried into the 2016 publication of 90.1, but could be amended during the continuous maintenance process.

5.4.3 Air Leakage
5.4.3.1 Building Envelope Sealing

The following areas of the building envelope shall be sealed, caulked, gasketed or weather-stripped to minimize air leakage:

(a) joints around *fenestration* and *door* frames,
(b) junctions between *walls* and foundations, between *walls* at building corners, between *walls* and structural floors or roofs, and between *walls* and *roof* or *wall* panels,
(c) openings at penetrations of utility services through roofs, *walls* and floors,
(d) site-built *fenestration* and *doors*,
(e) building assemblies used as ducts or plenums,
(f) joints, seams and penetrations of vapor retarders,
(g) all other openings in the building envelope.

90.1-2004 basic air sealing language

The requirements for air sealing have changed more dramatically than those for thermal insulation in the modern codes era.

High building envelope air leakage often is the primary energy efficiency failure in modern construction.

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This technical brief developed in conjunction with Mathis Consulting Company. Please consult with local code officials for determinations in your state or municipality.

APPENDIX Climate Zone-Specific Thermal Insulation Requirements