

ROOF INSULATION R-VALUES FOR COMMERCIAL BUILDINGS

UNDER ASHRAE AND "ABOVE-CODE" STANDARDS

By Jared Blum

Since the first known building code was created – the Code of Hammurabi in 1795 BC – building performance has typically been addressed after a crisis event such as the Chicago Fire of 1871, the San Francisco Earthquake of 1906, and, more recently, Hurricanes Andrew in 1992 and Katrina in 2005. These types of disasters can often lead to improved building codes.

The OPEC oil embargo of the 1970s was no different. Constrained oil supply prompted state and federal initiatives to improve the efficiencies of residential and commercial buildings alike. In 1975, the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) published its first version of a model energy-efficiency standard for buildings, Standard 90. Shortly thereafter, state and national codes sought some measure by which building energy efficiency could be assessed and regulated.

Surprisingly, since 1989 and ASHRAE Standard 90.1, roof and wall insulation levels in commercial and non-low-rise residential buildings (referred to as “commercial” from here on out) have remained essentially flat. That is, until now. There are two pending ASHRAE standards that are expected to become final soon, which will result in higher building efficiency performance for commercial buildings.

With respect to above-deck insulation, the R-values required under ASHRAE’s

Standard 90.1 will increase before the end of 2007 and quite likely will be part of the Standard 90.1-2007 standards set. Although adoption of the 2007 version of ASHRAE by state and local governments could take several years, more and more architects and designers are recognizing their obligation to adhere to a higher standard of care, resulting in their utilization of the most current version of ASHRAE, regardless of local adoption.

The other important change is the dramatic increase in roof insulation that would be required under ASHRAE’s proposed Standard 189 for green buildings. This proposed standard recently went through a public comment period and, depending on the comments received, may become final before the end of 2007.

ASHRAE Standard 189

ASHRAE’s proposed Standard 189 for green buildings will address not only energy efficiency but also other environmental and health impacts of a building, such as water use and indoor air quality. In terms of energy efficiency, the goal of the standard is to achieve at least a 30-percent reduction in energy use over Standard 90.1-2007. Upon completion, Standard 189 will be an ANSI-accredited standard that can be incorporated into state and local building codes. Also, it is intended that the standard will eventually become a prerequisite for LEED (Leadership in Energy and Environmental Design) certification.

The credit system under the U.S. Green Building Council’s (USGBC’s) LEED standard provides significant incentives for energy efficiency, but only recently has the LEED system actually required any minimal level of energy efficiency (i.e., a 7-percent improvement over ASHRAE 90.1-2004 for existing buildings and 14-percent improvement for new buildings). Also, direct influence of the LEED rating system has been limited to market leaders, whereas Standard 189 is intended to be a catalyst for energy efficiency and green-building design across the mainstream market.

The energy requirements under Standard 189 are also significant because they are likely to be used in guiding the ASHRAE committee responsible for developing Standard 90.1-2010. ASHRAE has pledged to increase the stringency of the 90.1 standard by 30 percent over the 2004 version by 2010. This target ends up being very close to the energy requirements under Standard 189.

ASHRAE 90.1

ASHRAE Standard 90.1-2004 is the current energy code referenced in the International Building Code (IBC) and the International Energy Conservation Code (IECC). As such, this standard defines code minimums for the classes of construction covered.

The code has multiple compliance paths—from the simple, prescriptive compliance approach (checklist) to complex build-

ing-energy simulations (performance-based compliance). When the prescriptive levels change (efficiency levels are increased), a new bar is also established for those seeking to use the more complicated energy-simulation tools. The changes are climate-zone- and building-type-specific. See *Figure 1*.

The ASHRAE standard addresses building envelope and system requirements for commercial buildings, residential buildings higher than three stories, and semi-conditioned buildings (warehouses, etc.). It is the nation's model standard for

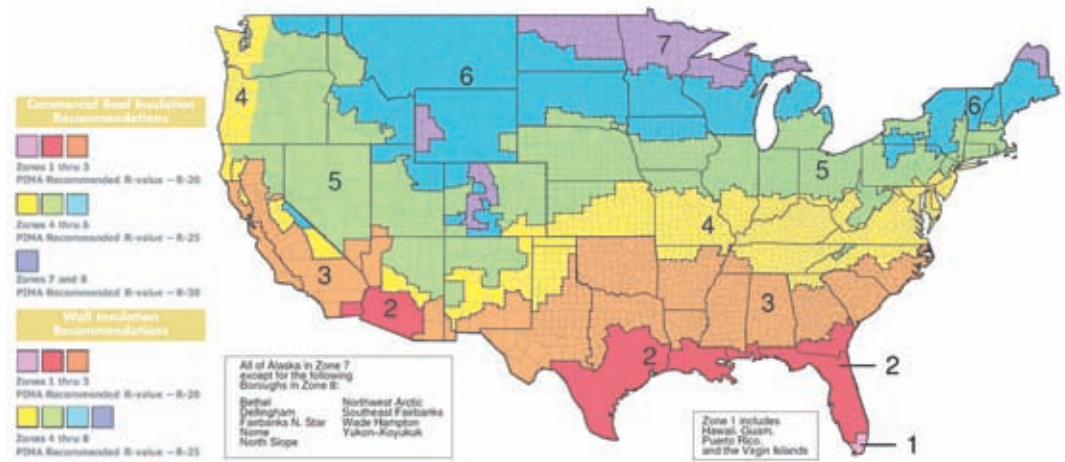


Figure 1

PRESCRIPTIVE R-VALUE REQUIREMENTS AND RECOMMENDATIONS FOR INSULATION INSTALLED ENTIRELY ABOVE DECK									
(All assume continuous insulation [c.i.] .)									
Climate Zones	1	2	3	4 Except Marine	4 Marine	5	6	7	8
2006 IECC (same as 2004)	15	15	15	15	20	20	20	25	25
ASHRAE 90.1-2004	15	15[3.8]*	15[3.8]	15[3.8]	15[3.8]	15[5]	15[5]	15[5]	20[10]
ASHRAE 90.1 (2007 proposal)	15[20]#[3.8]	20[3.8]	20[5]	20[5]	20[5]	20[7.6]	20[10]	20[10]	20[15]
ASHRAE 189 (2007 proposal)	20[25][5]	25[5]	25[7.6]	25[7.6]	25[7.6]	25[10]	30[15]	35[15]	35[20]
NBI benchmark recommendations	20	20	20	25	25	25	30	35	35
ASHRAE's AEDG for small office buildings	15ci	15ci	20	20	20	20	20	20	30

*[for semi-heated spaces] #[residential if different]

PRESCRIPTIVE R-VALUE REQUIREMENTS AND RECOMMENDATIONS FOR METAL BUILDING ROOFS									
(All assume an R-5 thermal block.)									
Climate Zones	1	2	3	4 Except Marine	4 Marine	5	6	7	8
2006 IECC (same as 2004)	19+10	19	19	19	19	19	19	19+10	19+10
ASHRAE 90.1-2004	19	19[6]*	19[10]	19[10]	19[10]	19[10]	19[10]	19[10]	13+19[16]
ASHRAE 90.1 (2007 proposal)	No change								
ASHRAE's AEDG for small office buildings	19	19	13+13	13+19	13+19	13+19	13+19	13+19	19+19
NBI benchmark recommendations. In zones 6-8, rigid insulation is installed below the purlins with crossed batts (sag & bag) above the rigid foam.	13+19	13+19	13+19	19+13	19+13	19+13	30 +6 c.i.	19+10 +10 c.i.	19+10 +10 c.i.
ASHRAE 189 (2007 proposal)	13+19 (19+10)[6]	19+10 [10]	19+10 [16]	19+10 [16]	19+10 [16]	19+10 [16]	30 +6 c.i. [19]	30 +10 c.i. [19]	30 +10 c.i. [13+19]

*[for semi-heated spaces] #[residential if different]

establishing the energy performance requirements for these building types.

Adjacent are two tables that compare the insulation requirements for commercial roofs under the current and proposed ASHRAE and IECC standards with the requirements under the various “above-code” standards that have recently been developed or that are under development.

- ASHRAE 90.1-2004 standard (currently adopted in 11 states)
- 2006 IECC (currently adopted in nine states)¹

- Proposed ASHRAE 90.1-2007 standard
- Proposed ASHRAE 189 standard. The energy requirements are intended to be 30 percent more stringent than ASHRAE 90.1-2007.
- Recommendations under the New Buildings Institute’s (NBI) *Advanced Buildings Core Performance Guide*, July 2007, which replaces NBI’s *Energy Benchmark for High Performance Buildings*. The core program is intended to be 20 to 30 percent

more stringent than ASHRAE 90.1-2004, depending on climate.

- ASHRAE’s *Advanced Energy Design Guide (AEDG) for Small Office Buildings*. This AEDG is intended to be 30 percent more stringent than ASHRAE 90.1-1999. Others, soon to be published, will be 50 percent more stringent.

Because the 2006 IECC references ASHRAE 90.1-2004, the entire envelope for buildings constructed under the 2006 IECC

1. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 1 (ESSENTIALLY MIAMI)							
		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	NC	R-15ci	R-20ci	NR	R-3.8ci
	Metal buildings	R-19	NC	R-19	NC	NR	R-6
	Attic and other	R-30	NC	R-38	NC	NR	R-13
Walls, above-grade							
	Mass	NR	NC	R-5.7ci	NC	NR	NC
	Metal building	R-13	NC	R-13	NC	NR	R-13
	Steel-framed	R-13	NC	R-13	NC	NR	NC
	Wood-framed and other	R-13	NC	R-13	NC	NR	NC



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2. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 2 (PRIMARILY THE GULF COAST)

		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	NR	NC
	Metal buildings	R-19	NC	R-19	NC	NR	R-10
	Attic and other	R-30	R-38	R-38	NC	NR	NC
Walls, above-grade							
	Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	NR	NC
	Metal building	R-13	NC	R-13	NC	R-6	R-13
	Steel-framed	R-13	NC	R-13	R-13 + R-7.5ci	NR	R-13
	Wood-framed and other	R-13	NC	R-13	NC	NR	R-13

3. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 3 (SOUTHEAST, MOST OF CA)

		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	R-3.8ci	R-5ci
	Metal buildings	R-19	NC	R-19	NC	R-10	R-10
	Attic and other	R-30	R-38	R-38	NC	R-13	R-19
Walls, above-grade							
	Mass	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	NR	NC
	Metal building	R-13	NC	R-13	R-13 + R-13	R-6	R-13
	Steel-framed	R-13	R-13 + R-3.8ci	R-13 R-3.8ci	R-13 + R-7.5ci	NR	R-13
	Wood-framed and other	R-13	NC	R-13	NC	NR	NC

4. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 4 (VA, ST. LOUIS, ETC.)

		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	R-3.8ci	R-5ci
	Metal buildings	R-19	NC	R-19	R-13 + R-13	R-10	NC
	Attic and other	R-30	R-38	R-38	NC	R-13	R-19
Walls, above-grade							
	Mass	R-5.7ci	R-9.5ci	R-9.5ci	R-11.4ci	NR	NC
	Metal building	R-13	R-13 + R-13	R-13	R-13 + R-13	R-10	R-13
	Steel-framed	R-13	R-13 + R-7.5ci	R-13 + R-7.5ci	NC	R-13	NC
	Wood-framed and other	R-13	NC	R-13	R-13 + R-3.8ci	R-13	NC

may comply with either section 502 of the IECC or section 5 of ASHRAE 90.1-2004.

Climate zones (by county) for the 2004 Supplement to the IECC, the 2006 IECC, and ASHRAE 90.1-2004

The accompanying tables (Tables 1-8) use these content conventions:

- Approved changes to roof and wall R-values are shown in **bold red**.
- Where there are no specific roof, attic, or wall insulation requirements in the standard, the table shows “NR” for “No Requirement.”
- Where no changes are proposed, the table shows “NC” for “No Change.”
- R-values listed in the tables are minimum required R-values.
- “Continuous Insulation” (ci) means this is required, such as with insulating sheathing. Other insulation values can mean cavity fills, etc.
- These tables are abbreviated versions of the entire ASHRAE standard

5. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 5 (UP TO CHICAGO)							
		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	R-3.8ci	R-7.6ci
	Metal buildings	R-19	R-13 + R-13	R-19	R-13 + R-13	R-10	R-13
	Attic and other	R-30	R-38	R-38	NC	R-13	NC
Walls, above-grade							
	Mass	R-7.6ci	R-11.4ci	R-11.4ci	R-13.3ci	NR	R-5.7ci
	Metal building	R-13	R-13 + R-13	R-13 + -13	R-13 + R-13	R-11	R-13
	Steel-framed	R-13 + R-3.8ci	R-13 + R-5ci	R-13 + R-.5ci	NC	R-13	NC
	Wood-framed and other	R-13	R-13 + R-8ci	R-13	R-13 + R-7.5ci	R-13	NC

6. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 6 (MINNEAPOLIS AND MAINE)							
		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	R-5ci	R-10ci
	Metal buildings	R-19	R-13 + R-19	R-19	R-13 + R-19	R-10	R-16
	Attic and other	R-38	NC	R-38	NC	R-19	R-30
Walls, above-grade							
	Mass	R-9.5ci	R-13.3ci	R-11.4ci	R-15.2ci	NR	R-5.7ci
	Metal building	R-13	R-13 + R-13	R-13 + -13	NC	R-13	NC
	Steel-framed	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + R-7.5ci	NC	R-13	NC
	Wood-framed and other	R-13	R-13 + R-7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13	NC



7. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 7 (NORTHERN MN AND CANADA)

		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-15ci	R-20ci	R-15ci	R-20ci	R-5ci	R-10ci
	Metal buildings	R-19	R-13 + R-19	R-19	R-13 + R-19	R-10	R-16
	Attic and other	R-38	NC	R-38	NC	R-19	R-30
Walls, above-grade							
	Mass	R-11.4ci	R-15.2ci	R-13.3ci	R-15.2ci	NR	R-7.6ci
	Metal building	R-13 + R-13	NC	R-13 + R-13	NC	R-13	NC
	Steel-framed	R-13 + R-7.5ci	NC	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13	NC
	Wood-framed and other	R-13	R-13 + R-7.5ci	R-13 + R-7.5ci	NC	R-13	NC


8. APPROVED BUILDING ENVELOPE CHANGES FOR CLIMATE ZONE 8 (NORTHERN ALASKA)

		NONRESIDENTIAL		RESIDENTIAL		SEMI-HEATED	
	OPAQUE ELEMENTS	CURRENT	PROPOSED	CURRENT	PROPOSED	CURRENT	PROPOSED
Roofs							
	Insulation entirely above deck	R-20ci	NC	R-20ci	NC	R-10ci	R-15ci
	Metal buildings	R-13 + R-19	R-16 + R-19	R-13 + R-13	NC	R-16	R-19
	Attic and other	R-38	R-49	R-38	R-49	R-30	NC
Walls, above-grade							
	Mass	R-13.3ci	R-15.2ci	R-15.2ci	R-25ci	R-5.7ci	R-9.5ci
	Metal building	R-13 + R-13	NC	R-13 + -13	R-13 + R-16	R-13	NC
	Steel-framed	R-13 + R-7.5ci	NC	R-13 + R-10ci	R-13 + R-18.8ci	R-13	R-13 + R-3.8ci
	Wood-framed and other	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13	NC

tables, showing only the proposed insulation R-value changes for attics and above-grade walls.

- **Metal** building roofs and walls are currently under consideration by ASHRAE, and new proposals are expected for consideration in January 2008.

By understanding and implementing the changes in ASHRAE Standards 90.1 and 189, RCI members have an opportunity to demonstrate leadership in building envelope performance. While issues of implementation and timing are yet to be fully resolved, once approved by the ASHRAE Board, these standards will represent a new national criterion against which all codes will be compared. The increased values show a clear road map for the designer who values complying with and

even exceeding the “standard of care” exhibited by his or her projects. 

References

1. It is important to note that, for some climate zones, the R-values are higher under the IECC than they are under the ASHRAE 90.1-2004 stan-

dard; however, since ASHRAE 90.1 is referenced in the IECC, a person may comply with either standard (for the entire envelope).

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Jared O. Blum is the president of the Polyisocyanurate Insulation Manufacturers Association (PIMA), the Washington-based national trade association representing manufacturers of polyiso foam insulation, the most energy-efficient insulation on the market today. The association is committed to working independently and with public and private organizations to educate Americans about the critical importance of national energy conservation. To learn more about polyiso and PIMA, visit PIMA's Web site at www.pima.org.

