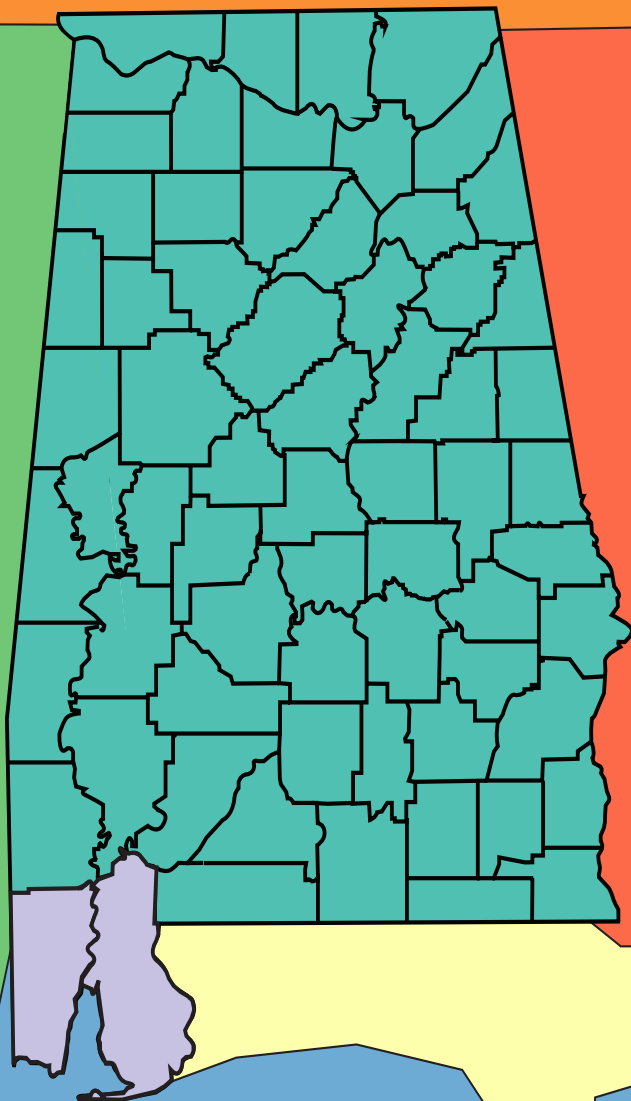


Alabama Commercial Energy Code

FIELD GUIDE



ASHRAE 90.1-2013 + IECC-2015

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Alabama Commercial Energy Code FIELD GUIDE

ASHRAE 90.1-2013
& IECC-2015

How to Use the Field Guide

This guide is intended to help explain the commercial portion of the energy code and does not necessarily include all aspects and details. This guide is organized by building component and attempts to compile all relevant information and key practices related to each component. Each entry emphasizes the requirements of ASHRAE 90.1-2013 and (where appropriate) includes references to the 2015 IECC Commercial Provisions. Graphics and illustrations are provided as examples only.

Need Help?

Additional Online Resources:

www.southface.org/education/our-courses/georgia-energy-code-support-documents

Southface Institute Energy Code Helpline:

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Introduction

The 2015 IECC / ASHRAE 90.1-2013 Alabama Commercial Energy Code was adopted on January 1, 2016:

305-2-4-.08

Commercial Energy Code

- (1) Either the 2015 International Energy Conservation Code or the ANSI/ASHRAE/IES Standard 90.1-2013 shall be implemented and enforced for commercial buildings.
- (2) For purposes of enforcement, this code shall become effective on January 1, 2016.

This Commercial Energy Code Field Guide is primarily intended for use by code officials when inspecting commercial construction projects for compliance with the ASHRAE Standard 90.1-2013. This includes new buildings and their systems, new portions of buildings and their systems, or new systems and equipment in existing buildings.

This field guide illustrates key inspection requirements of the energy code based on the Department of Energy's COMcheck Compliance Certificates for Envelope, Interior/Exterior Lighting, and Service Water Heating, plus ASHRAE 90.1-2013 requirements (A–R) per the Simplified Compliance Approach for Mechanical Systems. Each inspection requirement has specific details, code references, and graphics to assist code officials.

In Alabama, there is an alternate compliance option: 2015 International Energy Conservation Code (IECC-2015). Where applicable, this field guide includes references that indicate important differences between ASHRAE 90.1 and the IECC; however, as noted, the bulk of this guide is keyed to ASHRAE 90.1-2013. For more information or training on IECC Commercial Provisions, please visit www.southface.org/education/our-courses/georgia-energy-code-support-documents and/or email energycodes@southface.org.

Compliance Options

Compliance with the energy code can be demonstrated by the prescriptive, trade-off, or an energy simulation approach (e.g., Energy Cost Budget). About 85% of all commercial buildings can use either the prescriptive or simple trade-off approach. Though COMcheck is typically used to demonstrate the simple trade-off approach, it may also be used for documenting a project that follows the prescriptive approach. The end result is a project-specific checklist that can be easily verified by the code official.

For this reason, requiring the use of COMcheck as part of the permitting process is highly encouraged for all jurisdictions.

Note: If a trade-off or performance approach is used to demonstrate envelope compliance, it is possible that the building may NOT comply with the prescriptive code values listed in this field guide and yet may still be deemed to comply with the code (and therefore should be marked as compliant for the given checklist item) on the basis that some other aspect

of the building exceeds the code requirement. This trade-off will be validated by the COMcheck Compliance Certificate.

Exception: A building that has been specifically designated as historically significant by the adopting authority or is listed in the National Register of Historic Places or has been determined to be eligible for listing by the U.S. Secretary of the Interior need not comply with ASHRAE 90.1-2013 requirements.

Alabama Climate Zones by County

Many requirements in the energy code depend on the climate zone (CZ) where the building is located. In the table below, the digit indicates each county’s zone. Most Alabama counties are in CZ 3A with Mobile and Baldwin counties in CZ 2A. The letter indicates an area’s moisture regime; the entire state of Alabama is designated as Regime A (moist); no areas fall in B (dry) or C (marine). Additionally, an asterisk (*) indicates that a county is designated as a warm-humid location.

Climate Zone 3

Bibb Blount Calhoun Chambers Cherokee Chilton Clay Cleburne Colbert Coosa Cullman	DeKalb Etowah Fayette Franklin Greene Hale Jackson Jefferson Lamar Lauderdale Lawrence	Lee Limestone Madison Marion Marshall Morgan Pickens Randolph Shelby St. Clair Sumter	Talladega Tallapoosa Tuscaloosa Walker Winston
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Climate Zone 3* (moist-humid)

Autauga Barbour Bullock Butler Choctaw Clarke Coffee Conecuh	Covington Crenshaw Dale Dallas Elmore Escambia Geneva Henry	Houston Lowndes Macon Marengo Monroe Montgomery Perry Pike	Russell Washington Wilcox
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Climate Zone 2 (moist-humid)

Baldwin	Mobile
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Space Classifications

Spaces shall be assumed to be conditioned spaces and shall comply with the requirements for conditioned space at the time of construction, regardless of whether mechanical or electrical equipment is included in the building permit application or installed at that time. (In CZs 3-8, a space may be designated as either semiheated or unconditioned only if approved by the building official.)

Conditioned space: a cooled space, heated space, or indirectly conditioned space, each of which is defined as follows:

Cooled space: an enclosed space within a building that is cooled by a cooling system whose sensible output capacity exceeds 5 Btu/h-ft² of floor area.

Heated space: an enclosed space within a building that is heated by a heating system whose output capacity relative to the floor area is greater than or equal to 5 Btu/h-ft² of floor area in CZ2 and 10 Btu/h-ft² of floor area in CZ3.

Indirectly conditioned space: an enclosed space within a building that is heated or cooled indirectly by being connected to adjacent space(s), provided:

a. the product of the U-factor(s) and surface area(s) of the space adjacent to connected space(s) exceeds the combined sum of the product of the U-factor(s) and surface area(s) of the space adjoining the outdoors, unconditioned spaces, and to or from semiheated spaces (e.g., corridors)

OR

b. air from heated or cooled spaces is intentionally transferred (naturally or mechanically) into the space at a rate exceeding 3 ACH (e.g., atria).

Space-Conditioning Categories

Separate commercial building exterior envelope requirements are specified for each of three categories of conditioned space, defined as follows:

Nonresidential: all occupancies other than residential.

Residential: spaces in buildings used primarily for living and sleeping. Residential spaces include but are not limited to dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and fire stations.

Semiheated: an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h-ft² of floor area but is not a conditioned space. The heating system must not exceed 5 Btu/h-ft² for CZ2, 10 Btu/h-ft² for CZ3; otherwise the space is heated enough to be considered conditioned.

Inspections

Per ASHRAE 90.1-2013 (Section 4.2.4), all building construction, additions, or alterations subject to the provisions of this standard shall be subject to inspection by the building official, and all such work shall remain accessible and exposed for inspection purposes until approved in accordance with the procedures specified by the building official. Items for inspection include at least the following:

- a. Wall insulation after the insulation is in place but before concealment
- b. Roof/ceiling insulation after roof/insulation is in place but before concealment
- c. Slab/foundation wall after slab/foundation insulation is in place but before concealment
- d. Fenestration after all glazing materials are in place
- e. Mechanical systems and equipment and insulation after installation but before concealment
- f. Electrical equipment and systems after installation but before concealment

Roof, Insulation Entirely Above Deck

Inspection Requirements

Verify that R-value of continuous insulation (c.i.) above roof deck meets or exceeds the value required by climate zone. The COMcheck Compliance Certificate (if applicable) should match the installed insulation levels.

Details

Continuous rigid insulation installed above the roof deck is a more effective application of roof insulation than attic insulation, as it provides unbroken thermal resistance from the sun's radiant energy and reduces heat transfer to the conditioned space.

Ensure that consistent, minimum R-value is met, even at the lowest point on the roof, as insulation thickness is sometimes compromised to provide drainage for roofs. Pay attention to areas adjacent to drains and scuppers. Roof surfaces shall be reflective* or an increased R-33 (max. U-0.030) must be attained for non-residential (R-34, max. U-0.029 for residential).

☑ *The 2015 IECC R-values for continuous insulation entirely above roof deck are equivalent to ASHRAE 90.1-2013.*

☑ *To comply with the prescriptive code, either the prescriptive R-value (e.g., R-25 continuous insulation) may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

** Minimum 3-year aged solar reflectance of 0.55 and thermal emittance of 0.75 or SRI > or = 64. Some exceptions apply.*

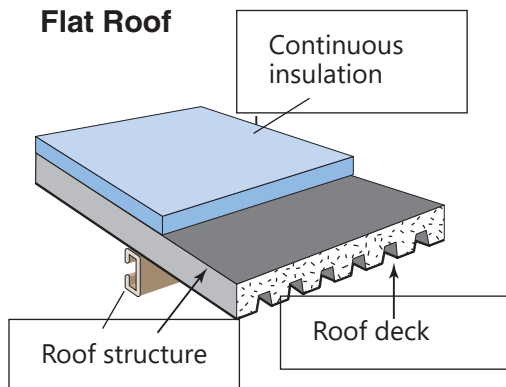
Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-25.0 c.i.	R-25.0 c.i.	R-5.0 c.i.
3	R-25.0 c.i.	R-25.0 c.i.	R-7.6 c.i.

Code reference

ASHRAE 90.1-2013—Section 5.5.1

Flat Roof



Roof, Metal Building

Inspection Requirements

Verify that R-value of metal building insulation meets or exceeds the level required and that thermal blocks are installed. Verify that the installed levels match the value in the COMcheck Compliance Certificate (if applicable).

Details

The code requires insulation to be draped perpendicular to the roof purlins with thermal blocks (A2.3.2.1). Better described as “strips” than “blocks,” this minimum R-3 rigid insulation material runs the length of each purlin/girt and acts as a thermal break to reduce conductive energy transfer to/from the roof.

The prescriptive values below contain additional footnotes pertaining to metal building insulation systems. In this context, *fc* stands for “filled cavity” and *ls* stands for “liner system.” The first R-value listed refers to insulation run perpendicular and draped over the purlin. The second R-value listed refers to unfaced insulation installed above the first layer and parallel to the purlin. Some compression will occur. Roof surface shall be reflective* or the metal building shall have R-35 (max U-0.028).

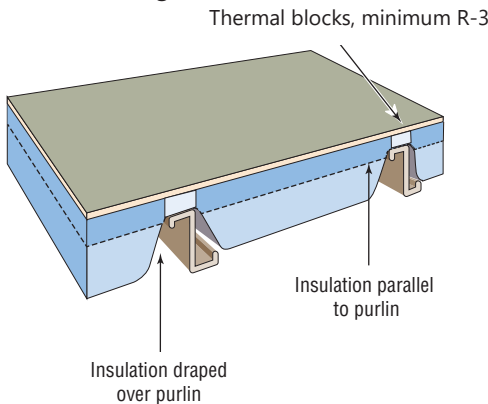
- ☑ *The 2015 IECC requires R-19 + 11 ls for metal building roofs in CZ 2–3.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*
- * Minimum 3-year aged solar reflectance of 0.55 and thermal emittance of 0.75 or SRI > or = 64. Some exceptions apply.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-10.0 + R-19.0 fc	R-10.0 + R-19.0 fc	R-16.0
3	R-10.0 + R-19.0 fc	R-10.0 + R-19.0 fc	R-16.0

Code reference ASHRAE 90.1-2013—Section 5.5.1

Metal Building



Roof, Attic and Other

Inspection Requirements

Verify that R-value of insulation meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Any roof insulation that is not entirely above deck or part of a metal building roof falls into this category.

Blown or loose-fill insulation should be applied at a uniform depth or thickness and should extend to the entire thermal boundary, in this case over the top plate to the outermost face of each exterior wall.

Rulers installed every 300 sq. ft. are a good way to verify the blown or loose-fill attic depth.

- ☑ *The 2015 IECC requires R-38 for attic insulation in CZs 2–3.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-38.0	R-38.0	R-19.0
3	R-38.0	R-38.0	R-19.0

Code reference

ASHRAE 90.1-2013—Section 5.5.1



Ruler shows depth of installed blown-in insulation. Typical blown-in fiberglass insulation has an R-value of around R-3 per inch; 12 to 14 inches of blown-in insulation is typical to achieve R-38.

Walls, Above Grade—Mass

Inspection Requirements

Verify that R-value of continuous insulation (c.i.) on mass walls meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Mass walls are thick, heavy walls; typical materials are concrete, CMU, or solid multiwythe brick.

- ☑ *The 2015 IECC R-values for above-grade mass wall insulation are equivalent to ASHRAE 90.1-2013.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p. 18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-5.7 c.i. ^b	R-7.6 c.i.	N/A
3	R-7.6 c.i.	R-9.5 c.i.	N/A

^b For above-grade insulation, an exception for mass walls using approved construction assembly types is permitted. For additional details see ASHRAE 90.1-2013 section 5.5.3.2.

Code reference

ASHRAE 90.1-2013—Section 5.5.3.2



Installation of a waterproof coating installed under continuous insulation on a concrete wall.

Walls, Above Grade—Metal Building

Inspection Requirements

Verify that R-value of continuous insulation (c.i.) on metal buildings meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Insulation is draped perpendicular to purlins. Compression at purlins is allowed.

- ☑ *The 2015 IECC requires a minimum R-13 + 6.5 c.i. for metal building walls in CZs 2–3. See IECC Table C402.1.3 for details.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-9.8 c.i.	R- 9.8 c.i.	R-13.0
3	R-9.8 c.i.	R-13.0 c.i.	R-13.0

Code reference

ASHRAE 90.1-2013—Section 5.5.3.2



Walls, Above Grade—Steel-Framed

Inspection Requirements

Verify that R-value of continuous insulation (c.i.) at steel-framed walls meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Metal readily conducts energy; continuous insulation (c.i.) across the face of a metal stud wall (ideally on the exterior) minimizes the thermal bridging effect. Therefore, the code often requires both cavity insulation and continuous insulation. Verify that cavity insulation is in permanent continuous contact with the exterior sheathing, with no gaps or voids.

- ☑ *In some instances, the 2015 IECC requires slightly higher levels of continuous insulation for commercial building metal framed walls in CZs 2–3. See IECC Table C402.1.3 for insulation R-values (p.20).*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

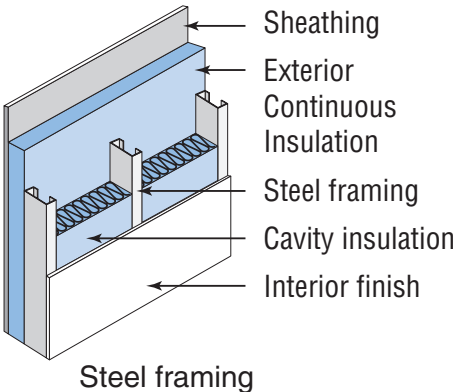
Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-13.0 + R-3.8 c.i.	R-13.0 + R7.5 c.i.	R-13.0
3	R-13.0 + R-5 c.i.	R-13.0 + R7.5 c.i.	R-13.0

Note: two values indicate cavity + continuous insulation

Code reference

ASHRAE 90.1-2013—Section 5.5.3.2



Walls, Above Grade—Wood-Framed

Inspection Requirements

Verify that R-value of insulation on wood-framed walls meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Verify that cavity insulation is in permanent, continuous contact with the exterior sheathing, with no gaps or voids.

- ✓ *The 2015 IECC requires either R-13 + 3.8 c.i. or R-20 for above grade wood-framed walls in CZs 2–3.*
- ✓ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

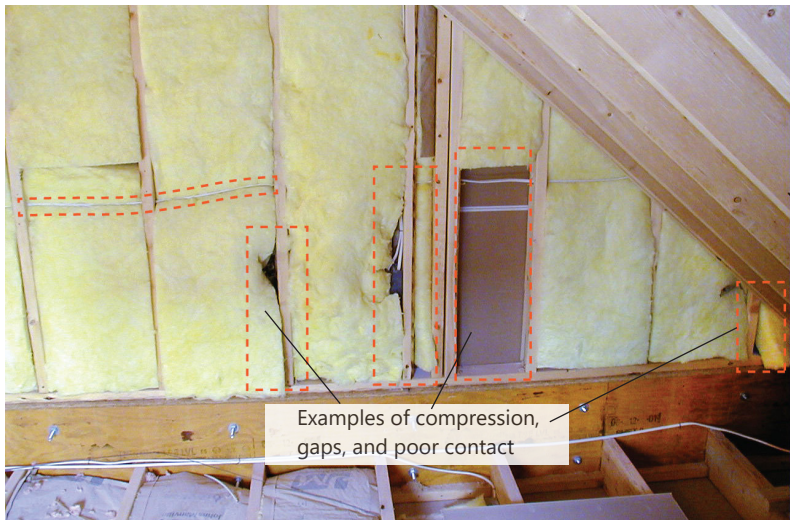
Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-13.0	R-13.0	R-13.0
3	R-13.0	R-13.0+R-3.8 or R-20	R-13.0

Note: two values indicate cavity + continuous insulation

Code reference

ASHRAE 90.1-2013—Section 5.5.3.2



Unacceptable installation: R-value of insulation is reduced by gaps, voids, compression, moisture, and lack of contact with air barrier on all sides.

Walls, Below Grade

Inspection Requirements

Verify that R-value of insulation on below-grade walls meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

In Alabama, insulation on below-grade (basement) walls is not required.

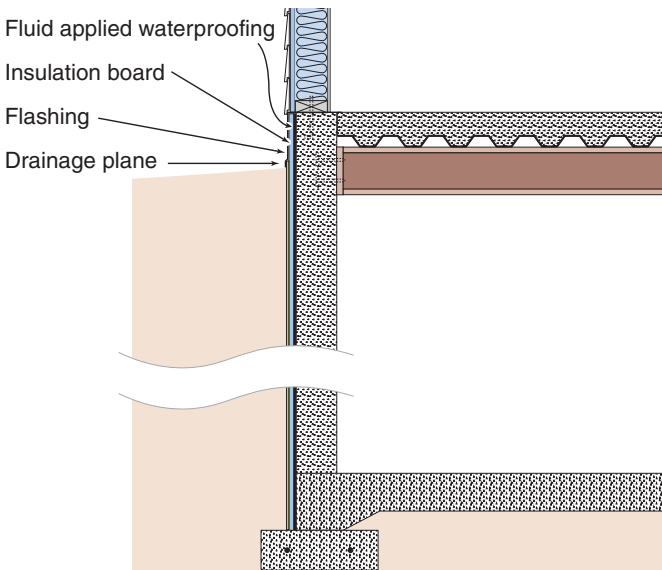
☑ *The 2015 IECC also does not require insulation for below-grade walls.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	N/A	N/A	N/A
3	N/A	N/A	N/A

Code reference

ASHRAE 90.1-2013—Section 5.5.3.3



Floors, Mass

Inspection Requirements

Verify that R-value of continuous insulation (c.i.) on the mass floors meets or exceeds the values required by climate zone. Verify that the installed insulation value matches COMcheck Compliance Certificate (if applicable).

Details

Insulation installed on mass floors should cover the structure completely, with no gaps or voids visible. Mass-floor insulation is often required for elevated slabs above parking decks in commercial buildings.

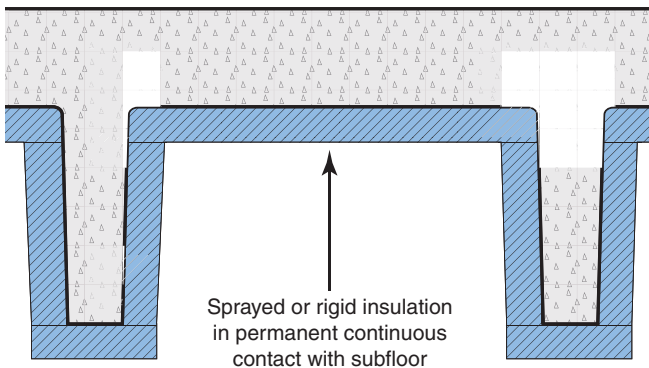
- ☑ *The 2015 IECC R-values for mass floor insulation are equivalent to ASHRAE 90.1-2013 for CZs 2–3.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-6.3 c.i.	R-8.3 c.i.	N/A
3	R-10.0 c.i.	R-10.0 c.i.	R-4.2 c.i.

Code reference

ASHRAE 90.1-2013—Section 5.5.3.4



Floors, Steel-Joist

Inspection Requirements

Verify that R-Value of floor cavity insulation meets or exceeds the values required by climate zone and insulation is in permanent continuous contact with the underside of the floor deck. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Pay close attention to the installation of insulation in framed floors. Air spaces created by floor insulation that has separated (dropped/sagged) from direct contact with the underside of a floor may allow air to flow through the insulation and negate the thermal benefits.

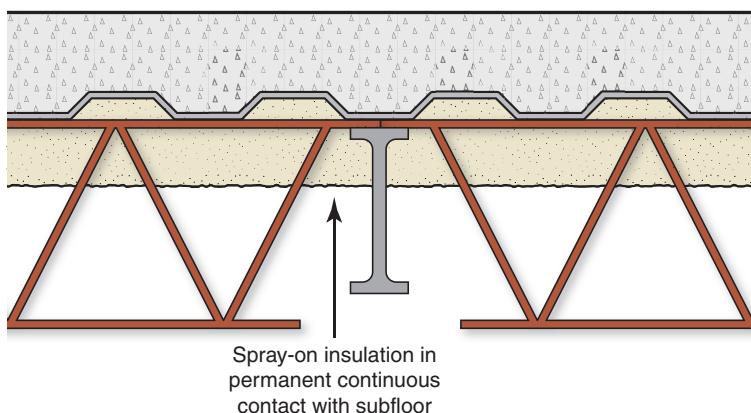
- ☑ *The 2015 IECC R-values for steel-joist framed floors are equivalent to ASHRAE 90.1-2013.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-30	R-30	R-13
3	R-30	R-30	R-19

Code reference

ASHRAE 90.1-2013—Section 5.5.3.4



Floors, Wood-Framed

Inspection Requirements

Verify that R-value of floor cavity insulation meets or exceeds the values required by climate zone and insulation is in permanent continuous contact with the underside of the floor deck. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Pay attention to the installation of insulation in framed floors. Air spaces created by floor insulation that has separated (dropped/sagged) from direct contact with the underside of a floor may allow air to flow through the insulation and negate the thermal benefits. Cantilevered floors must be insulated and the joist cavities blocked above the supporting exterior wall.

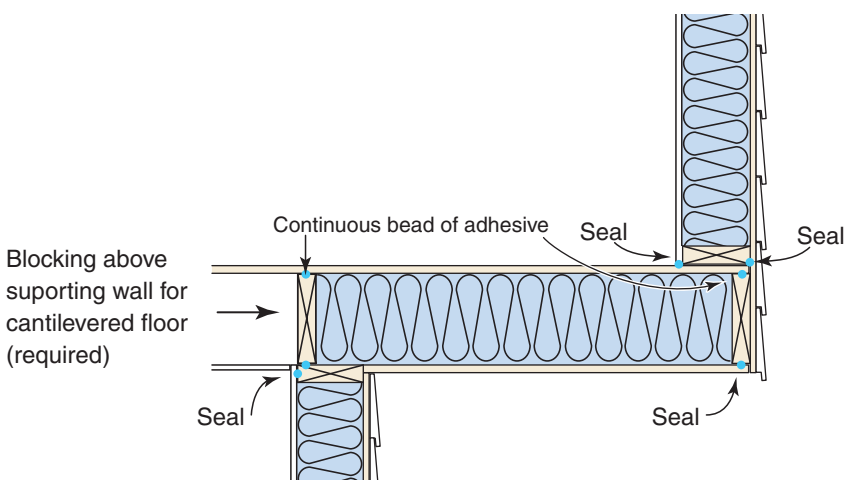
- ☑ *The 2015 IECC R-values for wood-framed floors are equivalent to ASHRAE 90.1-2013.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-30	R-30	R-13
3	R-30	R-30	R-19

Code reference

ASHRAE 90.1-2013—Section 5.5.3.4



Floors, Slab-on-Grade—Heated Floors

Inspection Requirements

Verify that R-value and extent of slab perimeter insulation meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable). Note: a "heated slab" implies there is a heating distribution system within the slab.

Details

Heat loss at slab edge is minimized by slab perimeter insulation installed per ASHRAE 90.1-2013, Tables 5.5-2 thru 5.5-3.

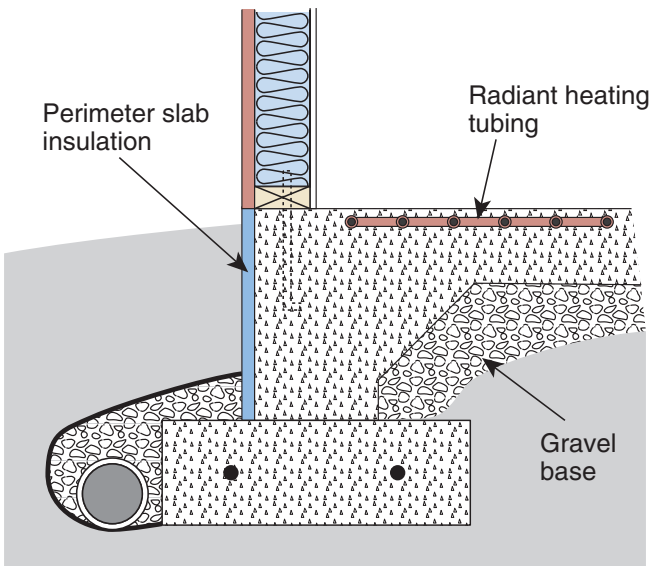
- ☑ *The 2015 IECC R-values for heated, slab-on-grade floors are less stringent than ASHRAE 90.1-2013. The IECC requires R-7.5 to R-15 for commercial buildings depending on climate zone. See IECC Table C402.1.3 for details.*
- ☑ *To comply with the prescriptive code, either the prescriptive R-value may be satisfied or any assembly with a U-factor that does not exceed the table threshold will comply. See prescriptive code values on p.18–20 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-10.0 for 24 in.	R-15.0 for 24 in.	R-7.5 for 12 in.
3	R-15.0 for 24 in.	R-15.0 for 24 in.	R-7.5 for 12 in.

Code reference

ASHRAE 90.1-2013—Section 5.5.3.5



Note: Insulation under slab is not required or especially useful in CZs 2–3.

Floors, Slab-on-Grade—Unheated Floors

Inspection Requirements

Verify that R-value and extent of slab perimeter insulation meets or exceeds the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

In Alabama CZ3, unheated slabs in residential commercial buildings now require insulation. Heat loss at slab edge is minimized by slab perimeter insulation installed per ASHRAE 90.1-2013, Tables 5.5-3.

☑ *The 2015 IECC requires no unheated slab floor insulation for CZ2–3.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp18–20.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	NR	NR	NR
3	NR	R-10 for 24in.	NR

Code reference

ASHRAE 90.1-2013—Section 5.5.3.5

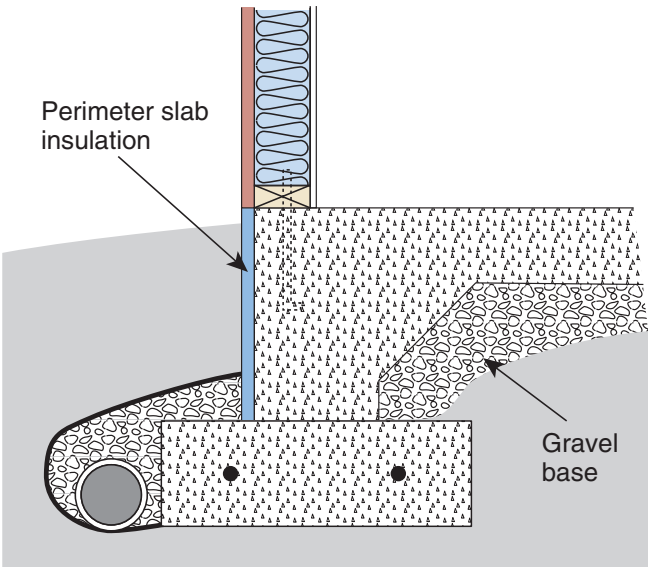


Table 5.5, Building Envelope Requirements CZs 2–3

Tables 5.5-2 to 5.5-3 are included here and on the following pages as supplements to the Opaque Elements section (pp.6–17, above) and show assembly U-factors and other requirements for various components. IECC prescriptive R-values and U-factors are also included.

Table 5.5-2 Building Envelope Requirements for Climate Zone 2 (A,B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.173	R-5 c.i.
Metal Building ^a	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16
Attic and Other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19
<i>Walls, above Grade</i>						
Mass	U-0.151 ^b	R-5.7 c.i. ^b	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	U-0.094	R-0 + R-9.8 c.i.	U-0.094	R-0 + R-9.8 c.i.	U-0.162	R-13
Steel Framed	U-0.084	R-13 + R-3.8 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
Wood Framed and Other	U-0.089	R-13	U-0.089	R-13	U-0.089	R-13
<i>Wall, below Grade</i>						
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
<i>Floors</i>						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.069	R-13
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.066	R-13
<i>Slab-on-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.900	R-10 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
<i>Vertical Fenestration, 0%–40% of Wall</i>						
		(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.40			U-0.40		U-0.93
Metal framing, fixed	U-0.57			U-0.57		U-1.20
Metal framing, operable	U-0.65	SHGC-0.25	1.10	U-0.65	SHGC-0.25	1.10
Metal framing, entrance door	U-0.83			U-0.77		U-0.83
<i>Skylight, 0%–3% of Roof</i>						
All types	U-0.65	SHGC-0.35	NR	U-0.65	SHGC-0.35	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

b. Exception to Section 5.5.3.2 applies for mass walls above grade.

Table 5.5, Building Envelope Requirements, continued

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated				
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value			
Roofs									
Insulation Entirely above Deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.119	R-7.6 c.i.			
Metal Building ^a	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16			
Attic and Other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19			
Walls, above Grade									
Mass	U-0.123	R-7.6 c.i.	U-0.104	R-9.5 c.i.	U-0.580	NR			
Metal Building	U-0.094	R-0 + R-9.8 c.i.	U-0.072	R-0 + R-13 c.i.	U-0.162	R-13			
Steel Framed	U-0.077	R-13 + R-5 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13			
Wood Framed and Other	U-0.089	R-13	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13			
Wall, below Grade									
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR			
Floors									
Mass	U-0.074	R-10 c.i.	U-0.074	R-10 c.i.	U-0.137	R-4.2 c.i.			
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19			
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19			
Slab-on-Grade Floors									
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR			
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.			
Opaque Doors									
Swinging	U-0.700		U-0.500		U-0.700				
Nonswinging	U-0.500		U-0.500		U-1.450				
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
Vertical Fenestration, 0%–40% of Wall		(for all frame types)		(for all frame types)		(for all frame types)			
Nonmetal framing, all	U-0.35			U-0.35			U-0.87		
Metal framing, fixed	U-0.50			U-0.50			U-1.20		
Metal framing, operable	U-0.60	SHGC-0.25	1.10	U-0.60	SHGC-0.25	1.10	U-1.20	NR	NR
Metal framing, entrance door	U-0.77			U-0.68			U-0.77		
Skylight, 0%–3% of Roof									
All types	U-0.55	SHGC-0.35	NR	U-0.55	SHGC-0.35	NR	U-1.70	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

IECC Prescriptive Requirements

Opaque Element

IECC 2015 Prescriptive R-values

IECC 2015 Prescriptive Ufactors

Climate Zone	2		3		2		3	
	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R
Insulation entirely above roof deck	R-25ci	R-25ci	R-25ci	R-25ci	U-0.039	U-0.039	U-0.039	U-0.039
Metal buildings	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	U-0.035	U-0.035	U-0.035	U-0.035
Attic and other	R-38	R-38	R-38	R-38	U-0.027	U-0.027	U-0.027	U-0.027
Mass ^d	R-5.7ci ^c	R-7.6ci	R-7.6ci	R-9.5ci	U-0.151	U-0.123	U-0.123	U-0.104
Metal Building	R-13 + R-6.5 ci	R-13+ R-13 ci	R-13 + R-6.5 ci	R-13 + R-13 ci	U-0.079	U-0.079	U-0.079	U-0.052
Metal Framed	R-13 + R-5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	U-0.077	U-0.064	U-0.064	U-0.064
Wood framed and other ^e	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	U-0.064	U-0.064	U-0.064	U-0.064
Below-grade wall ^f	NR	NR	NR	NR	C-1.140 ^a	C-1.140 ^a	C-1.140 ^a	C-1.140 ^a
Mass	R-6.3ci	R-8.3ci	R-10ci	R-10ci	U-0.107	U-0.087	U-0.076	U-0.076
Joist/Framing	R-30	R-30	R-30	R-30	U-0.033	U-0.033	U-0.033	U-0.033
Unheated slabs	NR	NR	NR	NR	F-0.73 ^a	F-0.73 ^a	F-0.73 ^a	F-0.73 ^a
Heated Slabs ^g	R-7.5 for 12" below	R-7.5 for 12" below	R-10 for 24" below	R-10 for 24" below	F-0.70	F-0.70	F-0.70	F-0.70
Nonswinging	R-4.75	R-4.75	R-4.75	R-4.75	F-0.61	F-0.61	F-0.61	F-0.61

ci = Continuous insulation, NR = No requirement, LS = Liner system.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-°F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. "Mass floors" shall include floors weighing not less than:

1. 35 pounds per square foot of floor surface area; or

2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

Opaque Doors, Swinging

Inspection Requirements

Verify that assembly U-value as stamped on product is no higher than the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Labeling of U-values on doors is not standard industry practice. It is often necessary to request documentation demonstrating compliance when no label is present on the installed product.

- ☑ *The 2015 IECC requires U-0.61 for all swinging doors in commercial buildings in CZs 2–3.*

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.70	U-0.50	U-0.70
3	U-0.70	U-0.50	U-0.70

Code reference ASHRAE 90.1-2013—Section 5.5.3.6



National Fenestration
Rating Council®
CERTIFIED

World's Best Door Co.

Entrance Door
CPD#000-x-000
Insulated Steel Wood Edge Door

ENERGY PERFORMANCE RATINGS				
Product Description* Default Frame** Wood	U-Factor/Solar Heat Gain Coefficient (SHGC)			
	1/4 Lite ≤410†	1/2 Lite ≤900†	3/4 Lite ≤1100†	Full Lite >1100†
2/A1/na/NI/0.250	0.23	0.30	—	0.40
2/A1/.020(3)/ARG/0.750	0.21	0.24	—	0.28
2/A1/na/NI/0.675	—	0.28	0.33	0.34
3/SS/na/NI/0.250	0.21	0.25	—	0.29
Flush/Embossed	U-Factor 0.19 SHGC 0.04			

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size.
* glazing layers / spacer type / low-e emissivity (surface) / gap fill / gap width (na—not applicable)
** per NFRC 100 Section B3.24 † square inches

www.nfrc.org

Opaque Doors, Non-Swinging

Inspection Requirements

Verify that assembly U-value as stamped on product is no higher than the values required by climate zone. Verify that the installed insulation value matches the COMcheck Compliance Certificate (if applicable).

Details

Labeling of U-values on doors is not standard industry practice. It is often necessary to request documentation demonstrating compliance when no label is present on the installed product.

- ☑ *The 2015 IECC requires R-4.75 for all non-swinging doors in commercial buildings in CZs 2–3.*

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.50	U-0.50	U-1.45
3	U-0.50	U-0.50	U-1.45

Code reference

ASHRAE 90.1-2013—Section 5.5.3.6



Vertical Glazing, 0%–40% of Wall Area

Inspection Requirements

Verify that the assembly U-value, SHGC, and VT/SHGC as listed on product or certificate comply with the values required by climate zone. Verify that the installed product values match the COMcheck Compliance Certificate (if applicable).

Details

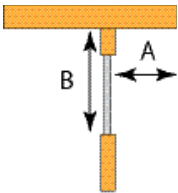
The prescriptive building envelope option is applicable only if the vertical fenestration area does not exceed 40% of the gross wall area for each space-conditioning category. Buildings with greater than 40% glazing must use COMcheck or Section 11 Energy Cost Budget performance pathway to show compliance.

Assembly U-value and SHGC can be verified either with a factory installed label or by a certificate from the manufacturer.

The SHGC target value of 0.25 in CZs 2–3 can be difficult to achieve with glazing performance alone. An overhang or shading device may improve the performance of the glazing.

The “projection factor” credit for an overhang can be calculated using values from the Table 5.5.4.4.1. This table value times the actual glass SHGC will yield a lower effective SHGC. COMcheck is generally the easiest way to receive credit for this external shading benefit of the 90.1 code. See example problem, p.25.

 World's Best Window Co. Millennium 2000® Vinyl-Clad Wood Frame Double Glazing - Argon Fill - Low E Product Type: Vertical Slider	
ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P) 0.30	Solar Heat Gain Coefficient 0.30
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance 0.51	Air Leakage (U.S./I-P) 0.2
Manufacturer requires that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not warrant any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.	



$PF = A/B$

Projection Factor (PF) and SHGC
 $PF =$ Ratio of overhang projection
divided by height from window
sill to bottom of overhang (must
be permanent)

Table 5.5.4.4.1 SHGC Multipliers for Permanent Projections

Projection Factor	SHGC Multiplier (non-North Orientations)	SHGC Multiplier (North Oriented)
0-0.10	1.0	1.0
>0.10-0.20	0.91	0.95
>0.20-0.30	0.82	0.91
>0.30-0.40	0.74	0.87
>0.40-0.50	0.67	0.84
>0.50-0.60	0.61	0.81
>0.60-0.70	0.56	0.78
>0.70-0.80	0.51	0.76
>0.80-0.90	0.47	0.75
>0.90-1.00	0.44	0.73

ASHRAE 90.1-2013 requires compliance with the Visible Transmittance to Solar Heat Gain Coefficient Ratio (VT/SHGC). The ratio must not be less than 1.1, the requirement specified in the following table.

In addition, section 5.5.4.5 of ASHRAE 90.1 prescriptively limits the east and west glazing area. To remain prescriptive, the area of the west glazing shall not exceed 25% of the total glazing area, and the area of the east glazing shall not exceed 25% of the total glazing area. If the proposed design cannot comply, COMcheck may be used to demonstrate a valid trade-off.

- ☑ *The 2015 IECC limits fenestration to 30% of the gross wall area when using the prescriptive pathway. (Continued on next page.)*
- ☑ *The 2015 IECC requires U-0.50 in CZ2 and U-0.46 in CZ3 for commercial building fixed fenestration. SHGC requirements are the same as ASHRAE (0.25) for glazing that faces south, east, and west. North-facing glazing has a separate SHGC requirement in the IECC. Projection factor is also credited differently by the IECC. See IECC Table C402.4 for details.*
- ☑ *The 2015 IECC does not require VT/SHGC ratio compliance.*

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.57, SHGC-0.25, VT/SHGC-1.10	U-0.57, SHGC-0.25, VT/SHGC-1.10	U-1.20, SHGC – NA, VT/SHGC - NA
3	U-0.50, SHGC-0.25, VT/SHGC-1.10	U-0.50, SHGC-0.25, VT/SHGC-1.10	U-1.20, SHGC – NA, VT/SHGC - NA

Prescriptive values above are for fixed metal framing (curtainwall or storefront). For other vertical glazing prescriptive values, refer to ASHRAE 90.1-2013, Tables 5.5-2 thru 5.5-4.

ASHRAE 90.1-2013—Section 5.5.4 & 5.8.2

CERTIFICATE OF COMPLIANCE		T.O. – Certificate of Compliance OVERALL RATING				
Certificate Authorization Name _____ Date _____		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;"> U-Factor: (max=0.30) </td> <td style="width: 50%; padding: 5px;"> _____ </td> </tr> <tr> <td style="padding: 5px;"> SHEG: </td> <td style="padding: 5px;"> _____ </td> </tr> </table>	U-Factor: (max=0.30)	_____	SHEG:	_____
U-Factor: (max=0.30)	_____					
SHEG:	_____					
Declaration: We hereby certify that the above information was obtained from the manufacturer of the product and is true and correct. We warrant that the product complies with the requirements of the applicable code and standards. We warrant that the product is suitable for the intended use. We warrant that the product is suitable for the intended use. We warrant that the product is suitable for the intended use.						
Signature _____		Date _____				
CERTIFICATE THAT THE MATERIALS LISTED ON THIS CERTIFICATE COMPLY WITH THE REQUIREMENTS OF THE APPLICABLE CODE AND STANDARDS.						
PROJECT INFORMATION:						

[illegible]

Example Compliance Certificate

Calculating Projection Factor (PF) and SHGC Problem

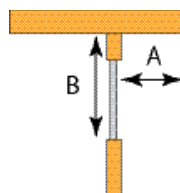
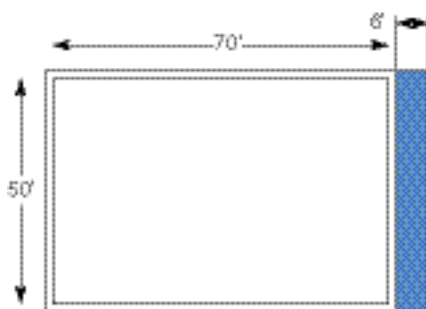
Small Retail Building

All metal curtain-wall glazing is on the Front (East) facade and shaded by a 6' overhang

Option 1: Glazing $U=0.50$, $SHGC=0.52$

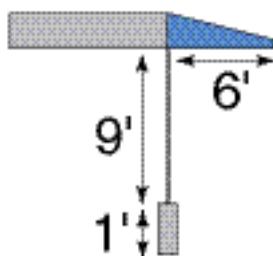
Option 2: Glazing $U=0.36$, $SHGC=0.44$

Does either option comply with the CZ3 prescriptive glazing requirements of 90.1?



$$PF = A/B$$

Projection Factor (PF) and SHGC
 PF = Ratio of overhang
 projection divided by height
 from window sill to bottom of
 overhang (must be permanent)



Solution to Glazing Example problem:

CZ3: Prescriptive Code max. U-factor for Fixed Metal Frame Fenestration is 0.50 and max. SHGC for glazing is 0.25.

Both Glazing Options 1&2 comply with Ufactor, however neither complies with SHGC using the glass alone.

Taking credit for $6'/9' = 0.67$ PF, the multiplier is 0.56 for East oriented glazing.

- Option 1 effective SHGC: $0.52 \times 0.56 = 0.29$ (does not comply with prescriptive 0.25)
- Option 2, effective SHGC: $0.44 \times 0.56 = 0.24$ (does comply with prescriptive 0.25 requirement)

[Note that either glazing could be credited with PF and traded to show compliance if COMcheck is used]

Prescriptive Fenestration Requirements

Table 5.5-2 Building Envelope Requirements for Climate Zone 2 (A,B)*

Fenestration	Nonresidential			Residential			Semiheated		
	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
<i>Vertical Fenestration, 0%-40% of Wall</i>	(for all frame types)			(for all frame types)			(for all frame types)		
Nonmetal framing, all	U-0.40			U-0.40			U-0.93		
Metal framing, fixed	U-0.57			U-0.57			U-1.20		
Metal framing, operable	U-0.65	SHGC-0.25	1.10	U-0.65	SHGC-0.25	1.10	U-1.20	NR	NR
Metal framing, entrance door	U-0.83			U-0.77			U-0.83		
<i>Skylight, 0%-3% of Roof</i>									
All types	U-0.65	SHGC-0.35	NR	U-0.65	SHGC-0.35	NR	U-1.80	NR	NR

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

Fenestration	Nonresidential			Residential			Semiheated		
	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC
<i>Vertical Fenestration, 0%-40% of Wall</i>	(for all frame types)			(for all frame types)			(for all frame types)		
Nonmetal framing, all	U-0.35			U-0.35			U-0.87		
Metal framing, fixed	U-0.50			U-0.50			U-1.20		
Metal framing, operable	U-0.60	SHGC-0.25	1.10	U-0.60	SHGC-0.25	1.10	U-1.20	NR	NR
Metal framing, entrance door	U-0.77			U-0.68			U-0.77		
<i>Skylight, 0%-3% of Roof</i>									
All types	U-0.55	SHGC-0.35	NR	U-0.55	SHGC-0.35	NR	U-1.70	NR	NR

CLIMATE ZONE	2		3	
Vertical fenestration				
U-factor				
Fixed fenestration	0.50		0.46	
Operable fenestration	0.65		0.60	
Entrance doors	0.83		0.77	
SHGC				
Orientation ^a	SEW	N	SEW	N
PF < 0.2	0.25	0.33	0.25	0.33
0.2 ≤ PF < 0.5	0.30	0.37	0.30	0.37
PF ≥ 0.5	0.40	0.40	0.40	0.40
Skylights				
U-factor	0.65		0.55	
SHGC	0.35		0.35	

Skylights, U-Factor and SHGC

Inspection Requirements

Verify that the assembly U-value as listed on product is no higher than the values required by climate zone. Verify that the installed product U-factor and SHGC values match the COMcheck Compliance Certificate (if applicable).

Details

Assembly U-value and SHGC can be verified either with a factory installed label or by a certificate from the manufacturer.

- ☒ *Prescriptive values for skylight U-factor and SHGC are the same for 2015 IECC (Table C402.4).*

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.65, SHGC-0.35	U-0.65, SHGC-0.35	U-1.80
3	U-0.55, SHGC-0.35	U-0.55, SHGC-0.35	U-1.7

Prescriptive values above are for skylights comprising less than 3% of roof area per space category.

Code reference

ASHRAE 90.1-2013—Section 5.5.4 & 5.8.2



Skylights, Maximum and Minimum Fenestration Area

Inspection Requirements

Verify that skylight maximum and minimum area is compliant.

Details

ASHRAE 90.1-2013 generally limits total skylight maximum area to 0–3% of the total roof area for each space-conditioning category. Buildings may be allowed up to 6% skylight area provided they have the following:

- Haze value > 90%
- VT > 0.40
- Multilevel photocontrols for fixtures in their daylit zones
- Total skylight daylit area $\geq$ half the space floor area

Additionally, ASHRAE 90.1-2013 requires some buildings to have a minimum skylight area. This minimum area is described in Section 5.5.4.2.3 and applies to spaces in buildings which:

1. Are 2,500 sq. ft. or larger
2. Have ceilings with a height greater than 15 feet

Applicable space types include office, lobby, atrium, concourse, corridor, storage (including nonrefrigerated warehouse), gymnasium and gymnasium seating area, fitness/exercise area, playing area, convention exhibit/event space, courtroom, automotive service, fire station engine room, manufacturing corridor/transition and bay areas, retail, library reading and stack areas, distribution/sorting area, transportation baggage and seating areas, and workshops.

- ☑ *The 2015 IECC limits skylights to 3% gross roof area. See section C402.4 for details.*
- ☑ *The 2015 IECC also has a minimum skylight area of 3% for spaces greater than 2,500 sq. ft. with ceilings higher than 15 feet. See IECC section 402.4.2 for details.*

Code reference

ASHRAE 90.1-2013—Section 5.5.4 & 5.8.2

Labeled Fenestration

Inspection Requirements

Verify that windows and skylights are labeled and certified by the manufacturer for U-factor, SHGC, air leakage rate, and visual transmittance.

Details

A compliance certificate from the manufacturer is also acceptable documentation.

Code reference

ASHRAE 90.1-2013—Sections 5.8.2.3–5.8.2.5

CERTIFICATE of COMPLIANCE

10.0 – Certificate of Compliance

Certificate Authorization

Name: _____ Company: _____

Signature: _____ Date: _____

OVERALL RATING

U-Factor:
($Btu/h \cdot ft^2 \cdot F$)

SHGC:

Directions: Fill out form completely. Determine the Overall Rating for this project by using the C.O.G. U-Factor and C.O.G. SHGC from Table 1 and looking up the overall rating from Table 2. Indicate the Overall Rating in the space above. Linear interpolation is permitted.

CERTIFIES THAT THE MATERIALS LISTED ON THIS CERTIFICATE WERE INSTALLED ON THE PROJECT IDENTIFIED BELOW.

PROJECT INFORMATION:

Street Address: _____

City: _____ State: _____ Zip: _____

GLAZING CONTRACTOR / INSTALLER:

Street Address: _____ Contact Person: _____

City: _____ Phone Number: _____

State: _____ Zip: _____

GLAZING MATERIAL SUPPLIER:

Street Address: _____ Contact Person: _____

City: _____ Phone Number: _____

State: _____ Zip: _____

Glass and Spacer Type: _____

Center-of-glass (C.O.G.) U-Factor: _____ Center-of-glass (C.O.G.) SHGC: _____

$Btu/h \cdot ft^2 \cdot F$

FRAMING MATERIAL SUPPLIER:

Street Address: _____ Contact Person: _____

City: _____ Phone Number: _____

State: _____ Zip: _____

U-Factor Matrix ($Btu/h \cdot ft^2 \cdot F$)

C.O.G. U-Factor	OVERALL U-Factor	C.O.G. SHGC	OVERALL SHGC
0.48	0.69	0.75	0.67
0.46	0.67	0.70	0.63
0.44	0.65	0.65	0.59
0.42	0.64	0.60	0.54
0.40	0.62	0.55	0.50
0.38	0.61	0.50	0.46
0.36	0.59	0.45	0.41
0.34	0.58	0.40	0.38
0.32	0.56	0.35	0.32
0.30	0.54	0.30	0.29
0.28	0.53	0.25	0.23
0.26	0.51	0.20	0.19
0.24	0.49	0.15	0.14
0.22	0.58	0.10	0.10
0.20	0.58	0.05	0.06

SHGC Matrix

Product Line: **YES 45 TU**

The overall ratings for U-factor and SHGC are based on a size of 2000 mm x 2000 mm (79 3/4 in x 79 3/4 in) as required in NFRC 100.

Overall U-factors and Solar Heat Gain Coefficients (SHGC) listed in the matrix were determined in accordance with NFRC 100 and NFRC 200 respectively by a NFRC accredited laboratory.

ACCREDITED LABORATORY:

Architectural Testing

Reference Test Report #: 76081.01-116-45

Unlabeled Fenestration Products

Inspection Requirements

Verify that fixed windows and skylights and other vertical fenestration (operable and fixed) that are unlabeled by the manufacturer have been site-labeled using the default U-factor and SHGC. Verify that no credit has been given for metal frames with thermal breaks, low-emissivity coatings, gas fillings, or insulating spacers.

Details

Unlabeled fenestration is required to use the default U-factor and SHGC. These default values are poor and will not comply with the Prescriptive Path values.

Code reference

ASHRAE 90.1-2013—A8.1, A8.2, & 5.8.2.5

TABLE A8.2 Assembly U-Factors, Assembly SHGCs, and Assembly Visible Light Transmittances (VLTs) for Unlabeled Vertical Fenestration

Frame Type	Glazing Type	Unlabeled Vertical Fenestration					
		Clear Glass			Tinted Glass		
		U-Factor	SHGC	VLT	U-Factor	SHGC	VLT
All frame types	Single glazing	1.25	0.82	0.76	1.25	0.70	0.58
	Glass block	0.60	0.56	0.56	n.a.	n.a.	n.a.
Wood, vinyl, or fiberglass frames	Double glazing	0.60	0.59	0.64	0.60	0.42	0.39
	Triple glazing	0.45	0.52	0.57	0.45	0.34	0.21
Metal and other frame types	Double glazing	0.90	0.68	0.66	0.90	0.50	0.40
	Triple glazing	0.70	0.60	0.59	0.70	0.42	0.22

Insulation in Attics

Inspection Requirements

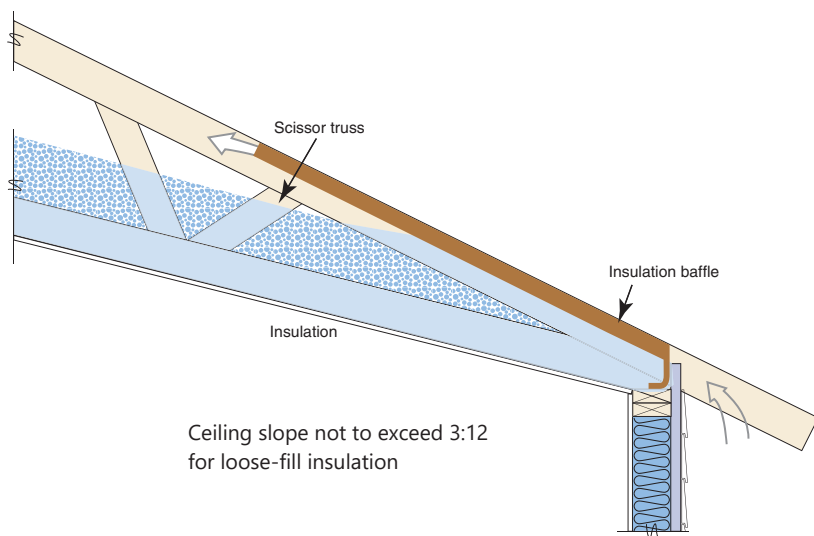
Verify that open-blown or poured loose-fill insulation is not used in attic roof spaces over ceilings with slope greater than 3:12. Insulation must be left exposed for inspection.

Details

Loose-fill insulation (open-blown or poured) can only be used on a ceiling slope of 3:12 or less. When the slope exceeds 3:12, loose-fill insulation is not acceptable.

Code reference

ASHRAE 90.1-2013—Section 4.2.4 & Section 5.8.1.3



Vent Baffles in Attics

Inspection Requirements

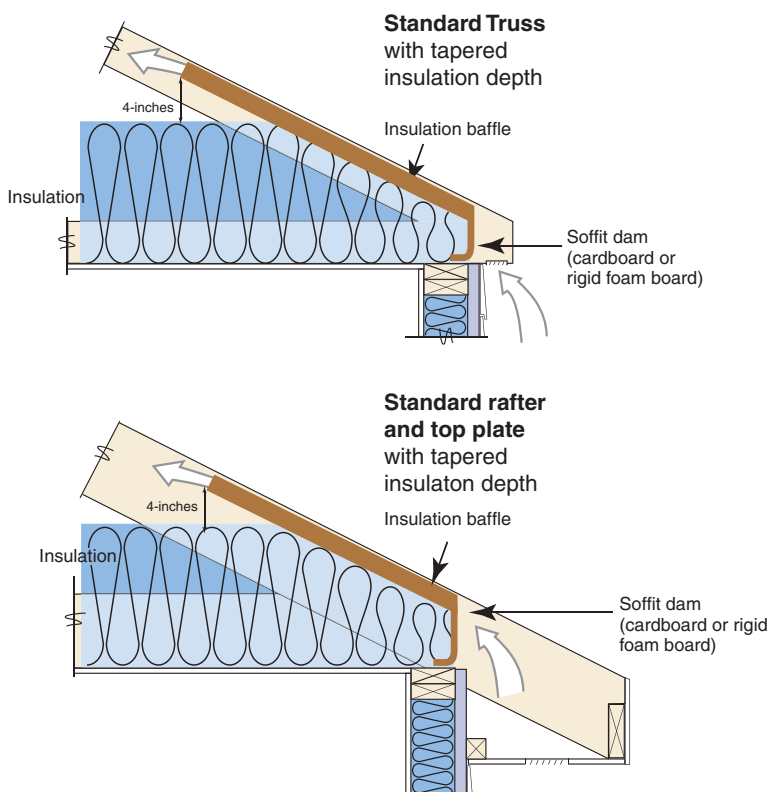
Verify that baffles are installed to deflect incoming air above insulation wherever vents are located.

Details

ASHRAE 90.1-2013 requires that vent baffles be installed to direct wind/air over the insulation (because batt and loose insulation can be blown out of place by wind passing through vents). Also, the resistance to energy transfer by batt and loose insulation is greatly diminished by convective air flow (often referred to as “wind-washing”).

Code reference

ASHRAE 90.1-2013—Section 5.8.1.4 & 5.8.2.5



Insulation, Substantial Contact

Inspection Requirements

Verify that insulation is installed in direct contact with an air barrier (solid surface or sheet material).

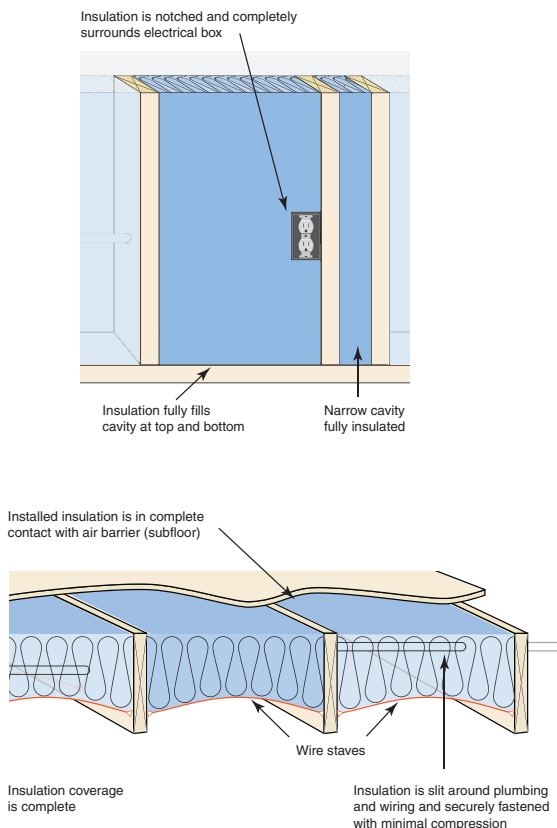
Details

Insulation must be installed in a permanent contact with the inside surface in accordance with manufacturer's recommendations for the type of framing system used.

Batt insulation installed in floor cavities must be supported in a permanent manner. Support spacing can be no greater than 24 inches on center.

Code reference

ASHRAE 90.1-2013—Section 5.8.1.5



Insulation Thickness

Inspection Requirements

Verify that recessed lights, equipment, and ducts do not affect insulation thickness.

Details

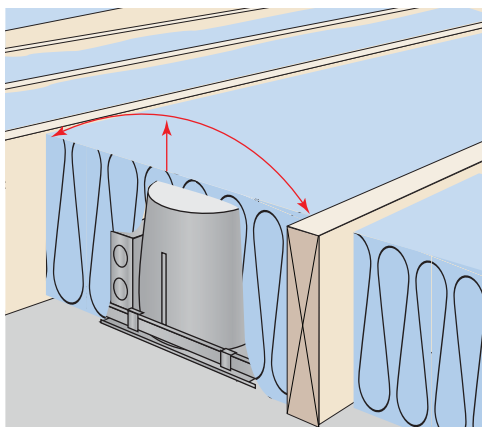
The installed insulation must maintain the proper thickness above can lights, below ducts, and wherever equipment is placed in an attic.

Insulation must not be compressed or reduced because of equipment. Batt and loose insulation will not meet prescribed R-values when compressed. Recessed lighting in an insulated ceiling should be airtight and insulation contact (IC) rated.

- ☑ *The 2015 IECC also requires airtight, IC-rated can lights to be installed in insulated ceilings.*

Code reference

ASHRAE 90.1-2013—Section 5.8.1.6



Suspended Ceilings

Inspection Requirements

Verify that roof insulation is not installed on a suspended ceiling with removable ceiling panels.

Details

The ASHRAE 90.1 standard does not allow insulation on suspended ceilings as part of the building's thermal envelope. Suspended ceilings are not an effective air barrier. Additionally, insulation supported by a suspended ceiling will often be disturbed by maintenance activities, which decreases effectiveness.

- ☑ *The 2015 IECC also does not allow insulation on suspended ceilings as part of the building's thermal envelope.*

Code reference

ASHRAE 90.1-2013—Section 5.8.1.8



Envelope insulation may not be installed on top of suspended ceiling panels. Drop/suspended ceilings may be insulated for sound, but that insulation cannot be counted as part of the roof insulation R-value.

Exterior Insulation Protection

Inspection Requirements

Verify that all exterior insulation is covered with protective material.

Details

Exterior insulation must be protective with a material that will prevent damage from sunlight, moisture, landscaping, maintenance, and wind.

Attics and mechanical rooms must provide easy access to equipment and prevent damage or compression of the insulation when accessing the space.

Foundation vents must not interrupt the insulation. Insulation materials in ground contact shall have a water absorption rate no greater than 0.3%.

Code reference

ASHRAE 90.1-2013—Section 5.8.1.7



Exterior insulation must be protected by a cladding system. Some examples are EIFS, stucco, brick veneer, lap siding, and metal or cementitious panels.

Air Sealing

Inspection Requirements

Verify mandatory air barrier materials/assemblies. Acceptable materials:

- 3/8" plywood or OSB
- 1/2" XPS or foil faced urethane foam board
- 1/2" gypsum or cement board
- Built up, modified bitumen, or fully adhered single ply roof membranes
- 1/2" cement/sand parge, stucco or gypsum plaster
- Concrete
- Sheet metal
- 1" closed cell foam
- CMU that is either fully grouted or painted.

Verify that all joints and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.

Details

Openings in the building thermal envelope (penetrations of the air barrier) can be sources of considerable air leakage, resulting in major loss of conditioned air and introduction of unfiltered outside air. The following areas of the building envelope must be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

- Joints around fenestration and door frames
- Junctions between walls at building corners and between walls and foundations, structural floors or roofs, roof or wall panels
- Openings at penetrations of utility services through roofs, walls, and floors
- Site-built fenestration and doors
- Building assemblies used as ducts or plenums
- Joints, seams, and penetrations of vapor retarders
- All other openings in the building envelope

Pay special attention to roof wall connections and any junctions hidden by suspended ceilings or chases.

- ☑ *The 2015 IECC (Section C402.5) requires commercial buildings to create an air-sealed thermal envelope. Like ASHRAE, the IECC has requirements for acceptable air barrier materials and construction methods.*

Code reference

ASHRAE 90.1-2013—Section 5.4.3.1.2



Fenestration Air Leakage Certification

Inspection Requirements

Verify that windows, doors, and skylights are certified as meeting air-leakage requirements.

Details

Fenestration air leakage must be labeled on the product. If air leakage information is not labeled on product, it must be provided by the manufacturer.

- ☑ *The 2015 IECC (Section C402.5) also requires labeling of fenestration for air leakage.*

Code reference

ASHRAE 90.1-2013—Section 5.4.3.2

 National Fenestration Rating Council® CERTIFIED	World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider		
ENERGY PERFORMANCE RATINGS			
U-Factor (U.S./I-P)		Solar Heat Gain Coefficient	
0.30		0.30	
ADDITIONAL PERFORMANCE RATINGS			
Visible Transmittance		Air Leakage (U.S./I-P)	
0.51		0.2	
Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org			

Component Labels and Supporting Documentation

Inspection Requirements

Verify that all envelope component R-values and U-factors are labeled as certified or that 'other' components have supporting documentation for proposed U-factors.

Details

For certain assemblies—including built-up wall, roof, or floor—make sure each component (such as plywood sheathing or brick) is labeled or that some documentation is provided to demonstrate compliance.

Code reference

ASHRAE 90.1-2013—Section A1.1

TABLE A3.1-1 Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft ³ Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft ³ Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft ³ Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	R-0	U-0.740	U-0.580	U-0.480
	UngROUTed Cores Filled with Loose-Fill Insulation	NA	NA	U-0.350
Continuous Metal Framing at 24 in. on Center Horizontally				
1.0 in.	R-0	U-0.414	U-0.359	U-0.318
1.0 in.	R-3.8	U-0.325	U-0.290	U-0.263
1.0 in.	R-5	U-0.314	U-0.281	U-0.255
1.0 in.	R-6.5	U-0.305	U-0.274	U-0.249
1.5 in.	R-11	U-0.267	U-0.243	U-0.223
2.0 in.	R-7.6	U-0.230	U-0.212	U-0.197
2.0 in.	R-10	U-0.219	U-0.202	U-0.188
2.0 in.	R-13	U-0.210	U-0.195	U-0.182
3.0 in.	R-11.4	U-0.178	U-0.167	U-0.157
3.0 in.	R-15	U-0.168	U-0.158	U-0.149
3.0 in.	R-19.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-11.0	U-0.168	U-0.158	U-0.149
3.5 in.	R-13.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-15.0	U-0.155	U-0.147	U-0.140

Vestibules

Inspection Requirements

Verify that building entrances are constructed as required. Note that buildings in CZ2 are exempt from vestibule requirements.

Details

Vestibules reduce the loss of conditioned air when exterior doors are open. Building entrances are defined in ASHRAE Section 3.2 as “the means ordinarily used to gain access to the building.” Therefore, exits from fire stairwells, handicapped access doors, and access to mechanical/electrical rooms are not considered building entrances.

Building entrances separating conditioned space from the exterior must be protected with an enclosed vestibule. All doors opening into and out of the vestibule must be equipped with self-closing devices. Vestibules must be designed so that—when a person passes through the vestibule—the interior and exterior doors do not open at the same time. Interior and exterior doors in the closed position shall be no less than 7 feet apart.



The exterior envelope (glazing) of conditioned vestibules must meet the requirements for thermal performance of fenestration required by climate zone. The interior and exterior envelope of unconditioned vestibules must comply with the requirements of a semi-heated space.

There are some exceptions to these requirements:

- Building entrances with revolving doors
 - Doors not intended to be used as a building entrance
 - Doors opening directly from a dwelling unit
 - Building entrances in buildings located in CZ2
 - Building entrances in buildings located in CZ3 that are less than four stories above grade and < 10,000 sq. ft. in area
 - Doors that open directly from a space that is < 3000 sq. ft. in area and is separate from the building entrance
- ☑ *The 2015 IECC (C402.5.7) requires all commercial buildings to have vestibules on primary entrances unless the building or space qualifies for one of the following exceptions: buildings in CZs 1-2; doors not for use by the public; doors opening from a dwelling unit; doors from a space < 3000 sq. ft.; revolving doors; and use of air curtains.*

Code reference

ASHRAE 90.1-2013—Section 5.4.3.4

Scope of Simplified Approach Option for HVAC Systems

Approach

The simplified approach is an optional path for compliance within ASHRAE 90.1. This approach involves 18 requirements, which are detailed on the following pages.

Buildings may comply with the mechanical section of ASHRAE 90.1 when the following conditions are met:

- a. Building is two stories or fewer in height.
- b. Gross floor area is less than 25,000 sq. ft.
- c. Each HVAC system in the building must comply with the 18 requirements.

Code reference

ASHRAE 90.1-2013—Section 6.3



This small commercial office building is an excellent candidate for the simplified compliance approach.

1. Single Zone

Inspection Requirements

Verify that each system serves a single HVAC zone.

Details

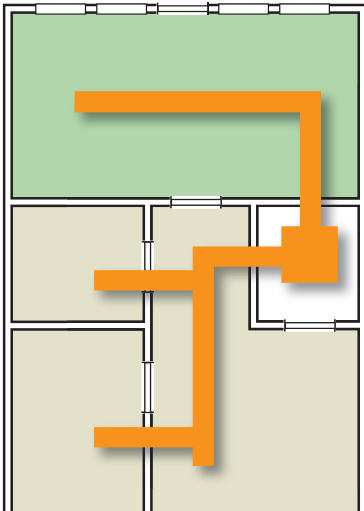
An HVAC zone is a space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g., temperature) can be maintained throughout using a single sensor (e.g., thermostat or temperature sensor).

Each system should have only one thermostat. Multi-zone mechanical systems would not meet this requirement (and would thus not be able to show compliance using the Simplified Approach), but separate mechanical systems serving each zone would.

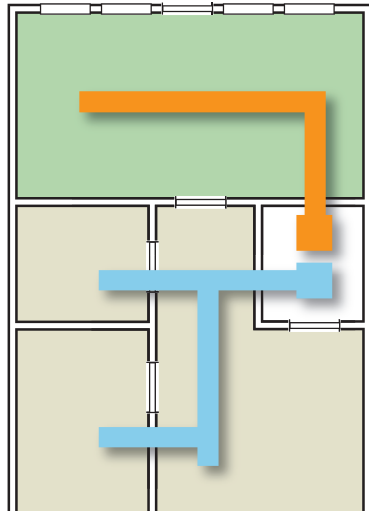
Code reference

ASHRAE 90.1-2013—Section 6.3.2

Improperly zoned spaces



Properly zoned spaces



2. Variable Flow Equipment

Inspection Requirements

Verify that variable fan speed equipment meets control requirements of Section 6.5.3.2.1.

Details

DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control. The following rules apply:

- Low or minimum speed shall not exceed 66% of full speed.
- At low or minimum speed, the fan system shall draw no more than 40% of the fan power at full fan speed.
- Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

All other units—including DX cooling units and chilled-water units that control the space temperature by modulating airflow—shall have modulating fan control. The following rules apply:

- Minimum speed shall not exceed 50% of full speed.
- At minimum speed, the fan system shall draw no more than 30% of the power at full fan speed.
- Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

Units that include an air-side economizer to meet the requirements of Section 6.5.1 shall have a minimum of two speeds of fan control during economizer operation.

Some exceptions are made when ASHRAE 62.1 requirements necessitate larger volumes of outside air or for low-power fans. See Section 6.5.3.2.1 for full exception details.

Code reference

ASHRAE 90.1-2013—Section 6.3.2

3. Cooling Equipment

Inspection Requirements

Verify that construction documents indicate air-cooled or evaporatively cooled equipment meet minimum efficiencies. For example, a 5-ton or smaller heat pump or air conditioner must be a minimum 13.0 SEER while a 10-ton unit must be at least 11.2 EER and 12.9 IEER. Verify that field installation matches construction documents. Note: Evaporatively cooled equipment is rarely used in the Southeast.

Details

Cooling shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled, with efficiency meeting the requirements shown in ASHRAE 90.1-2013, Table 6.8.1-1 (air conditioners), Table 6.8.1-2 (heat pumps), or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps) for the applicable category.

Code reference ASHRAE 90.1-2013—Section 6.3.2,
Table 6.8.1-1, Table 6.8.1-2, or Table 6.8.1-4

TABLE 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—
Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure ^a
Air conditioners, air cooled	<65,000 Btu/h ^b	All	Split system	13.0 SEER	AHRI 210/240
			Single package	13.0 SEER (before 1/20/15) 14 SEER (as of 1/1/2015)	
Through the wall, air cooled	≤30,000 Btu/h ^b	All	Split system	12.0 SEER	
			Single package	12.0 SEER	
Small duct high velocity, air cooled	<65,000 Btu/h ^b	All	Split System	11.0 SEER	
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.2 EER 11.4 IEER (before 1/1/2016) 12.9 IEER (as of 1/1/2016)	
		All other	Split system and single package	11.0 EER 11.2 IEER (before 1/1/2016) 12.7 IEER (as of 1/1/2016)	



4. Economizers

Inspection Requirements

Verify that economizer functions are installed and properly functioning as required by Section 6.5.1. Note: Economizers are now required for most commercial buildings in CZs 2–3.

Details

ASHRAE 90.1-2013 now requires economizers for systems > 5 tons in CZs 2–3. (This is a significant change from the previous Alabama commercial energy code. Many more commercial buildings now require economizers.)

The HVAC system shall have an air economizer where indicated in Table 6.5.1 (equipment 5 tons and larger in CZs 2A–3A), with controls as indicated in Table 6.5.1.1.3 and with either barometric or powered relief which is sized to prevent over-pressurization of the building. Outdoor air dampers for economizer use shall be provided with blade and jamb seals.

There are 10 exceptions, including for systems in certain types of computer rooms, healthcare facilities, and supermarkets. See Section 6.5.1 for details.

Computer room economizers are never required in CZs 2–3. (See Table 6.5.1-2.)

The use of an economizer may be traded off with more efficient equipment. In CZ2, economizer controls can be eliminated by using equipment that is 17% more efficient than the minimum; in CZ3, the threshold is 27%. (See Table 6.5.1-3.)

Code reference

ASHRAE 90.1-2013—Section 6.3.2 & 6.5.1

Summary of Table 6.5.1 Economizer Exceptions:

1. Equipment < 5 tons
2. Non-particulate air treatment systems
3. Hospitals and surgery centers
4. Ample condenser heat recovery systems
5. Small capacity residential systems
6. Sensible load is small compared to 60F
7. Systems operating < 20 hours / week
8. Supermarkets and refrigerated cases
9. More efficient equipment (37% in CZ3A)
10. Most systems serving computer rooms
11. Dedicated computer room systems



5. Heating Equipment

Inspection Requirements

Verify that construction documents indicate heating equipment meets minimum efficiencies.

Verify that field installation matches construction documents.

Details

Heating must be provided by one of the following:

- Unitary packaged or split-system heat pump that meets applicable efficiency requirements shown in Table 6.8.1-2 (heat pumps) or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps)
- Fuel-fired furnace that meets applicable efficiency requirements shown in Table 6.8.1-5 (furnaces, duct furnaces, and unit heaters)
- Electric resistance heater
- Baseboard system connected to a boiler that meets applicable efficiency requirements shown in Table 6.8.1-6 (boilers)

Code reference

ASHRAE 90.1-2013—Section 6.3.2,
Table 6.8.1A, Table 6.8.1B or Table 6.8.1D;
Table 6.8.1-2 (heat pump requirements)

6. Exhaust Air Energy Recovery

Inspection Requirements

Verify that energy recovery is installed for exhaust air systems as required.

Details

The system shall meet the exhaust air energy recovery requirements of Section 6.5.6.1.

Each fan system shall have an energy recovery system when the system's supply airflow rate exceeds the value listed in Tables 6.5.6.1-1 and 6.5.6.1-2, based on the climate zone and percentage of outdoor airflow rate at design conditions. In general, this means very large systems, systems with a large volume of outdoor air, or systems which run more than 8,000 hours per year.

Table 6.5.6.1-1 is used for all ventilation systems that operate less than 8,000 hours per year. Table 6.5.6.1-2 is used for all ventilation systems that operate 8,000 or more hours per year.

Energy recovery systems must have at least 50% energy recovery effectiveness. Fifty percent energy recovery effectiveness means a change in the enthalpy of the outdoor air supply equal to 50% of the difference between the outdoor air and return air enthalpies at design conditions.

Provisions must be made to bypass or control the energy recovery system to permit air economizer operation as required by Section 6.5.1.1.

Code reference

ASHRAE 90.1-2013—Section 6.3.2

TABLE 6.5.6.1-1 Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Less Than 8,000 Hours per Year

% Outdoor air at full design airflow rate	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
Design supply airflow rate (cfm) for CZs 2–3	≥26,000	≥16,000	≥5,500	≥4,500	≥3,500	≥2,000	≥1,000	≥0

TABLE 6.5.6.1-2 Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Greater Than or Equal to 8,000 Hours per Year

% Outdoor air at full design airflow rate	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
Design supply airflow rate (cfm) for CZs 2–3	≥2,500	≥2,000	≥1,000	≥500	>0	>0	>0	>0

7. Thermostat Controls

Inspection Requirements

Verify that the system is controlled by a manual changeover or dual setpoint thermostat.

Details

A typical programmable thermostat will meet these requirements because the control requires the user to manually switch from heating to cooling.

Code reference ASHRAE 90.1-2013—Section 6.3.2



8. Supplemental Heat

Inspection Requirements

Verify that heat pump supplemental heat function (auxiliary electric resistance) has a proper lockout control system. This requirement is only applicable if heat pumps are installed. If so, projects must use some control device (such as an outdoor temperature lockout device) capable of restricting supplemental auxiliary resistance heat from operating when the heat pump compressor can meet the load.

Details

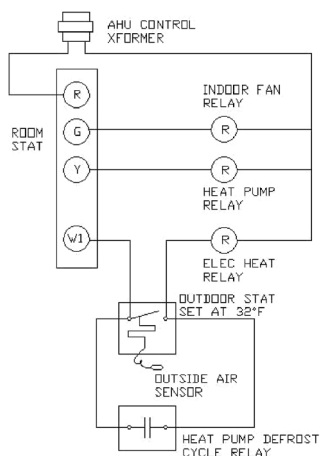
Heat pumps with auxiliary electric resistance heat must have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone. Supplemental heater operation is permitted during outdoor coil defrost cycles. The heat pump must be controlled by either:

1. A digital or electronic thermostat designed for heat-pump use that energizes auxiliary heat only when the heat pump has insufficient capacity to maintain setpoint or to warm up the space at a sufficient rate; OR,
2. A multistage space thermostat and an outdoor air thermostat wired to energize auxiliary heat only on the last stage of the space thermostat and when outdoor air temperature is less than 40°F.

There is an exception for some NAECA-certified equipment.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



Sample Wiring Schematic for Electric Heat Lockout on Heat Pumps

9. Reheat

Inspection Requirements

Verify that the system controls do not permit reheat or any other form of simultaneous heating and cooling for humidity control.

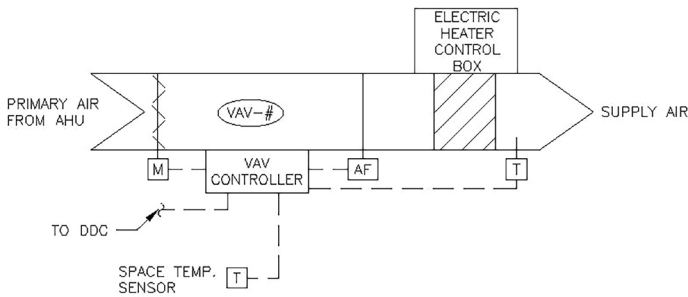
Details

A system may not cool then reheat air to control humidity. An example of this is commonly seen in schools where a 100% outside air rooftop unit cools then reheats air.

In general, reheat is banned (with a few exceptions such as site-solar energy) as more efficient means of dehumidification are available. If reheat is desired for humidity control, the Prescriptive Path must be used to demonstrate compliance.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



1
M502.0

TYPICAL VAV BOX WITH
ELECTRIC REHEAT CONTROL DIAGRAM
SCALE: NONE

Reheat is prohibited by the Simplified approach and has limited applications in the Prescriptive approach.

10. Timeclock Control

Inspection Requirements

Verify that appropriate timeclock controls have been installed.

Details

Systems with a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than 0.75hp must have a timeclock control that satisfies the following five requirements:

1. Can start and stop the system under different schedules for seven different day types per week
2. Is capable of retaining programming and time setting during a loss of power for a period of at least ten hours
3. Includes an accessible manual override that allows temporary operation of the system for up to two hours
4. Is capable of temperature setback down to 55°F during off-hours
5. Is capable of temperature setup to 90°F during off-hours

Hotel/motel guestrooms and spaces requiring continuous operation are exempted.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



11. Pipe Insulation

Inspection Requirements

Verify that insulation on piping is properly installed and protected.

Note: Refrigerant piping requires insulation, and insulation must be protected from the elements (e.g., wind, rain, solar UV).

Details

HVAC piping must be insulated according to Tables 6.8.3-1 and 6.8.3-2. Insulation exposed to weather must be protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation must be protected as above or painted with a coating that is water resistant and provides shielding from solar radiation.

Piping within manufacturer's units is exempt.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



12. Duct Insulation

Inspection Requirements

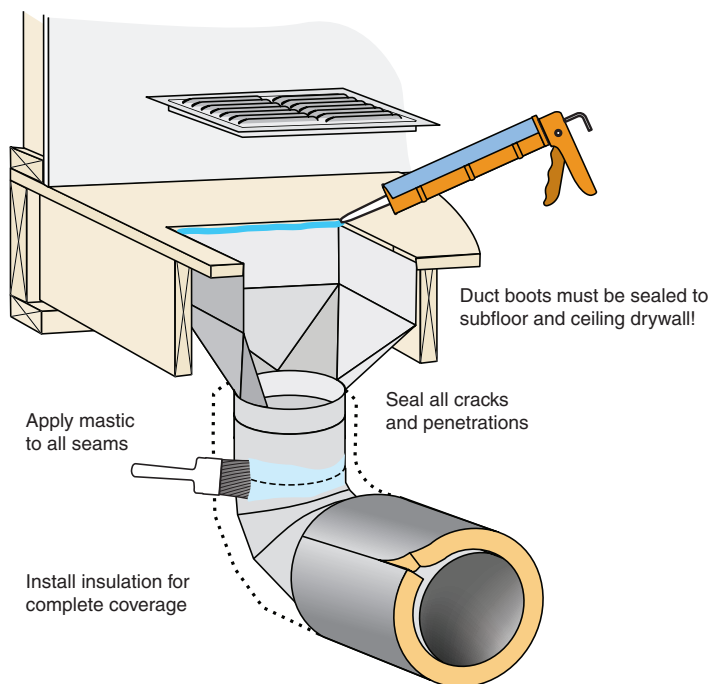
Verify that ductwork and plenums are insulated and sealed as required. R-6 will satisfy all conditions in CZs 2–3. Be sure the duct air barrier (liner, duct board, etc.) has been air sealed by performing a visual inspection of the duct system's collars, connectors, seams, and plenums.

Details

Ductwork and plenums must be insulated according to Tables 6.8.2-1 and 6.8.2-2. Ductwork must be sealed according to Section 6.4.4.2.1.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



13. Air Balancing Report

Inspection Requirements

Verify that construction documents require an air-balance report to be provided to the building owner (or representative) for all HVAC systems. Request report at final mechanical inspection.

Details

Construction documents shall require a ducted system to be air balanced according to industry-accepted procedures. Typically, this measured air flow is within 10% of the design CFM.

Code reference ASHRAE 90.1-2013—Section 6.3.2

Sample test and balance report

AIRE-BAL

AIR MOVING EQUIPMENT TEST SHEET

Project: Chastain Tennis Center Location: Fulton Co., GA Date: 8/23/10

Unit No.	AHU-1		DH-1	
Location	Mechanical Room		Mechanical Room	
Manufacturer	Trane		Honeywell	
Model No.	4TEE3F65B1000		DH150	
Serial No.	100831331V		D1009764	
Operating Conditions	Specified	Actual	Specified	Actual
Total CFM	1820	1835	---	---
Return CFM	1420	1442	---	---
O.S.A. CFM	400	393	---	---
Ext. S.P.	.60"	.71"	---	.27"
Suction Press.	---	.49"	---	.43"
Disch. Press.	---	.22"	---	-.16"
Fan Sheave	---	D.D.	---	D.D.
Motor Sheave	---	D.D.	---	D.D.
Belts	---	D.D.	---	D.D.
Motor Manuf.	---	G.E.	---	G.E.
Motor Size	1.0	1.0	160W	160W
Voltage	208	207	120	120
Phase	1	1	1	1
Motor RPM	MED	MED/HI	HIGH	HIGH
Operating Conditions	Rated	Running	Rated	Running
Amperage	7.0	2.4	1.4	1.0
Fan RPM	MED	MED/HI	HIGH	HIGH

14. Automatic Dampers

Inspection Requirements

Verify that ventilation and exhaust systems have a gravity or motorized damper as required.

Details

Outdoor air intake and exhaust systems shall meet the requirements of Section 6.4.3.4.

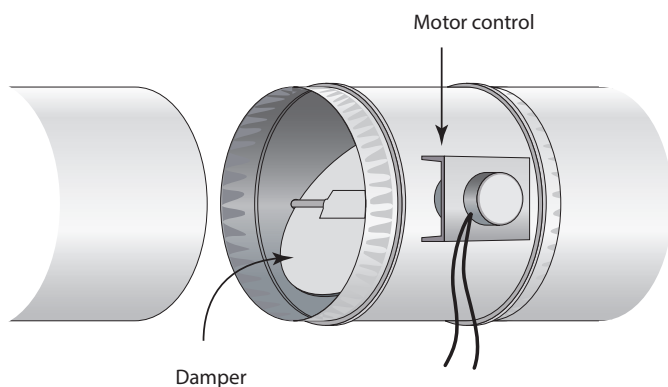
All outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use.

Non-motorized backdraft gravity dampers are acceptable for exhaust and relief in buildings fewer than three stories and for ventilation air intakes and exhaust/relief dampers in buildings of any height located in CZs 2–3 and in systems with a design outdoor air intake or exhaust capacity of 300 cfm or less.

Dampers are not required in ventilation or exhaust systems serving unconditioned spaces or in exhaust systems serving “Type 1” kitchen hoods.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



15. Interlocked Thermostats

Inspection Requirements

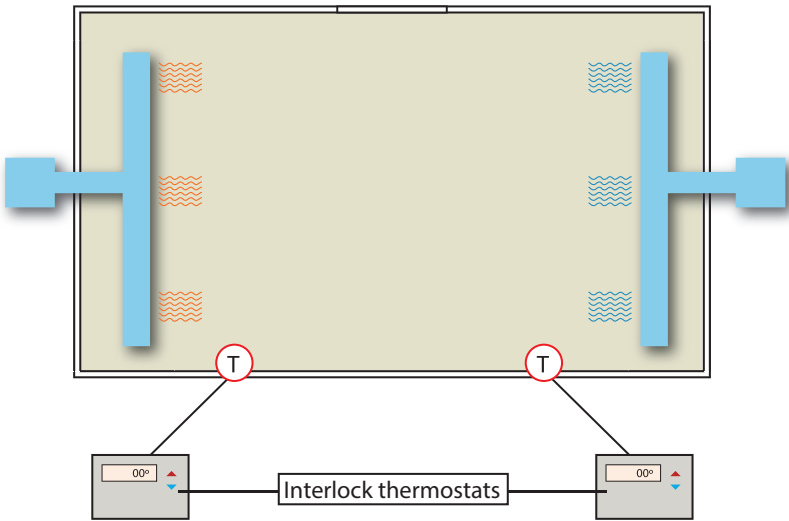
Verify that thermostat systems in the same zone have the ability to be interlocked. An example where this would be applicable is a conference room served by two systems. The system controls must be interlocked to prevent heating by one unit and cooling by another at the same time.

Details

Where separate heating and cooling equipment serves the same space or zone, thermostats must be interlocked to prevent simultaneous heating and cooling.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



Interlocked thermostats prevent simultaneous heating and cooling by separate systems

16. Optimum Start Controls

Inspection Requirements

Verify that systems with a design supply air capacity > 10,000 cfm have optimum start controls.

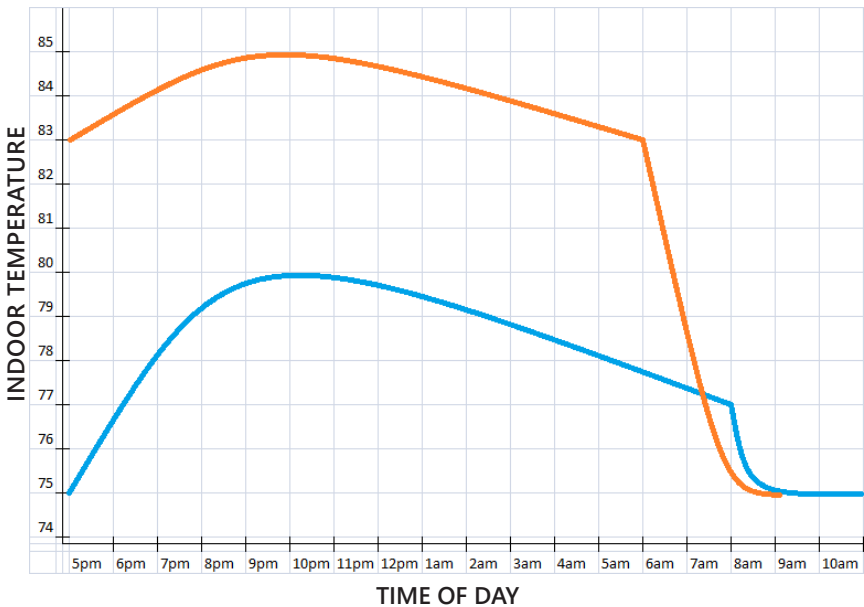
Details

Systems with a design supply air capacity greater than 10,000 cfm shall have optimum start controls.

A 10,000 cfm system will typically be 25 cooling tons or larger. These systems require a smart thermostat or control system to provide optimum start capability. Sometimes referred to as “adaptive learning,” these controls are designed to automatically adjust the start time of an HVAC system each day with the intention of bringing the space to the desired occupied temperature levels immediately before scheduled occupancy. For example, a building that is set back over the weekend will likely require a different (earlier) start time for the system to recover on Monday morning than on other weekdays.

Code reference ASHRAE 90.1-2013—Section 6.3.2

Cooling Season Optimum Start Recovery



17. Demand-Controlled Ventilation

Inspection Requirements

Verify that demand-controlled ventilation systems are installed as required.

Details

Demand-control ventilation (DCV) is required for spaces that are larger than 500 sq. ft. and have a design occupancy for ventilation of greater than 25 people per 1000 sq. ft. of floor area. In addition, these spaces must be served by systems with one or more of the following:

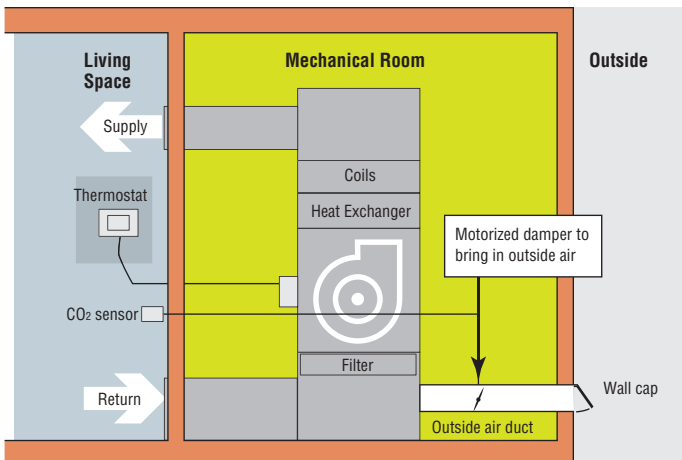
- Air-side economizer
- Automatic modulating control of outdoor air damper
- Design outdoor airflow greater than 3000 cfm

Exceptions are provided for:

- Systems with the exhaust air energy recovery complying with Section 6.5.6.1
- Multi-zone systems without direct digital control (DDC) of individual zones communicating with a central control panel
- Systems with a design outdoor airflow less than 750 cfm
- Spaces where >75% of the design outdoor airflow is required for makeup air that is exhausted or transfer air (required for makeup air that is exhausted from other spaces)
- Correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.

Code reference

ASHRAE 90.1-2013—Section 6.3.2



18. Door Switches

Inspection Requirements

Verify that the system complies with the door switch requirements.

Details

Any conditioned space with a door that opens to the outdoors must be provided with the following controls that when the door is open:

- Disables mechanical heating or resets the heating setpoint to 55°F or lower within five minutes of the door being left open
- Disables mechanical cooling or resets the cooling setpoint to 90°F or greater within five minutes of the door being left open

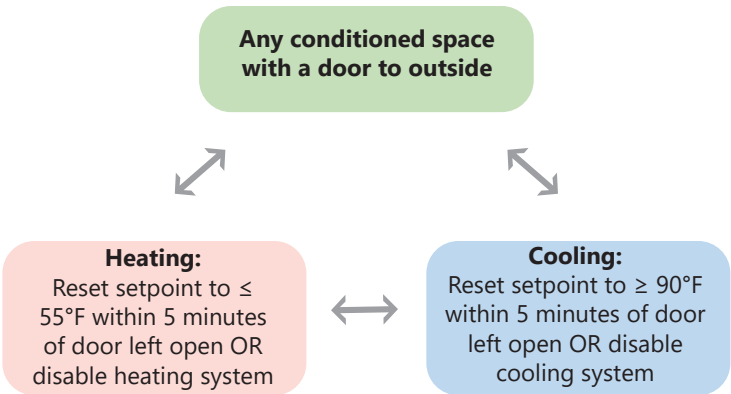
Mechanical cooling may remain enabled if outdoor air temperature is below space temperature. This includes doors with more than one-half glass.

Exceptions are provided for:

- Building entries with automatic closing devices
- Any space without a thermostat
- Alterations to existing buildings
- Loading docks

Code reference

ASHRAE 90.1-2013—Section 6.3.2



Service Water Heating

Inspection Requirements

Confirm the following:

- Minimum efficiency complies with Table 7.8
- Hot water system is sized per manufacturer's sizing guide
- Pipe insulation required on: all circulating systems; first 8 feet of outlet piping; inlet piping through heat trap; and externally heated piping (e.g., heat trace or impedance)
- First 8 ft. of outlet piping is insulated to 1/2 in. if nominal diameter of pipe is < 1.5 in.; to 1 in. if larger pipe
- Hot water storage temperature is adjustable down to 120°F or lower. (Lavatory faucet outlet temperature in public restrooms is limited to 110°F.)
- Heat traps are provided on inlet and outlet of storage tanks

Details

Water-heating equipment must meet the insulation and control requirements of Sections 7.4.3 and 7.4.4.

Code reference

ASHRAE 90.1-2013—Section 7.4.3 & 7.4.4



Feeder and Branch Conductors

Inspection Requirements

Verify that feeder conductors and branch conductors have been designed to meet the maximum voltage drop requirements. Voltage needed, phase, and length of circuit dictate wire size.

Details

Feeder conductors must be designed for a maximum voltage drop of 2%.

Branch conductors have been designed for a maximum voltage drop of 3%.

Code reference

ASHRAE 90.1-2013—Section 8.4.1.1 & 8.4.1.2

Calculating Voltage Drop - 1 Phase Branch Conductor

I: Amperage, also known as Current VD: Voltage Drop

R: Resistivity of wire, taken from NEC Chapter 9, Table 8

L: Length of run; drop is typically calculated per 1000 ft. lengths

CM: Circular Mils of Wire, measure of the diameter (thickness) of the wire, available from NEC tables

K: Resistivity Constant - 12 for Copper, 18 for Aluminum

Example using $VD = (2 * L * R * I) / 1000 \text{ ft}$

Find the voltage drop on a # 6 THWN copper, 3-wire, 120/240 Volt, single phase branch circuit of 100 foot length having a 60 A load.

Use the formula above and substitute the given values.

$$VD = (2 * 100' * .491 * 60) / 1000' = 5.892 \text{ Volts}$$

The voltage drop is 5.892 volts, we now have to check the % from the overall voltage.

$$\% = (VD / V) * 100$$

$$\text{Substituting values gives us: } \% = (5.892 \text{ Volts} / 240 \text{ Volts}) * 100 = 2.46 \%$$

Wire size	Insulation type	Ampacity
14	TW, THW, THWN	15
12	TW, THW, THWN	20
10	TW, THW, THWN	30
8	TW	40
8	THW, THWN	45
6	TW	55
6	THW, THWN	65
4	THW, THWN	85
2	TW	100
2	THW, THWN	115
1	THW, THWN	130
2/0	THW, THWN	175

Ampacity = allowable current

Automatic Receptacle Control

Inspection Requirements

Verify that the following are automatically controlled:

- a. At least 50% of all 125-volt 15- and 20-amp receptacles in all private offices, conference rooms, rooms used primarily for printing/copying, break rooms, classrooms, and individual workstations
- b. At least 25% of branch circuit feeders installed for modular furniture not shown on the construction documents.

Details

Automatic controls shall function on a scheduled basis using a time-of-day operated control device that turns receptacles off at specific programmed times. An independent program schedule must be provided for controlled (single floor) areas > 5000 sq. ft., and the occupant must be able to manually override the control device for up to two hours.

Alternately, controls may use an occupancy sensor that turns receptacles off within 20 minutes of all occupants leaving a space, OR an automated signal from another control or alarm system that turns receptacles off within 20 minutes after determining that the area is unoccupied.

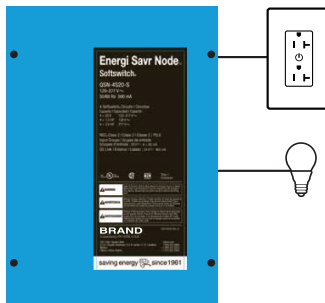
Controlled receptacles must be uniformly distributed throughout the space and permanently marked to visually differentiate them from uncontrolled receptacles. Note: Plug-in devices shall not be used to comply with these requirements.

Receptacles for the following do *not* require an automatic control device:

1. Receptacles specifically designated for equipment requiring continuous operation (24 hours/day, 365 days/year)
2. Spaces where an automatic control would endanger the safety or security of the room or occupant(s).

Code reference

ASHRAE 90.1-2013—Section 8.4.2



Electric Energy Monitoring

Inspection Requirements

Verify that there are measurement devices installed in new buildings to monitor the electrical energy use for each of the following separately:

- a. Total electrical energy
- b. HVAC systems
- c. Interior lighting
- d. Exterior lighting
- e. Receptacle circuits

Details

For buildings with tenants, these systems must be separately monitored for the total building and for each individual tenant (excluding shared systems).

Note: As an exception, up to 10% of the load for each of components in categories b, c, d, and e (above) may come from other loads.

The electrical energy usage for all specified loads must be recorded a minimum of every 15 minutes and reported at least hourly, daily, monthly, and annually. The data for each tenant space shall be made available to that tenant and the system must be able to maintain all data collected for a minimum of 36 months.

The following exceptions to this requirement apply to:

1. Buildings less than 25,000 sq. ft.
2. Individual tenant spaces less than 10,000 sq. ft.
3. Dwelling units
4. Residential buildings with less than 10,000 sq. ft. of common area
5. Critical and Equipment branches of NEC Article 517

Code reference

ASHRAE 90.1-2013—Section 8.4.3

Lighting Power Calculation

Inspection Requirements

Verify that the interior lighting power budget was calculated correctly to reflect building area category or space-by-space categories and allowable wattage.

Details

The interior lighting power budget is based on space or building use type and may be calculated using either the Building Area Method or Space-by-Space (SbS) Method.

The Building Area Method multiplies the building area by the building type allowable Lighting Power Density (LPD, Table 9.5.1). The result is the building's interior lighting budget, and the wattage can be used anywhere inside the building to power light fixtures. If the Building Area Method is used, the COMcheck options for Building Type are limited; therefore, the code official should verify that the designation selected by the project team is appropriate.

The SbS method requires each building space be identified and multiplied by the corresponding allowable LPD (Table 9.6.1). When using the SbS method, the Room Cavity Ratio (RCR) calculation allows for the space LPD to be increased. This requires that the RCR calculated for the room is greater than the RCR threshold for that space type (Table 9.6.1). The interior lighting power budget is the sum of lighting power allowances of all spaces and subspaces.

Besides the room geometry (RCR) allowance, when using the SbS approach, additional lighting power is permitted in certain spaces for the use of decorative lighting. Also, retail sales areas receive a base allowance plus additional wattage depending on type of merchandise being sold. Additionally, voluntary use of enhanced controls (such as continuous dimming in open offices) receives additional wattage for those applications (Table 9.6.3).

COMcheck is highly useful and strongly recommended for calculating and documenting the lighting power budget.

☑ *The 2015 IECC building interior lighting power budget calculation approach is similar to ASHRAE 90.1. IECC provides tables for Building Area (C405.4.2(1)) or Space-by-Space (C405.4.2(2)) calculations. The Room Cavity Ratio adjustment is not available in the IECC. However, the Space-by-Space calculation does provide additional wattage via the Additional Interior Lighting Power approach (C405.4.2.2.1).*

COMcheck will allow users to calculate lighting budget using either the IECC or ASHRAE approach. Be sure to select the proper reference code each time a new COMcheck report is created.

Code reference

ASHRAE 90.1-2013—Section 9.2

TRAINING AREA
108

Educational/Vocational
1945 sf/90 net=39 people

CLASSROOM
105
Educational Classroom
740 sf/20 net=37 people

CLOSET

DASH LINE INDICATES A 14R
ACOUSTICALLY INSULATED WALL

CLOSET

50'

3'-6"

MEN
107

MEN
106

WOMEN
102

KITCHEN
101

RECEPTION
100

Business:
1729 sf/100 gross = 18 pple

CABINETS

COMES w/ RECYCLING

ELEC

MEETING
103

OPEN OFFICE
104

SECRET FRONT FRAME,
SERRATED DOOR

BOLLARDS

Interior and Exterior Installed Lighting Wattage

Inspection Requirements

Verify that Interior Lighting Fixture Schedule meets the allowable budget and what is installed in the field. Verify that the COMcheck report (if applicable) reflects the installed fixtures present at final inspection.

Details

ASHRAE 90.1-2013 requires that installed light fixture wattage be calculated in accordance with code standards.

The following criteria are applied:

- Line voltage luminaires are calculated at the manufacturer's labeled wattage of the luminaire unless a separate ballast or transformer with a different rating is present.
- Luminaires with a separate ballast or control device are calculated at the maximum rated operating value of the lamp/ballast combination.
- Low-voltage lighting with plug-in busways is calculated at 30 watts per linear foot or the voltage of the transformer (whichever is greater).

COMcheck is helpful for documenting installed lamp wattage and making the required calculations. If a COMcheck report is available, verify that installed lamp type and wattage match the construction plans and wattage budget for the building. Installed lighting should reflect the contents of the COMcheck Interior Lighting and Power Compliance Certificate (if available).

See ASHRAE 90.1-2013 Section 9.1.4 for exceptions to these rules.

☑ *The 2015 IECC requires that certain rules are followed when calculating the total installed interior lighting power. Luminaires are calculated as follows:*

- *Screw base luminaires = labeled wattage of luminaire*
- *Low-voltage lighting = wattage of transformer*
- *Low-voltage lighting with plug-in busways = 30 watts per linear foot or the voltage of the luminaires (whichever is greater)*
- *All others must provide documentation of wattage from manufacturer*

See IECC 2015 Section C405.4.1 for exceptions to these rules.

Code reference

ASHRAE 90.1-2013—Section 9.1.4

Interior and Exterior Installed Lighting Examples



For screw-base bulbs, regardless of wattage, the installed power of the fixture to which they attach will be calculated at the manufacturer's rated wattage for the luminaire.



Luminaires with a separate control ballast will be calculated as the maximum operating input of the ballast or transformer.



Low-voltage lighting with plug-in busways will be calculated at the luminaire wattage (minimum 30 watts per linear foot) or the wattage of the transformer or current limiting device (whichever is greater).

Lighting Wattage Compliance

Inspection Requirements

Verify that total proposed interior lighting wattage does not exceed that allowed per COMcheck Compliance Certificate. Later, confirm that the installed lighting matches the proposed design wattage.

Details

If the permit applicant has provided a COMcheck report, verify that "Interior Lighting PASSES" appears in order to verify that the lighting design complies on the COMcheck Compliance Certificate.

Code reference

ASHRAE 90.1-2013—Section 9.2.2.3

Section 2: Interior Lighting and Power Calculation

A	B Floor Area	C Allowed Watts / ft2	D Allowed Watts
School/University	7673	1.2	9208
Total Allowed Watts =			9208

Section 3: Interior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
School/University (7673 sq.ft.)				
Linear Fluorescent 1: B2: Classrooms / Other / Electronic	2	69	34	2346
Compact Fluorescent 1: C1D: Classrooms/Conference / Triple 4-pin 32W / Electronic	1	30	32	960
Compact Fluorescent 2: C2: Entry/Hallways/Stairs / Triple 4-pin 32W / Electronic	1	38	32	1216
Compact Fluorescent 3: C4: Restrooms/Stairs / Triple 4-pin 42W / Electronic	1	21	42	882
Linear Fluorescent 2: E1/E2: Mechanical Rooms / 48" T8 32W / Electronic	2	10	64	640
HID 1: F1: Cupola / Metal Halide 250W / Standard	1	2	250	500
Total Proposed Watts =				6544

Section 4: Requirements Checklist

Lighting Wattage:

- ☐ 1. Total proposed watts must be less than or equal to total allowed watts.

Allowed Watts
9208

Proposed Watts
6544

Complies
YES

Exit Signs

Inspection Requirements

Verify that EXIT signs are 5 watts or less per side.

Details

Without explicitly stating it, this maximum wattage can likely only be met by installing LED technology.

Code reference

This has been eliminated from ASHRAE 90.1-2013 but is in 2015 IECC (C405.3)



Interior Lighting Controls

Inspection Requirements

Verify that the lighting controls installed in the building meet the requirements for each space and function as required.

Details

ASHRAE has made significant updates to the lighting control requirements for commercial buildings. ASHRAE 90.1-2013 requires that each space in a building have certain types of lighting controls in place. These control functions are listed by space type in Table 9.6.1.

Control types required for each space are indicated with the symbol "REQ." All controls listed as REQ are mandatory. The symbol "ADD1" indicates the user must choose one of the additional lighting control functions for the space. The symbol "ADD2" indicates the user must choose at least one more additional control function for the space.

These lighting control functions include the following: local control; restricted to manual ON; restricted partial automatic ON; bilevel lighting control; automatic daylight responsive controls for sidelighting; automatic daylight responsive controls for toplighting; automatic partial OFF (full OFF complies); automatic full OFF; and scheduled shutoff. Table 9.6.1 indicates which controls are required for a space using the REQ, ADD1, and ADD2 symbols.

ASHRAE 90.1 rewards certain lighting designs with more advanced controls by offering between 5-30% increased wattage for enhanced controls. For example, retail sales areas with advanced dimming can receive 10% more wattage for fixtures operated by these better-than-minimum controls. See Section 9.6.3 for more details.

☑ *The 2015 IECC has added new requirements to Section C405, which covers power and lighting systems in commercial buildings. While the IECC incorporates similar concepts to ASHRAE (including the use of occupant sensors, automatic OFF controls, and day-lighted zones), the IECC lighting control requirements are structured differently.*

NOTE: The IECC Lighting summary page at the end of the lighting section highlights some of the key differences between the ASHRAE and IECC lighting requirements.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1

A. Local Control

Inspection Requirements

Verify that independent manual or occupancy-sensing controls have been installed within each space. Use of a clearly labeled, remotely located switch with an “on/off” indicator is allowed when necessary for safety, remotely located, or security reasons.

Details

Each space enclosed by ceiling height partitions shall have at least one control device to independently control all lighting within the space.

The number of control devices required is determined by the size of the space. Each control device must control an area of no more than 2,500 sq. ft. in small spaces (i.e., less than 10,000 sq. ft.). For larger spaces, each control device cannot operate more than 10,000 sq. ft.

Each manual control device shall be readily accessible and located so the occupants can see the controlled lighting. (Remote switch with indicator allowed for safety or security, e.g., big-box retail stores.)

ASHRAE 90.1-2013 requires local control devices in nearly every space type. Only spaces designed specifically for visually impaired persons are exempt from this requirement.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1



B. Restricted Manual ON

Inspection Requirements

Verify that restricted manual ON controls have been installed in each space where they are required.

Details

The Restricted Manual ON control function requires that none of the lighting in the space be automatically turned on. Only Manual ON control devices are allowed. Manual ON/Automatic OFF controls (e.g., vacancy sensors), are allowed. Automatic ON (motion sensing) control devices are not permitted in spaces requiring restricted Manual ON control function.

ASHRAE 90.1-2013 requires restricted Manual ON in the majority of spaces. Only corridors, mechanical rooms, lobbies, restrooms, stairwells, storage rooms, dorms, fire stations, and certain types of healthcare facilities are exempt from this requirement. There are also exemptions for safety and security reasons. (See Table 9.6.1 for full space type and control function list.)

Code reference ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

C. Restricted Partial Manual ON

Inspection Requirements

Verify that restricted partial manual ON controls have been installed in each space where they are required.

Details

The Restricted Partial Manual ON control function requires that no more than 50% of the general lighting in the space be automatically turned on. None of the remaining lighting may be automatically turned on.

ASHRAE 90.1-2013 requires restricted partial manual ON in the majority of spaces. Only corridors, mechanical rooms, lobbies, restrooms, stairwells, storage rooms, dorm and fire station living quarters, and certain types of healthcare facilities are exempted from this requirement. (See table 9.6.1 for full space type and control function list.)

Code reference ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

D. Bi-Level Lighting Control

Inspection Requirements

Verify that bi-level lighting controls have been installed in each space where they are required.

Details

The bi-level lighting control function requires space lighting to have at least one light level step in addition to full ON and full OFF. This can be achieved through continuous dimming or a stepped lighting level between 30% and 70% of full power.

ASHRAE 90.1-2013 requires bi-level lighting control in a wide variety of spaces including offices, break rooms, sales areas, stairwells, healthcare facilities, warehouses, and others. (See Table 9.6.1 for full space type and control function list.)

Code reference ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1

E–F. Automatic Daylight Responsive Controls for Sidelighting and Toplighting

Inspection Requirements

Verify that automatic daylight responsive controls have been installed in each space where they are required.

Details

ASHRAE 90.1-2013 now requires many spaces to have automatic controls that are responsive to daylight in the space. These controls automatically reduce or turn OFF the powered lighting when natural daylight is available.

Sidelighting is generally defined as the daylight area adjacent to vertical fenestration (windows). Toplighting is generally defined as the daylight area below skylights and roof top monitors.

Automatic controls are required for areas with “sidelighting” (windows) and “toplighting” (skylights and roof monitors). Some exceptions do exist for these requirements. Specifically, buildings in which the daylight is fully blocked by an existing adjacent structure, very small window areas (less than 20 sq. ft. total), and retail spaces may be exempt from daylight responsive control requirements.

Designers must perform calculations to determine the sidelighted and toplighted areas. Inspectors should check for the presence of photocells in areas directly adjacent to windows and below skylights or roof monitors.

Automatic daylight responsive controls are generally required in sidelighted or toplighted areas, where a photocell device must automatically adjust lighting in these areas in three steps:

- 50% to 70%
- 20% to 40%
- Full OFF

Lighting controls must be accessible to allow calibration of functions.

ASHRAE 90.1-2013 requires automatic daylight responsive controls in a wide variety of spaces. The specific sidelighted and toplighted areas must be calculated by the building designer and installed control functions should be verified by inspectors.

See Table 9.6.1 for space type and control function list. See Section 3.2 for definitions and calculations related to sidelighted and toplighted areas. Section 9.4.1.1 for descriptions of required control functions.

Code reference ASHRAE 90.1-2013—Sections 3.2 & 9.4.1.1 & Table 9.6.1

G–H. Automatic OFF: Partial OFF and Full OFF**Inspection Requirements**

Verify that automatic OFF controls have been installed for each space in which they are required.

Details

Controls that automatically provide either Partial OFF or Full OFF are required for many spaces.

Generally, each space enclosed by ceiling height partitions shall have at least one control device capable of automatically turning off lights within 20 minutes of all occupants leaving the space.

Where Partial OFF is acceptable, the automatic lighting control must reduce lighting power by 50% within 20 minutes of all occupants leaving.

For spaces that require automatic Full OFF, all lighting shall be auto shut off within 20 minutes of being unoccupied.

Exceptions: Compliance is not required for spaces that meet all three of the following requirements:

1. The space has an LPD of no more than 0.80 W/ft².
2. The space is lighted by HID.
3. The general lighting power in the space is automatically reduced by at least 30% within 20 minutes of all occupants leaving the space

The maximum area served by each control is 5,000 sq. ft.

Note: Lighting is *not* required to be automatically shut off if it is general or task lighting in shop and laboratory classrooms, for safety and security reasons, or for a 24/7 operation.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1 & Table 9.6.1



I. Scheduled Shutoff

Inspection Requirements

Verify that scheduled shutoff lighting controls have been installed, which will automatically turn off lights during unoccupied times.

Details

Scheduled shutoff automatic control devices shall function on:

A scheduled basis using a time-of-day operated control device that turns lighting off at specific programmed times—an independent program schedule shall be provided for areas of no more than 25,000 sq. ft. but not more than one floor.

OR

A signal from another control or alarm system that indicates the area is unoccupied.

There are exceptions to this requirement for:

- Lighting intended for 24-hour operation
- Lighting in spaces where patient care is rendered
- Lighting in spaces where an automatic shutoff would endanger the safety or security of the room or building occupants

Code reference

ASHRAE 90.1-2013—Section 9.4.1.1



Hotel Guestroom Controls

Inspection Requirements

Verify that an automatically controlled switch has been installed that will automatically turn off lighting in hotel guestrooms and bathrooms.

Details

Hotel and motel guestrooms and guest suites must have an automatic shutoff device that turns off all permanently installed luminaires and switched receptacles within 20 minutes of occupants leaving the room.

“Captive key” systems that control the lighting and switched receptacles meet the intent of this requirement (and are therefore exempt).

Bathrooms in guestrooms must have a separate control device to turn off the lighting within 30 minutes of occupants leaving the room. A vacancy sensor (not occupancy sensor) will meet this requirement.

Bathrooms are permitted a “nightlight” of not more than 5 watts.

Code reference

ASHRAE 90.1-2013—Section 9.4.1.3



By removing the keycard upon occupant departure, lighting power is automatically interrupted for all interior lights.

Special Purpose Lighting Controls

Inspection Requirements

Verify that separate control device has been installed for specialty purpose and task lighting.

Details

ASHRAE 90.1-2013 requires the following types of specialty lighting be separately controlled.

- Display lighting
- Accent lighting
- Display case lighting
- Food warming lighting and other “non-visual” lighting
- Lighting that is for sale, demonstration, or education
- Task lighting
- Under-cabinet lighting

Code reference

ASHRAE 90.1-2013—Section 9.4.1.3



Display/accent lighting must be controlled independently from general space lighting.

Ballasts

Inspection Requirements

Verify that no ballasted light fixtures are single-lamp unless they are tandem-wired to another fixture or have an electronic high-frequency ballast.

Exceptions:

- Fixtures not on same switch
- Recessed fixtures > 10 ft. apart
- Emergency circuits

Details

It is more energy efficient to share conventional electromagnetic ballasts between multiple fixtures than to control the same number of lamps with separate ballasts.

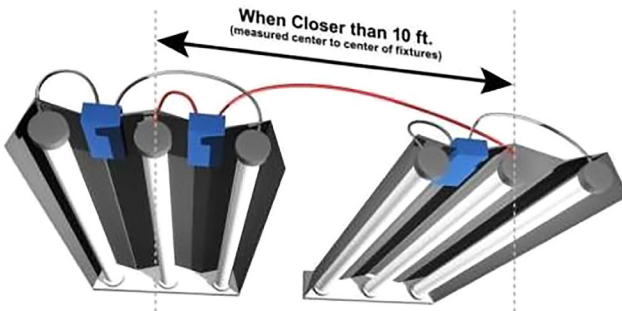
Code reference

ASHRAE 90.1-2013—Section 9.4.2

Electronic ballast



Electromagnetic ballast



Exterior Lighting Controls

Inspection Requirements

Verify that all exterior lighting fixtures are automatically turned OFF during daylight hours. Verify that exterior lighting control system meets after-hour and curfew capabilities.

Details

Exterior lighting must be automatically controlled, and those control systems must be capable of meeting daylight, curfew, and after-hours lighting setbacks and OFF functions.

There are 4 requirements for exterior lighting control systems:

- Automatic OFF during daylight hours (this can be controlled by a photosensor).
- Facade and landscape lighting must automatically turn OFF between midnight and 6 a.m. or close-to-open for the business. (This can be controlled by a time clock.)
- Lighting for signage must automatically reduce power by at least 30% from midnight to 6 a.m., one hour after close and before open of the business, or after 15 minutes of inactivity. (This can be accomplished using a time clock.)
- Control system must be capable of retaining programming and the time settings for at least ten hours during loss of power.

Exceptions are provided for certain types of lighting:

- Lighting in covered vehicle parking entrance and exit areas that is specifically designed for safety, security, and eye adaptation
- Lighting that is installed by the manufacturer within signage

Code reference

ASHRAE 90.1-2013—Section 9.4.1.4



Exterior Lighting Power

Inspection Requirements

Verify that the exterior lighting power installed does not exceed the exterior lighting power budget. Verify that the exterior lighting budget was created in accordance with Section 9.4.2. Confirm that square footage of exterior illuminated areas is accurate per site drawings, and that area/surface designations are logical.

Details

Calculating the exterior lighting power budget is done by totaling the exterior lighting zone base allowance, plus the building exterior allowance for tradable and non-tradable surfaces.

This means that each building exterior gets a base wattage for lighting determined by its lighting “zone” (location type). Exterior lighting zones are shown in Table 9.4.2-1.

There are 5 zone types:

0. Undeveloped park areas – 0 watts
1. Developed park areas – 500 watts
2. Residential and neighborhood business areas – 600 watts
3. All other areas – 750 watts
4. High-activity commercial districts – 1300 watts

Many commercial buildings will fall into Zone 4: “all other areas.”

Once the zone type is determined, Table 9.4.2-2 shows the base wattage allowed by zone and the tradable and non-tradable surface area wattage allowances.

Tradable surfaces are used to calculate an overall budget for the exterior lighting. This budget is developed by identifying the types of spaces on the exterior of the building (e.g., uncovered parking areas, grounds, entrances and exits, sales areas). The allowable wattage for these areas is determined by the building zone in Table 9.4.2-2. The sum of the base allowance plus the tradable surfaces can be used anywhere on the building exterior.

Non-tradable surfaces are also identified by Table 9.4.2-2. These areas are essentially feature lighting. If the feature is present on the building, the allowed wattage is permitted to light that feature. As the name implies, this wattage budget is not “tradable” to elsewhere on the building exterior. It may only be used to light the building feature for which the wattage is specified. Some examples include building facades, ATM machines, and drive-through windows. *(continued on next page)*

Exterior Lighting Power, *continued*

Details (*continued from previous page*)

Designers should show areas and calculations on plans. Inspectors should confirm that square footage of exterior illuminated areas is accurate per site drawings and that area/surface designations are logical.

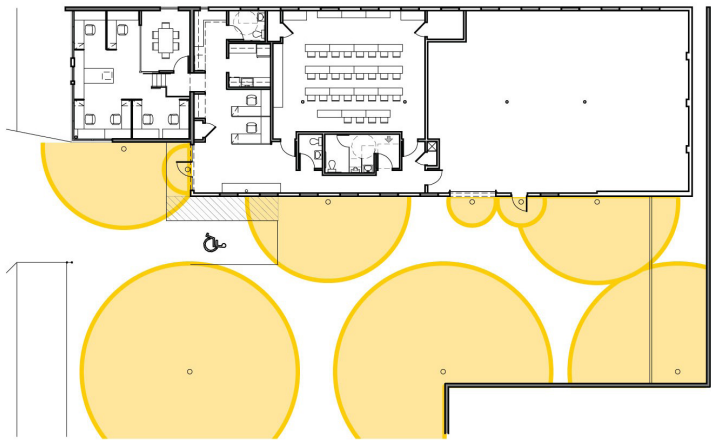
Code reference ASHRAE 90.1-2013—Section 9.4.2-1 & 9.4.2-2

Section 2: Exterior Lighting Area/Surface Power Calculation

A Exterior Area/Surface	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B x C)	F Proposed Watts
Main entry/exit	3 ft of door width	30	Yes	90	42
Other entry/exit	3 ft of door width	20	Yes	60	42
Other entry/exit	9 ft of door width	20	Yes	180	42
Parking area(s)	11500 ft ²	0.15	Yes	1725	1284
Total Tradable Watts* =				2055	1410
Total Allowed Watts =				2055	
Total Allowed Supplemental Watts** =				103	

* Wattage tradeoffs are only allowed between tradable areas/surfaces.

** A supplemental allowance equal to 5% of total allowed wattage may be applied toward compliance of both non-tradable and tradable areas/surfaces.



Lighting Wattage Compliance

Inspection Requirements

Verify that total proposed lighting wattage does not exceed what is allowed per COMcheck Exterior Lighting Area/Surface Power Calculation.

Details

Verify that Section 4, Item 1 of COMcheck Exterior Lighting Compliance Certificate indicates "Passes" next to Compliance.

Code reference

ASHRAE 90.1-2013—Section 9.4.2

Lighting Wattage:

1. Within each non-tradable area/surface, total proposed watts must be less than or equal to total allowed watts. Across all tradable areas/surfaces, total proposed watts must be less than or equal total allowed watts.

Compliance Passes.

Lighting Schedule—Exterior Fixtures

Inspection Requirements

Verify that COMcheck Exterior Lighting Fixture Schedule matches construction documents.

Details

Verify that installed lamp type, wattage per lamp, ballast type, and wattage match COMcheck Exterior Lighting and Power Compliance Certificate.

Code reference

ASHRAE 90.1-2013—Section 9.4.2



Exemption Claims—Exterior Fixtures

Inspection Requirements

Verify that any exterior lighting that is claimed to be exempt from the exterior lighting budget is a listed exempt lighting type and has a separate control system.

Details

Some exterior lighting may be exempt from the total exterior lighting power allowance provided it meets 9.4.1.4 and is equipped with a separate automatic control system which is independent of the non-exempt lighting.

Fixtures that are eligible for exemption include lighting used for the following exterior applications:

- Sign lighting that is integrally installed in the signage by the manufacturer
- Lighting for athletic playing areas
- Lighting for industrial production, material handling, transportation sites, and associated storage areas
- Theme elements in theme/amusement parks
- Lighting for public monuments and historic landmarks
- Special lighting for outdoor water features

Lighting used for the following exterior applications is exempt when controlled separately:

- Specialized signal, directional, and marker lighting associated with transportation
- Lighting integral to equipment or instrumentation and installed by its manufacturer
- Lighting for theatrical purposes, including performance, stage, film production, and video production
- Temporary lighting
- Lighting for hazardous areas
- Swimming pool lighting
- Searchlights

Code reference

ASHRAE 90.1-2013—Section 9.4.2

Functional Testing

Inspection Requirements

Test all lighting control devices and control systems to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

Details

When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures must be performed.

For occupant sensors:

1. Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
2. For projects with up to seven occupancy sensors, all occupancy sensors must be tested.
3. For projects with more than seven occupancy sensors, testing must be done for each unique combination of sensor type and space geometry.
 - a. For each sensor to be tested, verify that:
 - i. Status indicator (as applicable) operates correctly;
 - ii. Controlled lights turn off or down to the permitted level within the required time;
 - iii. For auto-on occupant sensors, the lights turn on to the permitted level when someone enters the space;
 - iv. For manual-on sensors, the lights turn on only when manually activated; and
 - v. The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation.

For automatic time switches:

1. Confirm that the automatic time-switch control is programmed with appropriate weekday, weekend, and holiday schedules.
2. Document details for the owner about automatic time-switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
3. Verify that correct time and date are properly set in the time switch.
4. Verify that any battery backup (as applicable) is installed and energized.

(Continued on next page...)

Functional Testing (*Continued*)

Automatic time switches (*cont.*)

5. Verify that the override time limit is set to no more than two hours.
6. Simulate occupied condition; verify and document:
 - a. All lights can be turned on and off by their respective area control switch;
 - b. Switch only controls lighting in the enclosed space where it is located.
7. Simulate unoccupied conditions; verify and document:
 - a. All exempt lighting turns off;
 - b. Manual override switch controls correct lights and automatically shuts off on schedule.

For daylight controls, confirm the following:

1. All photocells have been properly located, field calibrated, and set for appropriate setpoints and threshold light levels.
2. Daylight controlled lighting adjusts appropriately in response to available daylight.
3. The calibration adjustment location is readily accessible only to authorized personnel.

Note: The person responsible for the functional testing shall not be directly involved in either the design or construction of the project. This person shall provide documentation confirming that the lighting controls meet or exceed all documented performance criteria.

Code reference

ASHRAE 90.1-2013—Section 9.4.3

2015 IECC Lighting Summary

Inspection Requirements

Verify that occupancy/vacancy sensors, daylight responsive controls, and time switches have been installed as required.

2015 IECC Lighting Summary Interior Lighting Controls

The 2015 IECC has many of the same interior lighting control requirements as ASHRAE 90.1. However, these requirements are organized and worded differently. Below is a summary of the key differences between the IECC and ASHRAE approach to interior lighting controls. Buildings following the IECC code will need to satisfy these requirements.

- Dwelling units in commercial buildings must comply by having 75% of permanently installed fixtures be high efficacy (via section R404.1).
- Occupancy sensor controls (C405.2.1) are required in 12 types of spaces. Some common spaces include classroom/conference rooms, breakrooms, private offices, restrooms, warehouses, and all spaces 300 sq. ft. or less.
- Areas of the building not required to have occupancy-sensing controls must be controlled with time switches (C405.2.2). Time switch controls must be capable of seven-day programming with different daily programs, automatic holiday OFF, 10-hour power backup for settings, and 2-hour manual override (maximum 5,000 sq. ft. area served).
- Each building space is required to have a control that reduces the lighting power in the space by at least 50% (C405.2.2.2). Daylight responsive automatic controls are required in sidelighted and toplighted zones (C405.2.3). All other spaces are permitted to have manual controls.
- Specialty lighting is required to have an ON/OFF switch that is independent from the general lighting in the space. Specialty lighting types include display and accent lighting, task lighting, food warming and other nonvisual lighting, sales displays, and display cases (C405.2.4).
- Sleeping units in hotel and motel rooms must have an automatic control that shuts OFF all lights and switched outlets in the space within 20 minutes of the occupants leaving. Rooms with captive key systems are exempted (C405.2.4).

Code reference

IECC 2015 - Section C405

2015 IECC Exterior Lighting Summary

Inspection Requirements

Verify that controls and time switches have been installed as required.

2015 IECC Lighting Summary Exterior Lighting

The 2015 IECC has many of the same exterior lighting control requirements as ASHRAE 90.1. However, these requirements are organized and worded differently. Below is a summary of the key differences between the IECC and ASHRAE approach to exterior lighting controls. Buildings following the IECC code will need to satisfy these requirements.

- Exterior lights must have a control device that will automatically turn OFF exterior lights when daylight is available (C405.2.5). A photo-sensing device will satisfy.
- Building and landscape lighting must have a control capable of automatic dusk/dawn and open/close shutoff.
- Other exterior lights must have controls which automatically reduce the lighting power by a minimum of 30% from midnight to 6 a.m. or from one hour after close and before opening of the business. Alternatively, the control system must turn lighting OFF when no activity is detected for 15 minutes.
- All controls and switches must be capable of retaining programming for a minimum of 10 hours during loss of power.

Code reference

IECC 2015 - Section C405.2.5

2015 IECC Interior Lighting Summary

Inspection Requirements

Verify that the lighting power budget was calculated using the proper space types and allowable lighting power density (LPD) for the space. Verify that the installed lighting power does not exceed the budget for the building/space.

2015 IECC Lighting Summary Connected Power

Much like ASHRAE 90.1, the IECC uses lighting power densities (LPD) calculated using either the Building Area Method or the Space-by-Space method. The 2015 IECC also has some requirements for dwelling units and exit signs which are not part of the 90.1 standard.

Dwelling units in commercial buildings must comply by having 75% of permanently installed fixtures be high efficacy (via Section R404.1).

Exit signs are permitted a maximum of 5 watts per side (C405.3).

Per IECC 2015 LPD tables C405.4.2(1): Building Area Method and C405.4.2(2): Space by Space Method, the allowable watts per sq. ft. provided by the LPD tables are identical for ASHRAE 90.1 and 2015 IECC.

Additional interior lighting power may be calculated when using the space-by-space method under IECC 2015. This “bonus” lighting power must be calculated by the designer using the rules of Section C405.2.2.1. Additional lighting is primarily associated with retail, display, and sales lighting. These lights must be automatically controlled to turn OFF during non-business hours and must be separately controlled from general lighting in the space. Additionally, this “bonus” lighting is non-tradable, meaning it must be used only for the intended purpose and cannot be used elsewhere in the building to increase the overall lighting budget.

The exterior lighting power budget is calculated using Section C405.5.1. Much like ASHRAE 90.1, the IECC uses base-zone allowances for power in addition to allowances for “tradable” and “non-tradable” areas. The 2015 IECC does not have a “Zone 0.” It only includes Zones 1–4, which are similar to ASHRAE’s exterior lighting power zones. Many commercial buildings will fall into Zone 3. The 2015 IECC lighting power allowances for exterior Tradable and Non-Tradable surfaces (Table C405.5.1(2)) are identical to ASHRAE 90.1-2013.

Code reference

IECC 2015 - Section C405