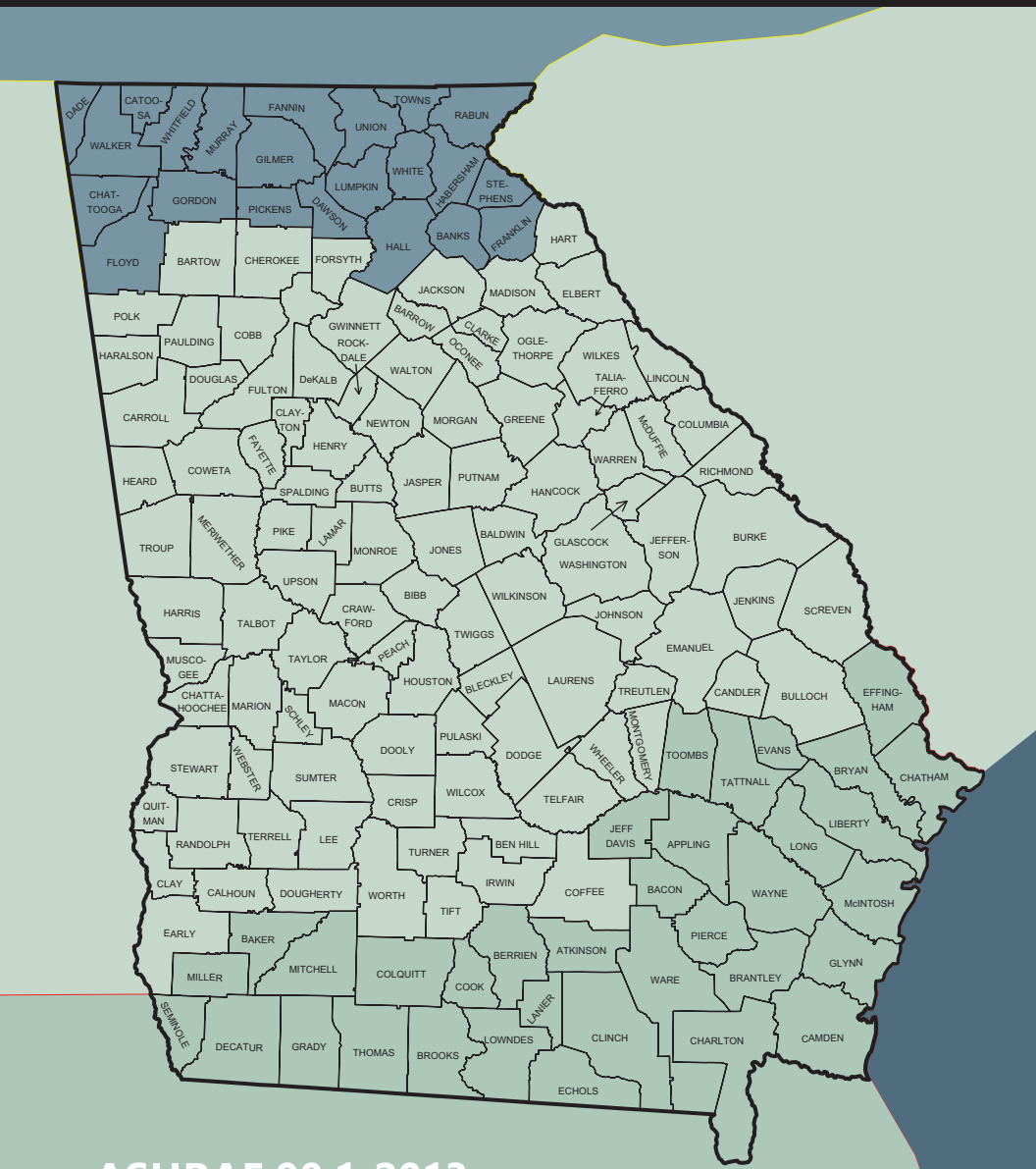
Georgia Commercial Energy Code

FIELD GUIDE



ASHRAE 90.1-2013 +

2020 GEORGIA STATE SUPPLEMENTS & AMENDMENTS

Version: 1a, July 2019

Georgia Commercial Energy Code

FIELD GUIDE

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2020 Georgia
State Supplements & Amendments

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 and/or 2020 Georgia State Supplements and Amendments. 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:
energycodes@southface.org
404-604-3598

Credits

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Contents

Introduction

The 2020 Georgia Commercial Energy Code Field Guide is intended for use by code officials when inspecting commercial construction projects for compliance with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (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 COM*check* 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 Georgia, there is another compliance option: 2*015 International Energy Conservation Code (IECC)*. 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

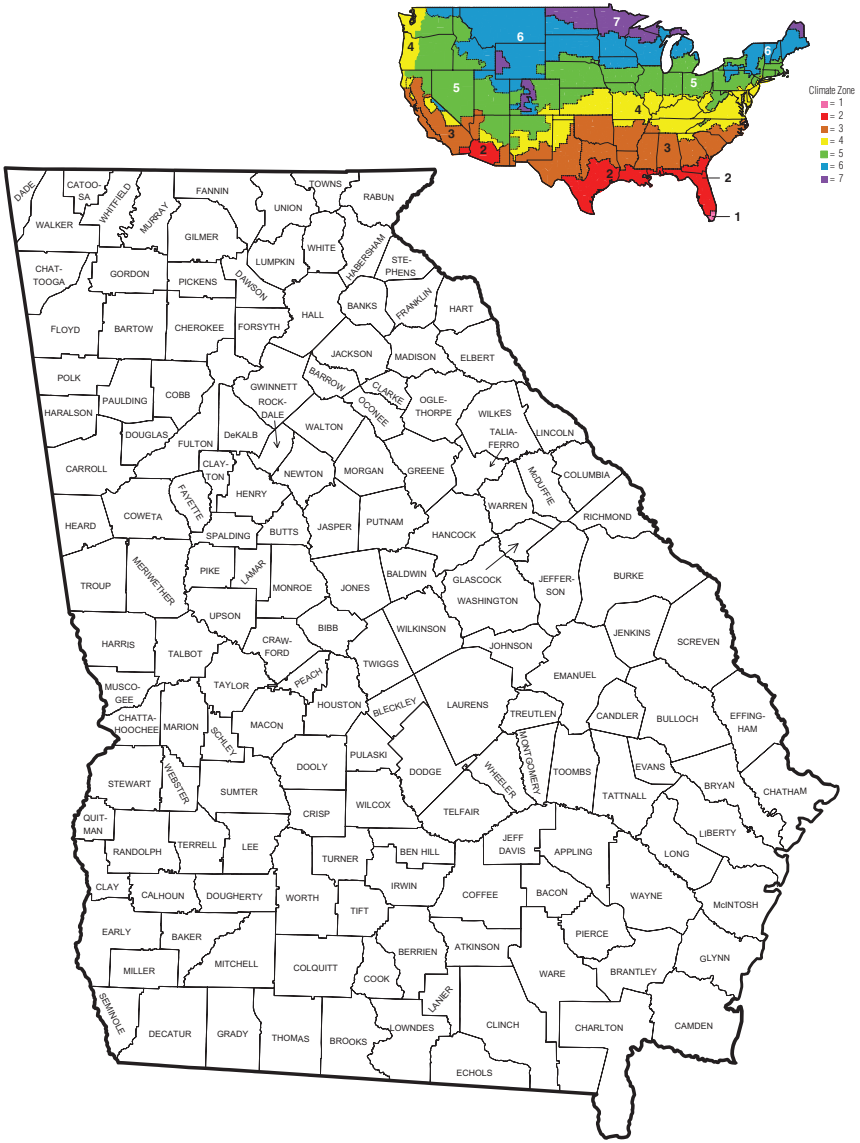
Compliance with the energy code can be demonstrated by the prescriptive, trade-off, or simulated performance approach. About 85% of all commercial buildings can use either the prescriptive or trade-off approach. Though COM*check* is typically used to demonstrate the trade-off approach, it may also be used to document 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 will be validated by the COM*check* 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.

Georgia Climate Zones by County
Many requirements in the energy code depend on the climate zone (CZ) where the building is located.

In the table on the next page, the digit indicates each county's zone. Most Georgia counties are in CZ3; some southern counties are in CZ2, while northern counties fall in CZ4. The letter indicates an area's moisture regime; the entire state of Georgia 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.



2A Appling*	2A Atkinson*	2A Bacon*	2A Baker*
3A Baldwin	4A Banks	3A Barrow	3A Bartow
3A Ben Hill*	2A Berrien*	3A Bibb	3A Bleckley*
2A Brantley*	2A Brooks*	2A Bryan*	3A Bulloch*
3A Burke	3A Butts	3A Calhoun*	2A Camden*
3A Candler*	3A Carroll	4A Catoosa	2A Charlton*
2A Chatham*	3A Chattahoochee*	4A Chattooga	3A Cherokee
3A Clarke	3A Clay*	3A Clayton	2A Clinch*
3A Cobb	3A Coffee*	2A Colquitt*	3A Columbia
2A Cook*	3A Coweta	3A Crawford	3A Crisp*
4A Dade	4A Dawson	2A Decatur*	3A DeKalb
3A Dodge*	3A Dooly*	3A Dougherty*	3A Douglas
3A Early*	2A Echols*	2A Effingham*	3A Elbert
3A Emanuel*	2A Evans*	4A Fannin	3A Fayette
4A Floyd	3A Forsyth	4A Franklin	3A Fulton
4A Gilmer	3A Glascock	2A Glynn*	4A Gordon
2A Grady*	3A Greene	3A Gwinnett	4A Habersham
4A Hall	3A Hancock	3A Haralson	3A Harris
3A Hart	3A Heard	3A Henry	3A Houston*
3A Irwin*	3A Jackson	3A Jasper	2A Jeff Davis*
3A Jefferson	3A Jenkins*	3A Johnson*	3A Jones
3A Lamar	2A Lanier*	3A Laurens*	3A Lee*
2A Liberty*	3A Lincoln	2A Long*	2A Lowndes*
4A Lumpkin	3A Macon*	3A Madison	3A Marion*
3A McDuffie	2A McIntosh*	3A Meriwether	2A Miller*
2A Mitchell*	3A Monroe	3A Montgomery*	3A Morgan
4A Murray	3A Muscogee	3A Newton	3A Oconee
3A Oglethorpe	3A Paulding	3A Peach*	4A Pickens
2A Pierce*	3A Pike	3A Polk	3A Pulaski*
3A Putnam	3A Quitman*	4A Rabun	3A Randolph*
3A Richmond	3A Rockdale	3A Schley*	3A Screven*
2A Seminole*	3A Spalding	4A Stephens	3A Stewart*
3A Sumter*	3A Talbot	3A Taliaferro	2A Tattnall*
3A Taylor*	3A Telfair*	3A Terrell*	2A Thomas*
3A Tift*	2A Toombs*	4A Towns	3A Treutlen*
3A Troup	3A Turner*	3A Twiggs*	4A Union
3A Upson	4A Walker	3A Walton	2A Ware*
3A Warren	3A Washington	2A Wayne*	3A Webster*
3A Wheeler*	4A White	4A Whitfield	3A Wilcox*
3A Wilkes	3A Wilkinson	3A Worth*	

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·ft^2 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·ft^2 of floor area in CZ2, 10 Btu/h·ft^2 of floor area in CZ3, and 15 Btu/h·ft^2 of floor area in CZ4.

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. that 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·ft^2 of floor area but is not a conditioned space. The heating system must not exceed 5 Btu/h·ft^2 for CZ2, 10 Btu/h·ft^2 for CZ3, or 15 Btu/h·ft^2 for CZ4; 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 COM*check* Compliance Certificate (if applicable) should match the installed insulation levels.

Details
Rigid foam board 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.

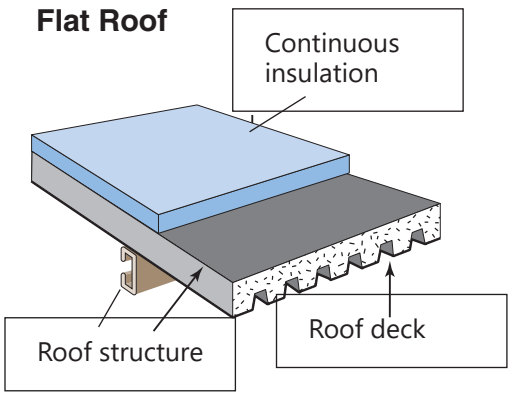
Ensure that consistent, minimum R-value is met, even at the lowest point on the roof, as insulation thickness is sometimes compromised to provide drainage for roofs. (Pay special attention to areas adjacent to drains and scuppers.)

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

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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.
4	R-30.0 c.i.	R-30.0 c.i.	R-10.0 c.i.

Code reference ASHRAE 90.1-2013—Section 5.5.1



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 COM*check* 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 or 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.

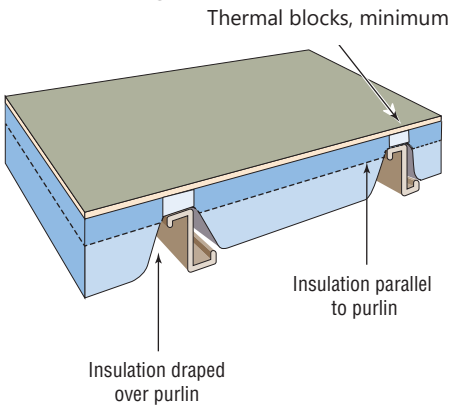
☑ *The 2015 IECC requires R-19 + 11 ls for metal building roofs in CZ 2–4.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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
4	R-19.0 + R-11 ls OR R-25 + R-8 ls	R-19.0 + R-11 ls OR R-25 + R-8 ls	R-19.0

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 COM*check* 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 2-4.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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
4	R-49.0	R-49.0	R-30.0

Code reference ASHRAE 90.1-2013—Section 5.5.1

Ruler shows depth of installed blown-in insulation. Typical blown-in insulation has an R-value of around R-3.2 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 COM*check* Compliance Certificate (if applicable).

Details
Mass walls are thick, heavy walls; typical materials are concrete, CMU, or solid multi-wythe brick.

☑ *The 2015 IECC R-values for above-grade mass wall insulation are equivalent to ASHRAE 90.1-2013.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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
4	R-9.5 c.i.	R-11.4 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 COM*check* 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 2-4. See IECC Table C402.1.3 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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
4	R-15.8 c.i.	R-19.0 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 COM*check* 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.

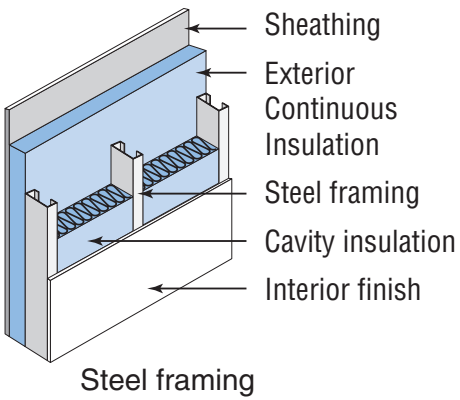
☑ *The 2015 IECC requires slightly higher levels of continuous insulation for commercial building metal framed walls in CZs 2-4. See IECC Table C402.1.3 for insulation R-values.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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
4	R-13.0 + R7.5 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 COM*check* Compliance Certificate (if applicable).

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

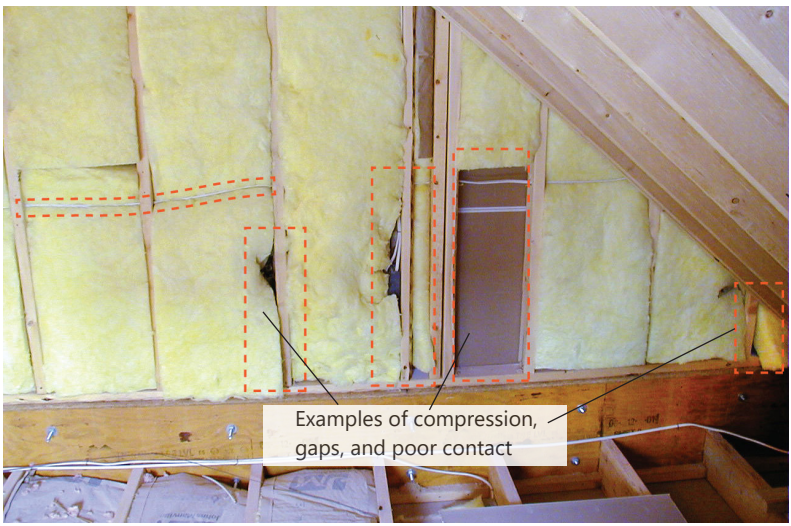
☑ *The 2015 IECC requires either R-13 + 3.8 c.i. or R-20 for above grade wood-framed walls in CZs 2-4.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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-13.0
4	R-13.0	R-13.0 + R-3.8 c.i. Or R-20	R-13.0

Note: two values indicate cavity + continuous insulation

Code reference ASHRAE 90.1-2013—Section 5.5.3.2



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 COM*check* Compliance Certificate (if applicable).

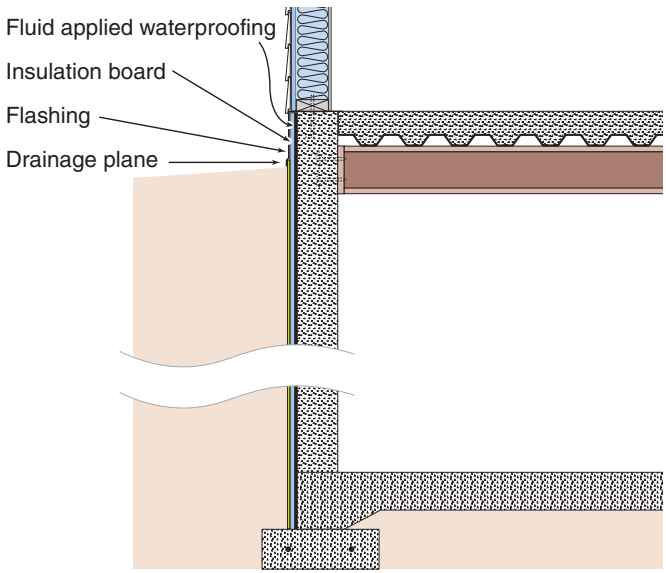
Details
In Georgia, insulation on below-grade walls is only required in CZ4.

☑ *The 2015 IECC requires R-7.5 c.i. for all below grade walls in CZ4.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	N/A	N/A	N/A
3	N/A	N/A	N/A
4	R-7.5	R-10.0	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 COM*check* Compliance Certificate (if applicable).

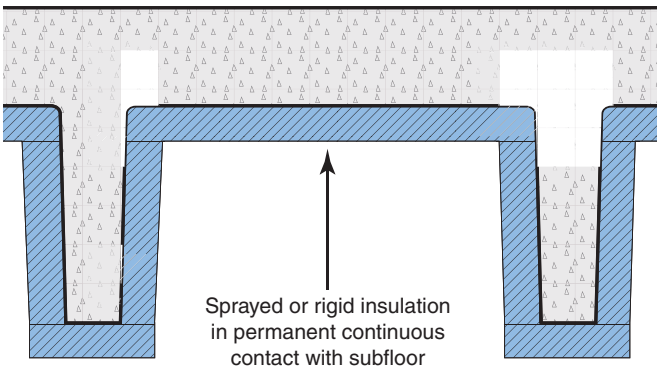
Details
Insulation installed on mass floors should cover the structure completely, with no gaps or voids visible. Mass-floor insulation is often required for elevated slabs above parking decks in commercial buildings.

☑ *The 2015 IECC R-values for mass floor insulation are equivalent to ASHRAE 90.1-2013 for CZs 2-3. The IECC requires R-10 c.i. for most commercial building mass floors in CZ4. See IECC 2015 Table C402.1.3 for details.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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.
4	R-14.6 c.i.	R-16.7 c.i.	R-6.3 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 COM*check* Compliance Certificate (if applicable).

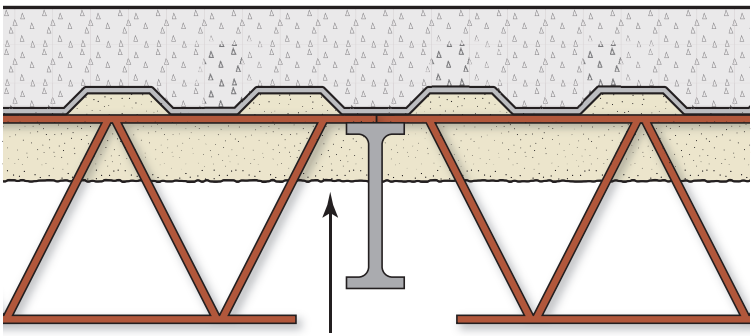
Details
Pay close attention to the installation of insulation in framed floors. Air spaces created by floor insulation that has separated (dropped/sagged) from direct contact with the underside of a floor may allow air to flow through the insulation and negate the thermal benefits.

☑ *The 2015 IECC R-values for steel-joist framed floors are equivalent to ASHRAE 90.1-2013.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-30	R-30	R-13
3	R-30	R-30	R-19
4	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 COM*check* Compliance Certificate (if applicable).

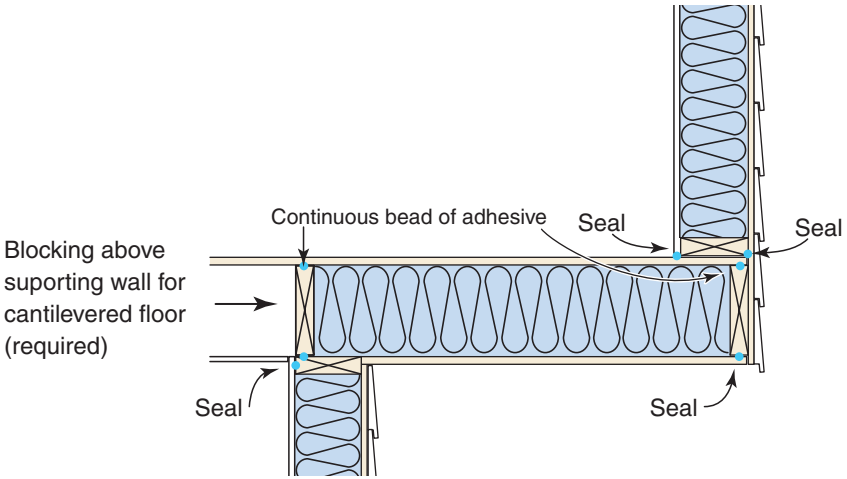
Details
Pay close attention to the installation of insulation in framed floors. Air spaces created by floor insulation that has separated (dropped/sagged) from direct contact with the underside of a floor may allow air to flow through the insulation and negate the thermal benefits. Cantilevered floors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

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-30	R-30	R-13
3	R-30	R-30	R-19
4	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 COM*check* Compliance Certificate (if applicable).

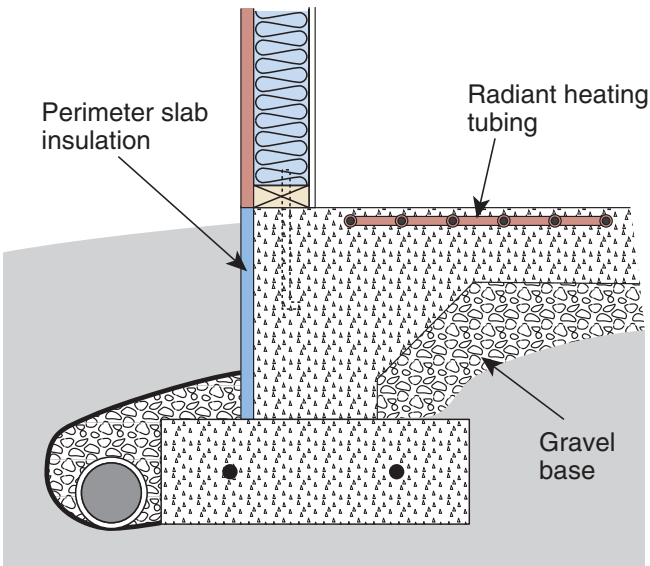
Details
Heat loss at slab edge is minimized by slab perimeter insulation installed per ASHRAE 90.1-2013, Tables 5.5-2 thru 5.5-4.

☑ *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.*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

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.
4	R-20.0 for 24 in.	R-20.0 for 24 in.	R-10.0 for 12 in.

Code reference ASHRAE 90.1-2013—Section 5.5.3.5



Note: Insulation under slab is not required or useful in CZs 2–4.

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 COM*check* Compliance Certificate (if applicable).

Details
In Georgia, some unheated slabs in CZs 3-4 now require insulation. Heat loss at slab edge is minimized by slab perimeter insulation installed per ASHRAE 90.1-2013, Tables 5.5-2 through 5.5-4.

☑ *The 2015 IECC requires R-10 for 24 inches for commercial building unheated slabs in CZ4 (Table C403.1.3); however, a Georgia 2020 Energy Code Amendment reduces this to zero (NR).*

Prescriptive Values (For assembly U-factor and other requirements, see Table 5.5 on pp19-21.)

Climate Zone	Non-Residential	Residential	Semi-Heated
2	NR	NR	NR
3	NR	R-10 for 24in.	NR
4	R-15 for 24in.	R-15 for 24in.	NR

Code reference ASHRAE 90.1-2013—Section 5.5.3.5

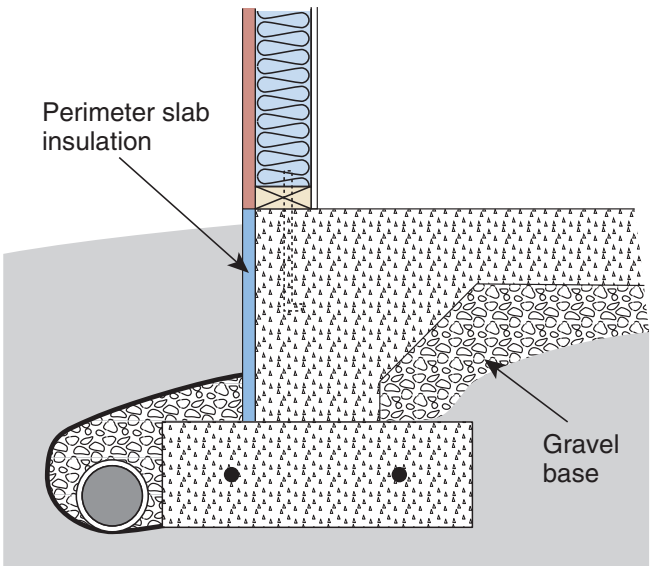


Table 5.5, Building Envelope Requirements CZs 2-4

Tables 5.5-2 to 5.5-4 are included here and on the following two pages as supplements to the Opaque Elements section (pp6-17, above) and show assemply U-factors and other requirements for various components.

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
Roofs						
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
Walls, above Grade						
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-0.064	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
Wall, below Grade						
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
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
Slab-on-Grade Floors						
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.
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-0.40			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		
Skylight, 0%–3% of Roof									
All types	U-0.65	SHGC-0.35	NR	U-0.65	SHGC-0.35	NR	U-1.80	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2); FC = filled cavity (see Section A2.3.2.5); I.s. = 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	SHGC-0.25	1.10	U-0.35	SHGC-0.25	1.10	U-0.87	NR	NR
Metal framing, fixed	U-0.50			U-0.50			U-1.20		
Metal framing, operable	U-0.60			U-0.60			U-1.20		
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).

Table 5.5, Building Envelope Requirements, continued

Table 5.5-4 Building Envelope Requirements for Climate Zone 4 (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-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.093	R-10 c.i.
Metal Building[a]	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
Attic and Other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above Grade						
Mass	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
Metal Building	U-0.060	R-0 + R-15.8 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.162	R-13
Steel Framed	U-0.064	R-13 + R-7.5 c.i.	U-0.064	R-13 + R-7.5 c.i	U-0.124	R-13
Wood Framed and Other	U-0.064	R-13 + R-3.8 c.i. or R-20	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-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
Floors						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 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-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.843	R-20 for 24 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U-0.500		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-0.51		
Metal framing, fixed	U-0.42			U-0.42			U-0.73		
Metal framing, operable	U-0.50	SHGC-0.40	1.10	U-0.50	SHGC-0.40	1.10	U-0.81	NR	NR
Metal framing, entrance door	U-0.77			U-0.68			U-0.77		
Skylight, 0%–3% of Roof									
All types	U-0.50	SHGC-0.40	NR	U-0.50	SHGC-0.40	NR	U-1.15	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).

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 COM*check* Compliance Certificate (if applicable).

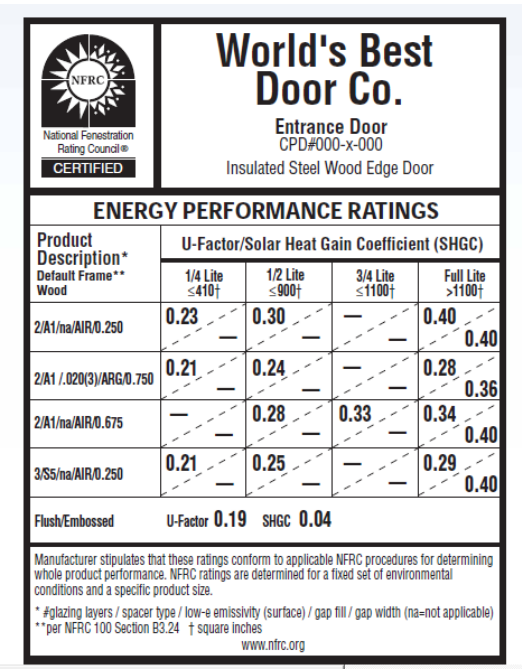
Details
Labeling of U-values on doors is not standard industry practice. It is often necessary to request documentation demonstrating compliance when no label is present on the installed product.

☑ *The 2015 IECC requires U-0.61 for all swinging doors in commercial buildings in CZs 2-4, equivalent to ASHRAE 90.1-2013.*

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
4	U-0.50	U-0.50	U-0.70

Code reference ASHRAE 90.1-2013—Section 5.5.3.6



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 COM*check* 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 2-4.*

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
4	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, SHCG, 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 COM*check* Compliance Certificate (if applicable).

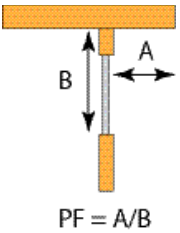
Details

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 the 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. 91*



Projection Factor (PF) and SHGC
PF= Ration 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

Vertical Glazing, 0%–40% of Wall Area, *continued*

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

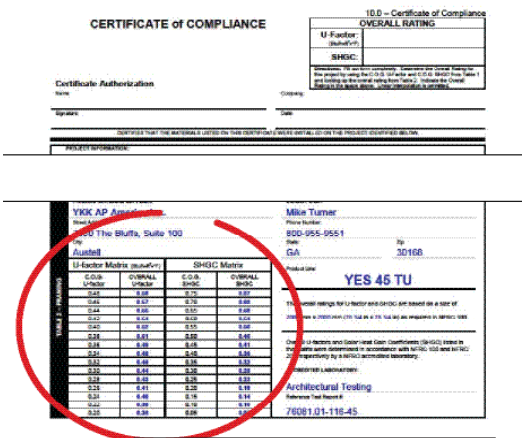
- ☑ *The 2015 IECC limits fenestration to 30% of the gross wall area when using the prescriptive pathway. (Continued on next page.)*
- ☑ *The 2015 IECC requires U-0.50 in CZ2, U-0.46 in CZ3, and U-0.38 in CZ4 for commercial building fenestration. SHGC requirements are the same as ASHRAE (0.25) for glazing that faces south, east, and west. North-facing glazing has a separate SHGC requirement in the IECC. Projection factor is also calculated differently by the IECC. See IECC Table C402.4 for details.*
- ☑ *The 2015 IECC does not require VT/SHGC ratio compliance.*

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.57, SHGC-0.25, VT/SHCG-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/SHCG-1.10	U-0.50, SHGC-0.25, VT/SHCG-1.10	U-1.20, SHGC – NA, VT/SHGC - NA
4	U-0.50, SHGC-0.40, VT/SHCG-1.10	U-0.50, SHGC-0.40, VT/SHCG-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.

Code reference ASHRAE 90.1-2013—Section 5.5.4 & 5.8.2



Example Compliance Certificate

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 COM*check* 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
4	U-0.50, SHGC-0.40	U-0.50, SHGC-0.40	U-1.15

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 meet all requirements of section 5.5.4.4.2, Exception 1.

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 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.*

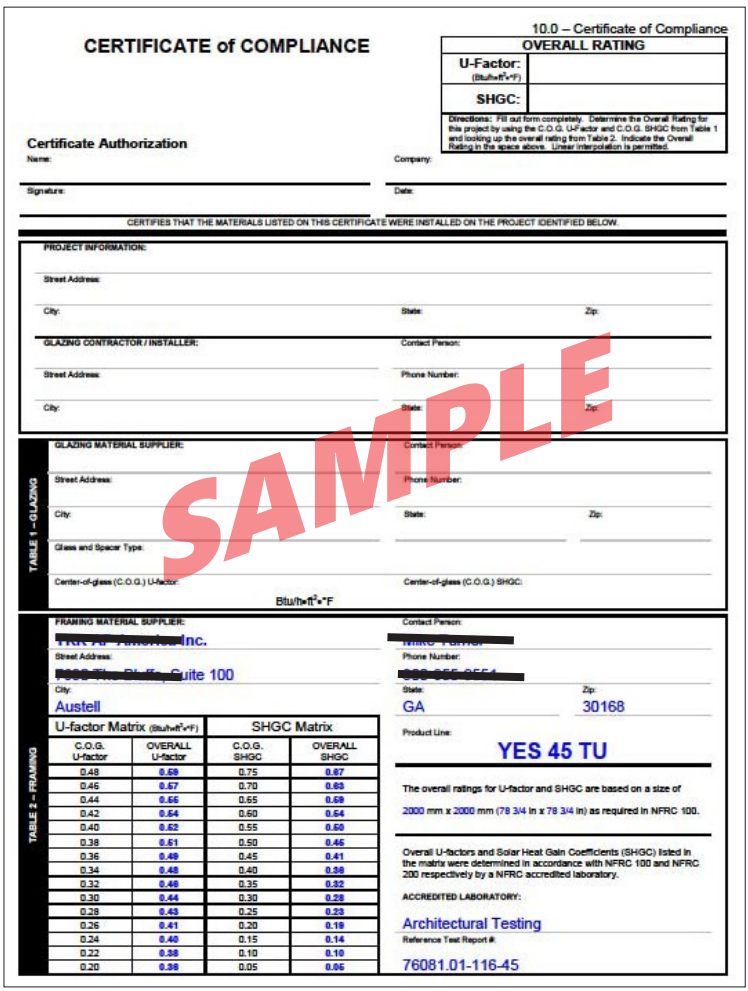
Code reference ASHRAE 90.1-2013—Section 5.5.4 & 5.8.2

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



10.0 – Certificate of Compliance

CERTIFICATE of COMPLIANCE

OVERALL RATING	
U-Factor: (Btu/h•ft²•°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.

Certificate Authorization

Name: Company:

Signature: Date:

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: Contact Person:
Street Address: Phone Number:
City: State: Zip:

TABLE 1 – GLAZING

GLAZING MATERIAL SUPPLIER: Contact Person:
Street Address: Phone Number:
City: State: Zip:
Glass and Spacer Type:
Center-of-glass (C.O.G.) U-factor: Center-of-glass (C.O.G.) SHGC:

Btu/h•ft²•°F

TABLE 2 – FRAMING

FRAMING MATERIAL SUPPLIER: [redacted] Inc. Contact Person: [redacted]
Street Address: [redacted] Suite 100 Phone Number: [redacted]
City: Austell State: GA Zip: 30168

U-factor Matrix (Btu/h•ft²•°F)		SHGC Matrix	
C.O.G. U-factor	OVERALL U-factor	C.O.G. SHGC	OVERALL SHGC
0.48	0.59	0.75	0.67
0.46	0.57	0.70	0.63
0.44	0.55	0.65	0.59
0.42	0.54	0.60	0.54
0.40	0.52	0.55	0.50
0.38	0.51	0.50	0.45
0.36	0.49	0.45	0.41
0.34	0.48	0.40	0.36
0.32	0.46	0.35	0.32
0.30	0.44	0.30	0.28
0.28	0.43	0.25	0.23
0.26	0.41	0.20	0.19
0.24	0.40	0.15	0.14
0.22	0.38	0.10	0.10
0.20	0.38	0.05	0.06

Product Line: **YES 45 TU**

The overall ratings for U-factor and SHGC are based on a size of 2000 mm x 2000 mm (78 3/4 in x 78 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

SAMPLE

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

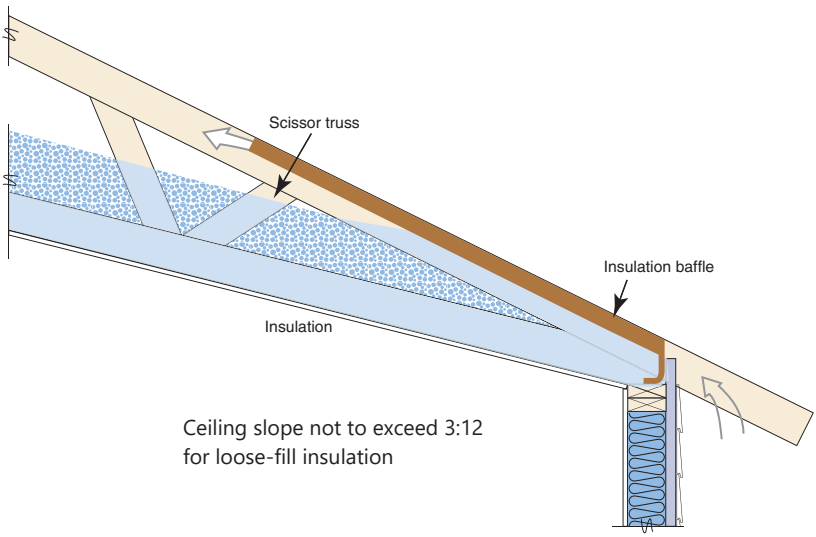
Frame Type	Glazing Type	Unlabeled Vertical Fenestration					
		Clear Glass			Tinted Glass		
		U-Factor	SHGC	VLT	U-Factor	SHGC	VLT
All frame types							
	Single glazing	1.25	0.82	0.76	1.25	0.70	0.58
	Glass block	0.60	0.56	0.56	n.a.	n.a.	n.a.
Wood, vinyl, or fiberglass frames							
	Double glazing	0.60	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



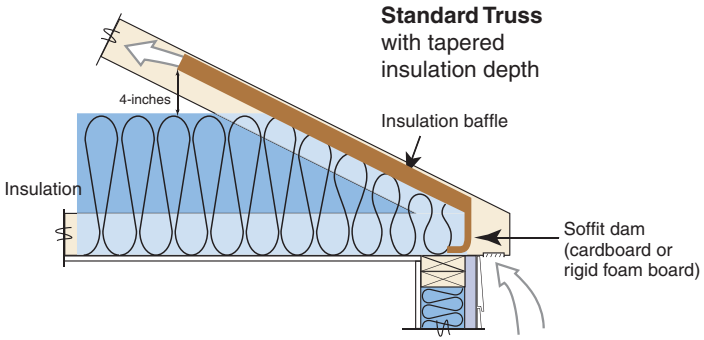
Ceiling slope not to exceed 3:12
for loose-fill insulation

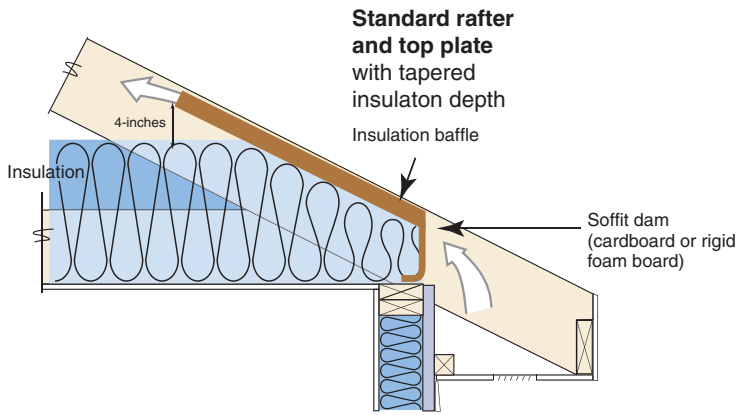
Vent Baffles in Attics

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





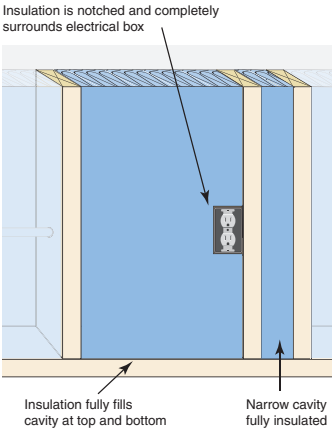
Insulation, Substantial Contact

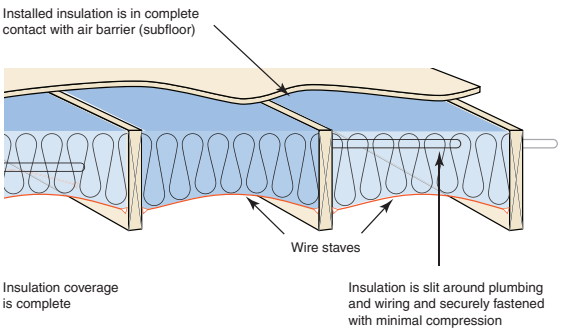
Inspection Requirements
Verify that insulation is installed in direct contact with an air barrier (solid surface or sheet material).

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

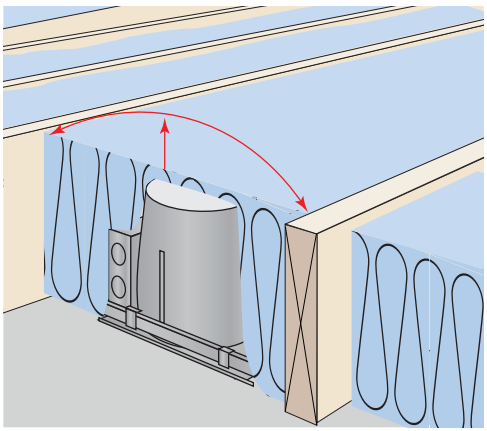
Inspection Requirements
Verify that recessed lights, equipment, and ducts do not affect insulation thickness.

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.

Loading Dock Weather Seals

Inspection Requirements
In CZ4, verify that cargo and loading dock doors are equipped with weather seals to restrict infiltration when vehicles are parked in the doorway.

Details
Weather seals reduce air infiltration that occurs when a trailer pulls up to unload or load at an open loading dock door.

Code reference ASHRAE 90.1-2013—Section 5.4.3.3

Air Sealing

Inspection Requirements
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.

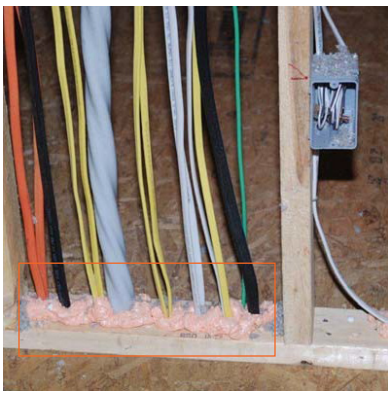
The following areas of the building envelope must be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

- Joints around fenestration and door frames
- Junctions between walls and foundations, between walls at building corners, between walls and structural floors or roofs, and between walls and 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

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 A3.1A 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 Where Specified)
No Framing	R-0	U-0.740	U-0.580	U-0.480
	Ungrouted Cores Filled with Loose-Fill Insulation	N/A	N/A	U-0.350
Continuous Metal Framing at 24 in. on Center Horizontally				
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
4.5 in.	R-17.1	U-0.133	U-0.126	U-0.121
4.5 in.	R-22.5	U-0.124	U-0.119	U-0.114
4.5 in.	R-25.2	U-0.122	U-0.116	U-0.112
5.0 in.	R-19.0	U-0.122	U-0.117	U-0.112
5.0 in.	R-25.0	U-0.115	U-0.110	U-0.106
5.0 in.	R-28.0	U-0.112	U-0.107	U-0.103

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 or 4 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; revolving doors; and use of air curtains.*

Code reference ASHRAE 90.1-2013—Section 5.4.3.4

Scope of Simplified Approach

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 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

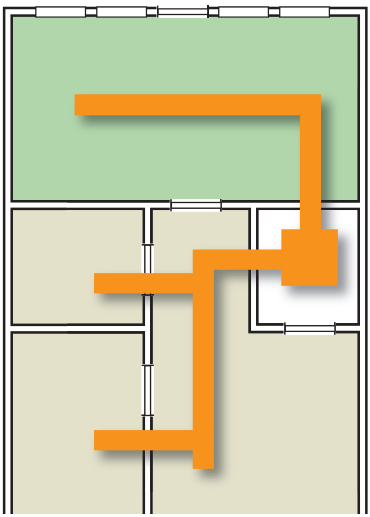
Inspection Requirements
Verify that each system serves a single HVAC zone.

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).

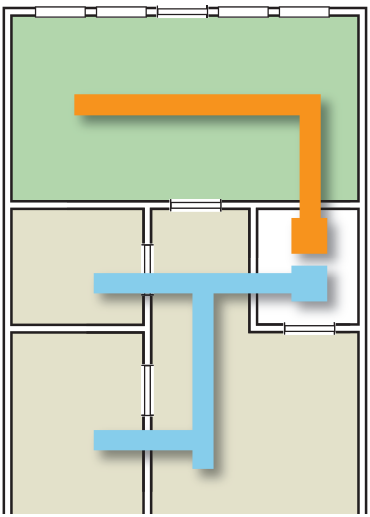
Each system should have only one thermostat. Multi-zone mechanical systems would not meet this requirement (and would thus not be able to show compliance using the Simplified Approach), but separate mechanical systems serving each zone would.

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 62.2 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 five-ton or smaller heat pump or air conditioner must be a 13.0 SEER or higher. 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 6.8.1A (air conditioners), Table 6.8.1B (heat pumps), or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps) for the applicable category.

Code reference ASHRAE 90.1-2013—Section 6.3.2, Table 6.8.1A, Table 6.8.1B or Table 6.8.1D

TABLE 6.8.1A Electronically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air conditioners, air cooled	<65,000 Btu/h[c]	All	Split system	13.0 SEER (as of 1/23/2006)	ARI 210/240
			Single package	13.0 SEER (as of 1/23/2006)	
Through-the-wall, air cooled	≤30,000 Btu/h[c]	All	Split system	10.9 SEER (as of 1/23/2006) 12 SEER (as of 1/23/2010)	
			Single package	10.6 SEER (as of 1/23/2006) 12.0 SEER (as of 1/23/2010)	
Small-duct high-velocity, air cooled	<65,000 Btu/h[c]	All	Split system	10 SEER	

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 2-4.

Details
ASHRAE 90.1-2013 now requires economizers for systems > 5 tons in CZs 2-4. (This is a significant change from the previous Georgia 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, with controls as indicated in Tables 6.5.1.1.3A and 6.5.1.1.3B and with either barometric or powered relief 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 2-4. (See Table 6.5.1-2.)

The use of an economizers may be traded off with more efficient equipment. In CZ2, economizer controls can be eliminated by using equipment that is 27% more efficient than the minimum; in CZ3, the threshold is 37% and in CZ4 it is 42%. (See Table 6.5.1-3.)

Code reference ASHRAE 90.1-2013—Section 6.3.2 & 6.5.1

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 2-4	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0

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 2-4	≥2500	≥2000	≥1000	≥500	>0	>0	>0	>0
CZ4	>0	>0	>0	>0	>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.

Code reference ASHRAE 90.1-2013—Section 6.3.2

8. Supplemental Heat

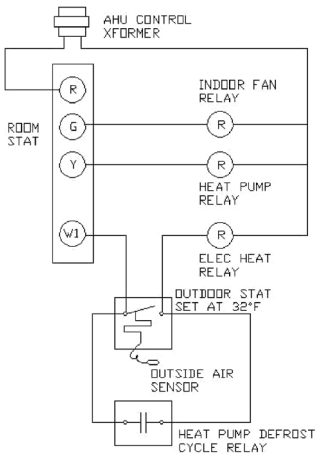
Inspection Requirements
Verify that heat pump supplemental (auxiliary) heat functions have proper control system. This requirement is only applicable if heat pumps are installed. If so, projects must use some control device (such as an outdoor temperature lockout device) capable of restricting supplemental 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

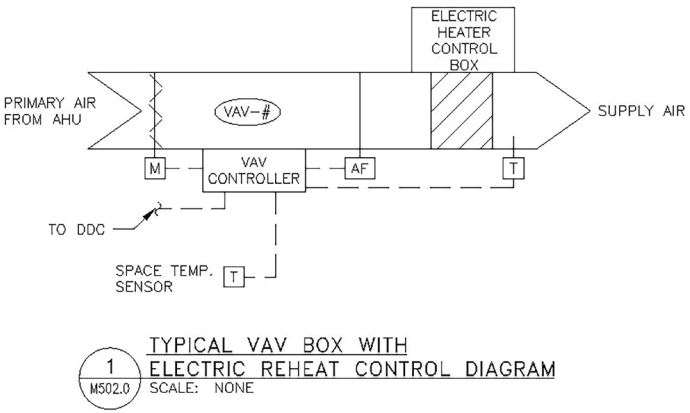
9. Reheat

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



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

10. Timeclock Control

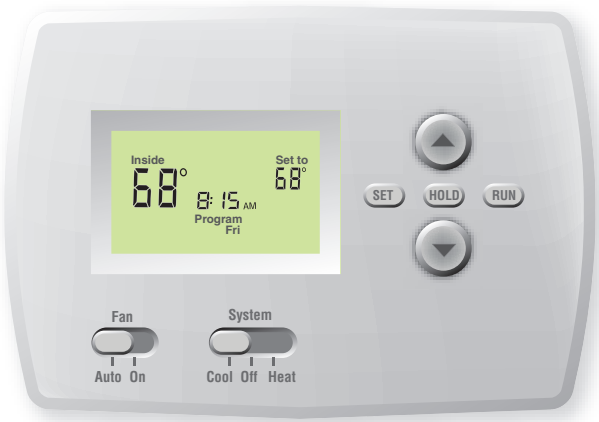
Inspection Requirements
Verify that appropriate timeclock controls have been installed.

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.

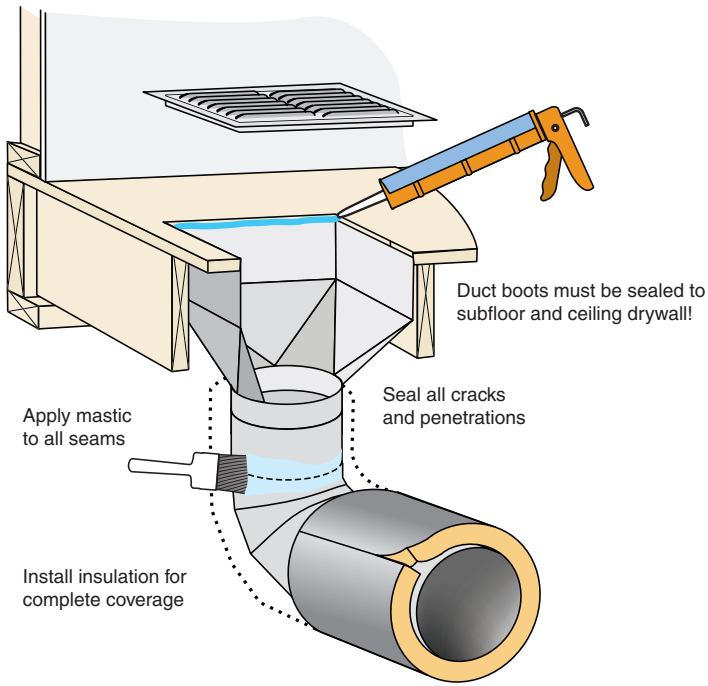
Code reference ASHRAE 90.1-2013—Section 6.3.2

12. Duct Insulation

Inspection Requirements
Verify that ductwork and plenums are insulated and sealed as required. R-6 will satisfy all conditions in CZs 2-4. 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.

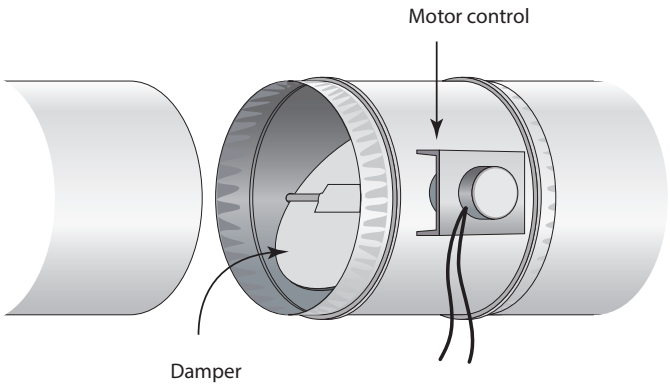
Details
Outdoor air intake and exhaust systems shall meet the requirements of Section 6.4.3.4.

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

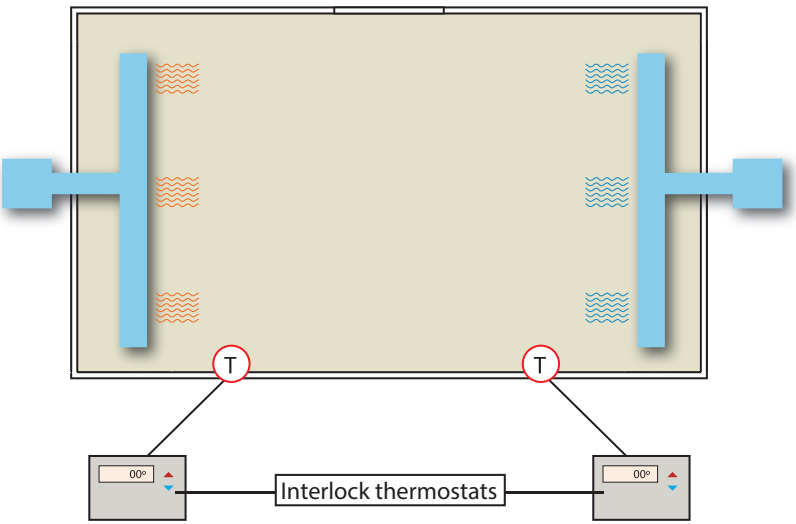


15. Interlocked Thermostats

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

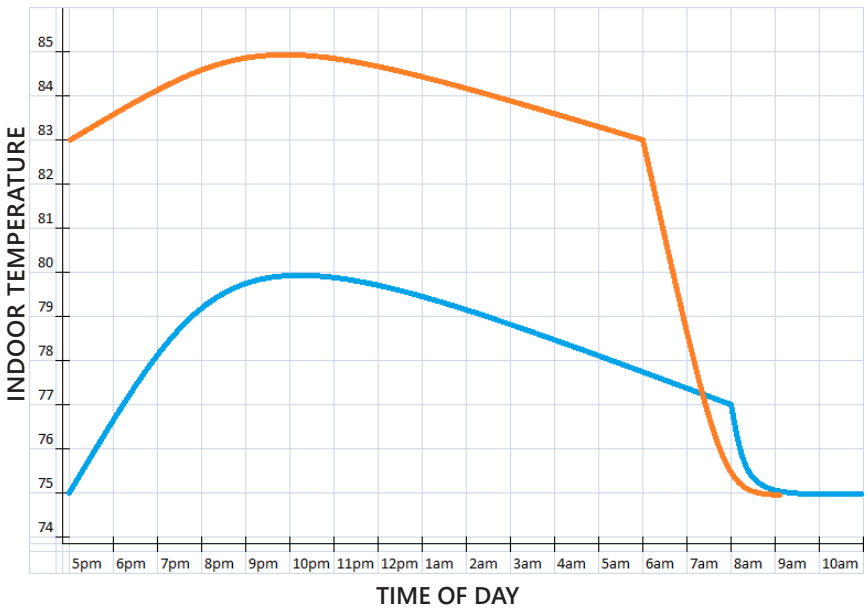
Inspection Requirements
Verify that systems with a design supply air capacity > 10,000 cfm have optimum start controls.

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.

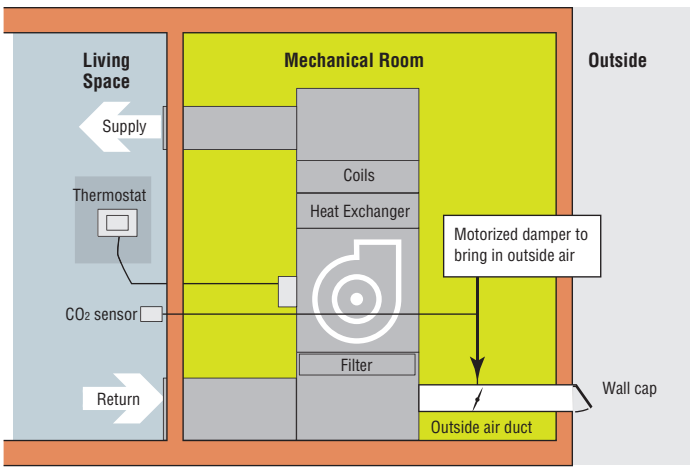
Details
Demand-control ventilation (DCV) is required for spaces that are larger than 500 sq. ft. and have a design occupancy for ventilation of greater than 25 people per 1000 sq. ft. of floor area. In addition, these spaces must be served by systems with one or more of the following:

- 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
- 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.
- 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. Verify that 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 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 Volts

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

% = (VD / V) * 100

Substituting values gives us: % = (5.892 Volts / 240 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 must 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.

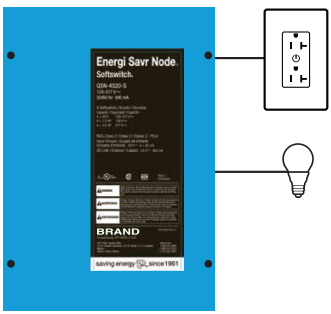
Also, controls must have an occupant sensor that turns receptacles off within 20 minutes of all occupants leaving a space, OR an automated signal from another control or alarm system that turns receptacles off within 20 minutes after determining that the area is unoccupied.

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 COM*check* 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).

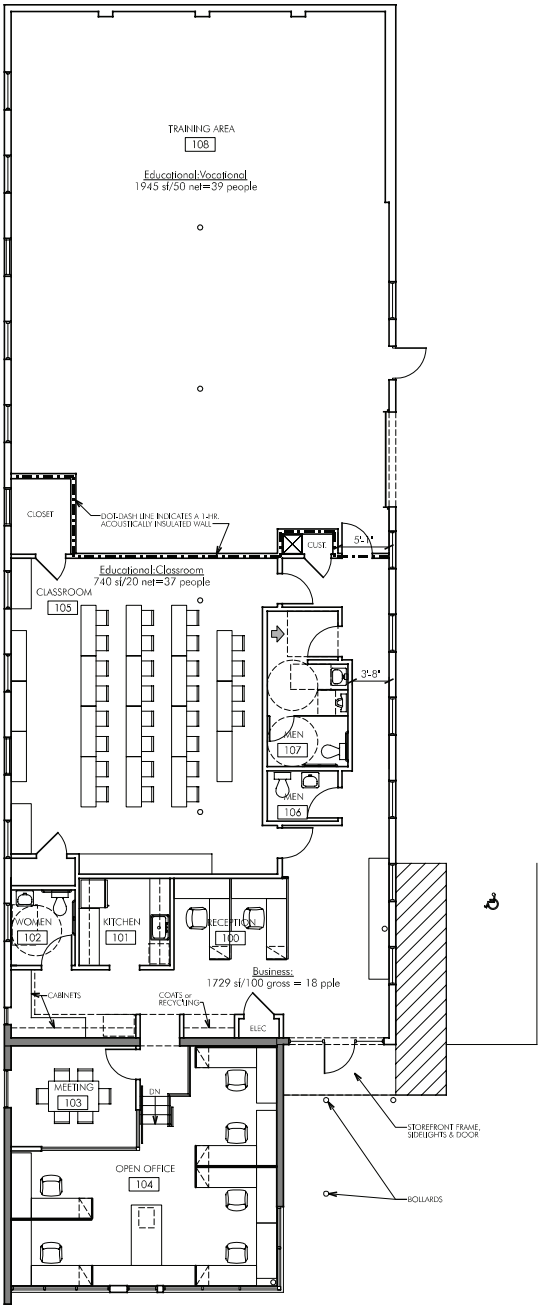
COM*check* is highly useful and strongly recommended for calculating and documenting the lighting power budget.

☑ *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).*

COM*check* 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 COM*check* report is created.

Code reference ASHRAE 90.1-2013—Section 9.2

Space-by-Space Method



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 COM*check* 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 lamp 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).

COM*check* is helpful for documenting installed lamp wattage and making the required calculations. If a COM*check* 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 COM*check* 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 lamps = labeled wattage of lamp*
- *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

Luminaires with attached (screw base) ballast. The installed power of the lights will be calculated at the manufacturer's rated wattage for the lamp.

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

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

Lighting Wattage Compliance

Inspection Requirements
Verify that total proposed interior lighting wattage does not exceed that allowed per COM*check* Compliance Certificate. Later, confirm that the installed lighting matches the proposed design wattage.

Details
If the permit applicant has provided a COM*check* report, verify that Section 4, Item 1, "Interior Lighting & Power" indicates 'YES' under 'Complies' on the COM*check* 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	Proposed Watts	Complies
9208	6544	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 only be met by installing LED lamps.

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 additional lighting control functions must be implemented for the space. The symbol "ADD2" indicates that at least one more additional control function must be installed 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. (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/ft^2.
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.

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

An occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space.

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:

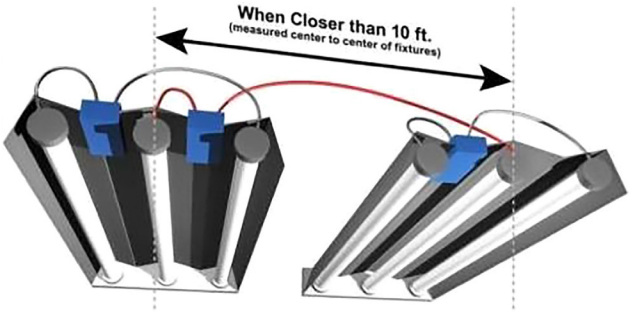
- Fixtures not on same switch
- Recessed fixtures > 10 ft. apart
- Emergency circuits

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. or one hour after close and before open of the business. (This can be controlled by 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:

1. Undeveloped park areas – 0 watts
2. Developed park areas – 500 watts
3. Residential and neighborhood business areas – 500 watts
4. All other areas – 750 watts
5. 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*

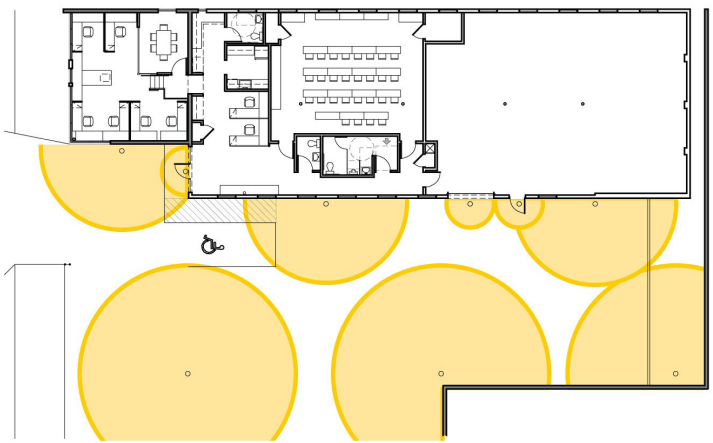
Details *(continued from previous page)*
Designers should show areas and calculations on plans. Inspectors should confirm that square footage of exterior illuminated areas is accurate per site drawings and that area/surface designations are logical.

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 ft2	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 COM*check* Exterior Lighting Area/Surface Power Calculation.

Details
Verify that Section 4, Item 1 of COM*check* 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.

Exemption Claims—Exterior Fixtures

Inspection Requirements
Verify that COM*check* Exterior Lighting Fixture Schedule matches construction documents.

Details
Verify that installed lamp type, wattage per lamp, ballast type, and wattage match COM*check* 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 and must only be equipped with a separate control system, which may be operated automatically or manually.

Exemption claims may include lighting used for the following exterior applications:

- 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:
        1. Status indicator (as applicable) operates correctly
        2. Controlled lights turn off or down to the permitted level within the required time
        3. For auto-on occupant sensors, the lights turn on to the permitted level when someone enters the space
        4. For manual-on sensors, the lights turn on only when manually activated
        5. 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.

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.

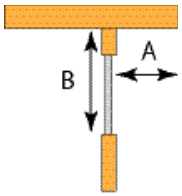
Code reference IECC 2015 - Section C405

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

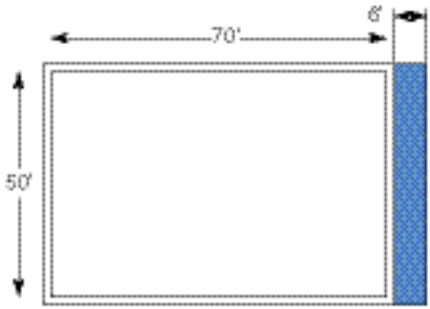
Option 1: Glazing U=0.50, SHGC=0.52
Option 2: Glazing U= 0.36, SHGC = 0.44

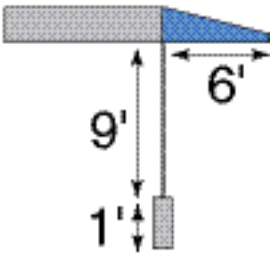
Does either option comply with the CZ3 prescriptive glazing requirements of 90.1?



PF = A/B

Projection Factor (PF) and SHGC
PF= Ration 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 x 0.56 = 0.29 (does not comply with prescriptive 0.25)
- Option 2, effective SHGC: 0.44 x 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]