ALABAMA + ASHRAE 90.1 2007

Commercial ENERGY CODE Field Guide

ADECA

2009 IECC + ASHRAE 90.1 - 2007:

Commercial Energy Code Field Guide

Alabama Department of Economic and Community Affairs

Energy Division

Montgomery, Alabama

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Introduction

The 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 90.1-2007. 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 (DOE) COM*check* Compliance Certificates for Envelope, Interior Lighting and Exterior Lighting, Service Water Heating, as well as ASHRAE 90.1-2007's 15 requirements per the Simplified Compliance Approach for Mechanical Systems. For every inspection requirement there are additional details, code references, and graphics/photographs to assist code officials.

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 COM*check* 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 US Secretary of the Interior need not comply with ASHRAE 90.1-2007 requirements.*

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 climate zones 3 through 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 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 CZ 2, 10 Btu/h·ft^2 of floor area in CZ 3, and 15 Btu/h·ft^2 of floor area in CZ 4.

indirectly conditioned space: an enclosed space within a building that is not a heated space or a cooled space, which 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: (a) *nonresidential conditioned* space, (b) *residential conditioned* space, and (c) *semiheated* space. These designations are defined as follows:

nonresidential: all occupancies other than residential.

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

semiheated: an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft2 of floor area but is not a conditioned space. The heating system must not exceed 5 Btu/h·ft2 for CZ 2, 10 Btu/h·ft2 for CZ 3, or 15 Btu/h·ft2 for CZ 4; otherwise the space is heated enough to be considered conditioned.

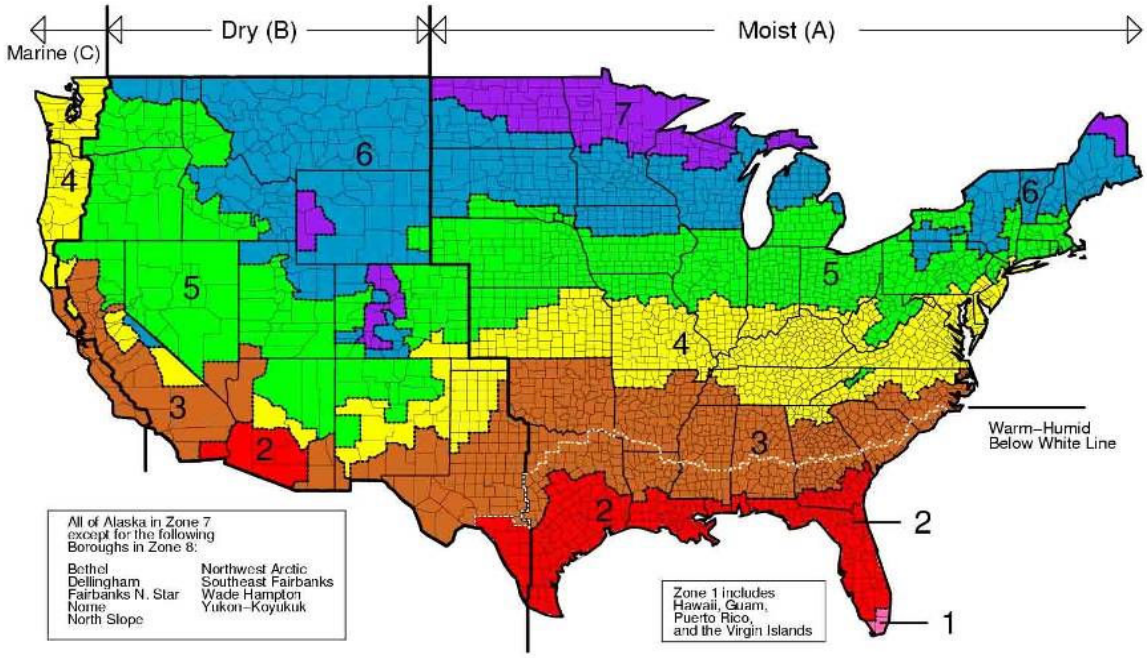
Inspections

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:

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

Climate Zone

Many of the requirements in the energy code depend on the climate zone of the home. This field guide lists the requirement by Climate Zone when applicable. The majority of Alabama is based in Climate Zone 3A. Baldwin and Mobile County are in Climate Zone 2A. To look up your climate zone by county, see the table on the following page:



Alabama CLIMATE ZONES BY COUNTY

Climate Zone 2A	
Baldwin	Mobile

**All other Alabama counties are located in Climate Zone 3A.*

COM*check* Software Version 3.9.0

Envelope Compliance Certificate

90.1 (2007) Standard

Section 1: Project Information

Project Type: **New Construction**
Project Title :

Construction Site: Owner/Agent: Designer/Contractor:

Section 2: General Information

Building Location (for weather data): **Montgomery, Alabama**
Climate Zone: **3a**
Building Type for Envelope Requirements: **Non-Residential**

Building Type	Floor Area
Unspecified	0

Section 3: Requirements Checklist

Envelope TBD: No envelope assemblies specified

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

Insulation:

- ☐ 1. Open-blown or poured loose-fill insulation has not been used in attic roof spaces with ceiling slope greater than 3 in 12.
- ☐ 2. Wherever vents occur, they are baffled to deflect incoming air above the insulation.
- ☐ 3. Recessed lights, equipment and ducts are not affecting insulation thickness.
- ☐ 4. No roof insulation is installed on a suspended ceiling with removable ceiling panels.
- ☐ 5. All exterior insulation is covered with protective material.
- ☐ 6. Cargo and loading dock doors are equipped with weather seals.

Fenestration and Doors:

- ☐ 7. Windows and skylights are labeled and certified by the manufacturer for U-factor and SHGC.
- ☐ 8. Fixed windows and skylights unlabeled by the manufacturer have been labeled using the default U-factor and SHGC.
- ☐ 9. Other unlabeled vertical fenestration, operable and fixed, that are unlabeled by the manufacturer have been site labeled using the default U-factor and SHGC. No credit has been given for metal frames with thermal breaks, low-emissivity coatings, gas fillings, or insulating spacers.

Air Leakage and Component Certification:

- ☐ 10. All joints and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.
- ☐ 11. Windows, doors, and skylights certified as meeting leakage requirements.
- ☐ 12. Component R-values & U-factors labeled as certified.
- ☐ 13. 'Other' components have supporting documentation for proposed U-Factors.
- ☐ 14. Building entrances that separate conditioned space from the exterior have an enclosed vestibule with all doors equipped with self-closing devices. Interior and exterior doors in the closed position are no less than 7 ft apart. Conditioned vestibules comply with the requirements for a conditioned space. Unconditioned vestibules comply with the requirements of a semiheated space.

SAMPLE

Exceptions:

- ❑ Building entrances with revolving doors.
- ❑ Doors not intended to be used as a building entrance.
- ❑ Doors opening directly from a dwelling unit.
- ❑ Buildings less than four stories above grade and less than 10,000 ft2 in area.
- ❑ Doors that open directly from a space less than 3000 sq. ft. in area and is separate from the building entrance.

SAMPLE

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Interior Lighting and Power Compliance Certificate

90.1 (2007) Standard

Section 1: Project Information

Project Type: **New Construction**
Project Title :

Construction Site: Owner/Agent: Designer/Contractor:

Section 2: Interior Lighting and Power Calculation

A	B Floor Area	C Allowed Watts / ft2	D Allowed Watts
	0	0	0
		Total Allowed Watts =	N/A

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)
(wattage exempt for this area)				
			Total Proposed Watts =	0

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
N/A	0	--

❑ 2. Exit signs 5 Watts or less per sign.

Controls, Switching, and Wiring:

❑ 3. Independent manual or occupancy sensing controls for each space (remote switch with indicator allowed for safety or security).

❑ 4. Occupant sensing control in class rooms, conference/meeting rooms, and employee lunch and break rooms.

Exceptions:

❑ Spaces with multi-scene control; shop classrooms, laboratory classrooms, and preschool through 12th grade classrooms.

❑ 5. Automatic shutoff control for lighting in >5000 sq.ft buildings by time-of-day device, occupant sensor, or other automatic control.

Exceptions:

❑ 24 hour operation lighting; patient care areas; where auto shutoff would endanger safety or security.

❑ 6. Master switch at entry to hotel/motel guest room.

❑ 7. Separate control device for display/accent lighting, case lighting, task lighting, nonvisual lighting, lighting for sale, and demonstration lighting.

❑ 8. Tandem wired one-lamp and three-lamp ballasted luminaires (No single-lamp ballasts).

Exceptions:

❑ Electronic high-frequency ballasts.

SAMPLE

- ❑ Luminaires not on same switch.
- ❑ Recessed luminaires 10 ft. apart or surface/pendant not continuous.
- ❑ Luminaires on emergency circuits.

Voltage Drop:

❑ 9. Feeder conductors have been designed for a maximum voltage drop of 2 percent.

❑ 10. Branch circuit conductors have been designed for a maximum voltage drop of 3 percent.

Interior Lighting TBD: Invalid building use type

SAMPLE

COM*check* Software Version 3.9.0

Exterior Lighting Compliance Certificate

90.1 (2007) Standard

Section 1: Project Information

Project Type: **New Construction**
Project Title :

Construction Site: Owner/Agent: Designer/Contractor:

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
	0	0	No	0	0
			Total Tradable Watts* =	0	0
			Total Allowed Watts =	0	
			Total Allowed Supplemental Watts** =	0	

* 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.

Section 3: Exterior 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)
			Total Tradable Proposed Watts =	0

Section 4: Requirements Checklist

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 to total allowed watts.

Compliance: Invalid exterior use type

Controls, Switching, and Wiring:

❑ 2. All exemption claims are associated with fixtures that have a control device independent of the control of the nonexempt lighting.

❑ 3. All lighting fixtures are controlled by a photosensor or astronomical time switch that is capable of automatically turning off the fixture when sufficient daylight is available or the lighting is not required.

Exceptions:

❑ Covered vehicle entrance/exit areas requiring lighting for safety, security and eye adaptation.

Exterior Lighting Efficacy:

❑ 4. All exterior building grounds luminaires that operate at greater than 100W have minimum efficacy of 60 lumen/watt.

Exceptions:

❑ Lighting that has been claimed as exempt and is identified as such in Section 3 table above.

❑ Lighting that is specifically designated as required by a health or life safety statue, ordinance, or regulation.

SAMPLE

- ❑ Emergency lighting that is automatically off during normal building operation.
- ❑ Lighting that is controlled by motion sensor.

Exterior Lighting TBD: Invalid exterior use type

SAMPLE

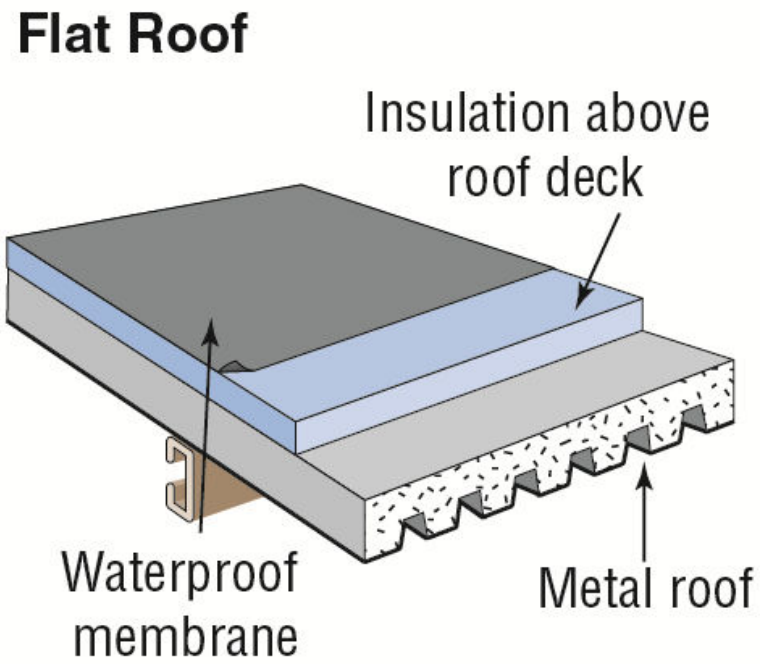
Roof—Insulation Entirely Above Deck

Inspection Requirements	Verify R-Value of continuous insulation (c.i.) above roof deck reflects the value(s) in the COM*check* Compliance Certificate (if applicable).
Details	Rigid foam board installed above the roof deck is a more effective application of roof insulation than attic insulation, as it protects the roof deck from the sun's radiant energy, and reduces heat transfer to the conditioned space. Ensure that the minimum R-value is met at the lowest point on the roof (adjacent to drains and scuppers).

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-20.0 c.i.	R-20.0 c.i.	R-3.8 c.i.
3	R-20.0 c.i.	R-20.0 c.i.	R-5.0 c.i.

Code Reference ASHRAE 90.1-2007—Section 5.5.3.1



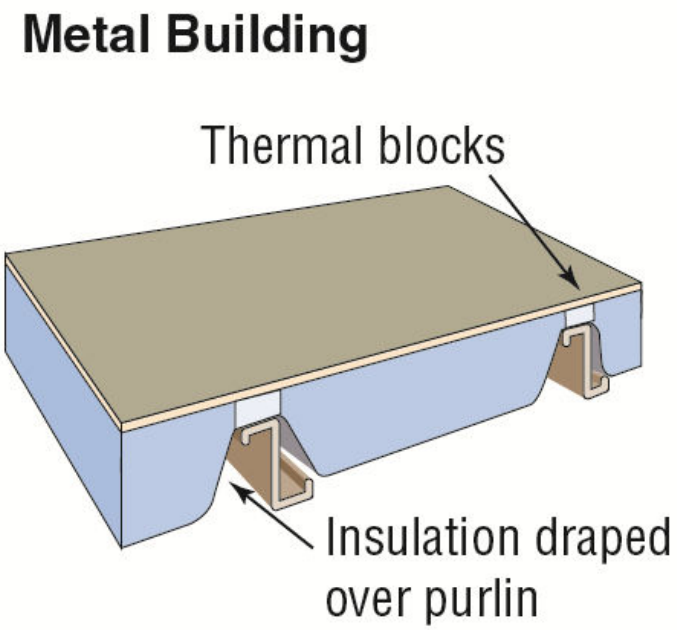
Roof—Metal Building

Inspection Requirements	Verify R-Value of metal building insulation reflects the value(s) in the COM*check* Compliance Certificate and that thermal blocks are installed (if applicable).
Details	Due to compression issues, the code typically requires insulation to be draped perpendicular to the roof purlins with thermal blocks. Perhaps better described as strips than blocks, this min. 1" thick rigid insulating material runs the full length of each purlin / girt acting as a thermal break to reduce conductive energy transfer to / from the metal roof .

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-19.0	R-19.0	R-6.0
3	R-19.0	R-19.0	R-10.0

Code Reference: ASHRAE 90.1-2007—Section 5.5.3.1



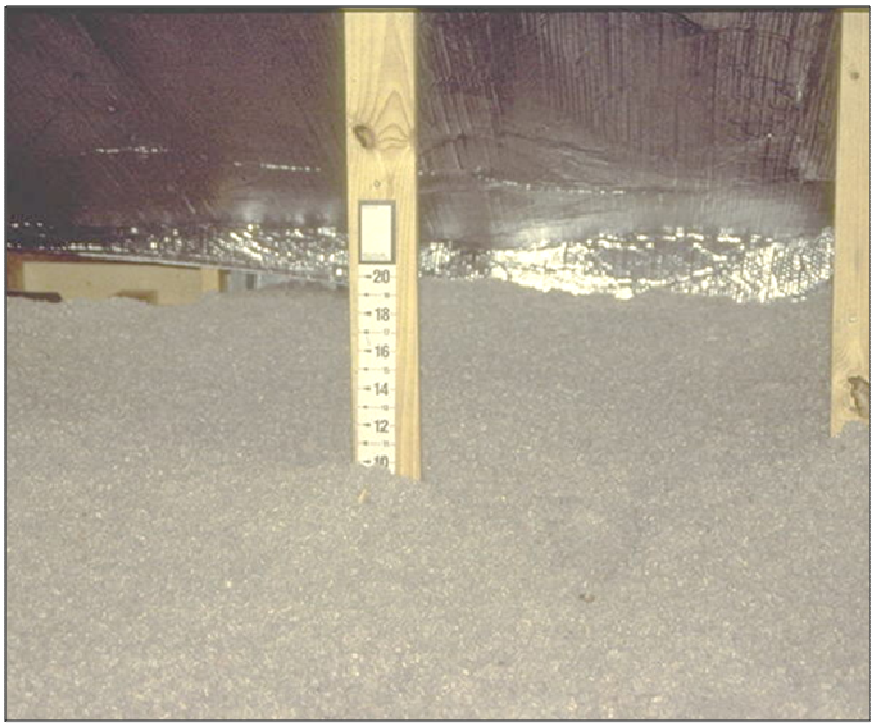
Roof—Attic and Other

Inspection Requirements	Verify R-Value of insulation reflects the value(s) in 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 plane established by the outermost face of each exterior wall.

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-38.0	R-38.0	R-13.0
3	R-38.0	R-38.0	R-19.0

Code Reference ASHRAE 90.1-2007—Section 5.5.3.1



Rulers installed every 300 sf are a good way to verify blown or loose fill attic insulation depth.

Walls, Above Grade—Mass

Inspection Requirements	Verify R-Value of continuous insulation (c.i.) on mass walls reflects the value in the COM*check* Compliance Certificate (if applicable).			
Details	Mass walls are thick, heavy walls—typical materials are concrete, CMU or solid multi-wythe brick.			
Prescriptive Values	**Climate Zone**	**Non-Residential**	**Residential**	**Semi-Heated**
	2	R-5.7 c.i.	R-7.6 c.i.	N/A
	3	R-7.6 c.i.	R-9.5 c.i.	N/A
Code Reference	ASHRAE 90.1-2007—Section 5.5.3.2			

Walls, Above Grade—Metal Building

Inspection Requirements	Verify R-Value of insulation on metal building walls reflects the value(s) in the COM*check* Compliance Certificate (if applicable).			
Details	Insulation is draped perpendicular to purlins . Compression at purlins is allowed.			
Prescriptive Values	**Climate Zone**	**Non-Residential**	**Residential**	**Semi-Heated**
	2	R-13.0	R-13.0	R-6.0
	3	R-13.0	R-13.0	R-6.0
Code Reference	ASHRAE 90.1-2007—Section 5.5.3.2			

Walls, Above Grade—Steel-Framed

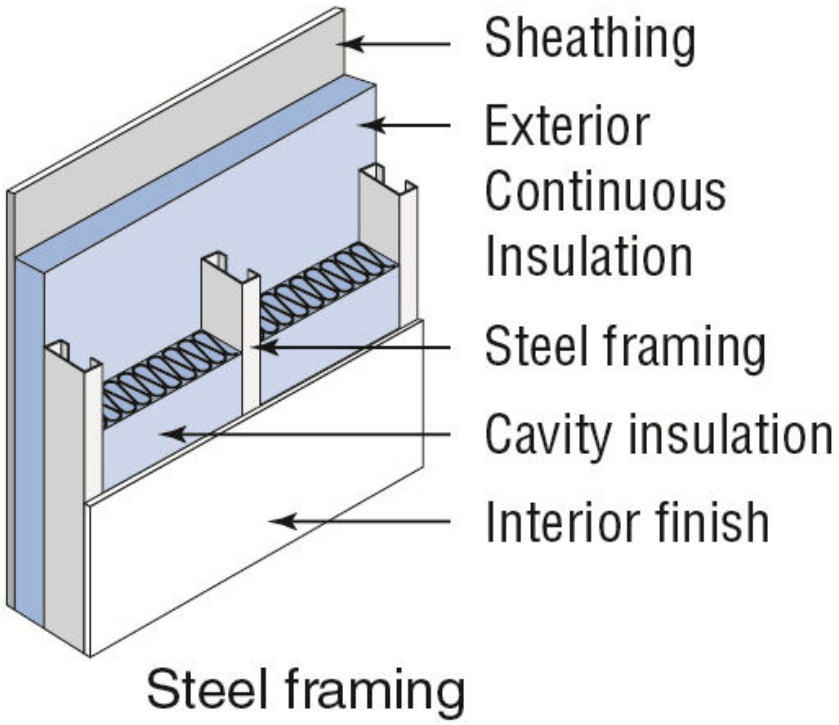
Inspection Requirements	Verify R-Value of insulation at steel-framed walls reflects the value(s) in the COM*check* Compliance Certificate.
Details	Metal readily conducts energy; continuous insulation across the face of a metal stud wall (preferably exterior) eliminates the thermal bridging effect. Therefore the code sometimes requires both cavity insulation and continuous insulation. Verify cavity insulation is in permanent continuous contact with the exterior sheathing with no gaps or voids.

Prescriptive Values

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

Note: two values indicate cavity + continuous insulation

Code Reference ASHRAE 90.1-2007—Section 5.5.3.2



Walls, Above Grade—Wood-Framed

Inspection Requirements	Verify R-Value of insulation on wood-framed walls reflects the value(s) in the COM*check* Compliance Certificate (if applicable).
Details	Verify cavity insulation is in permanent continuous contact with the exterior sheathing with no gaps or voids.

Prescriptive Values

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

Code Reference ASHRAE 90.1-2007—Section 5.5.3.2

R-value of insulation is reduced by gaps, voids, compression, moisture and when not in contact with air barrier on all sides.

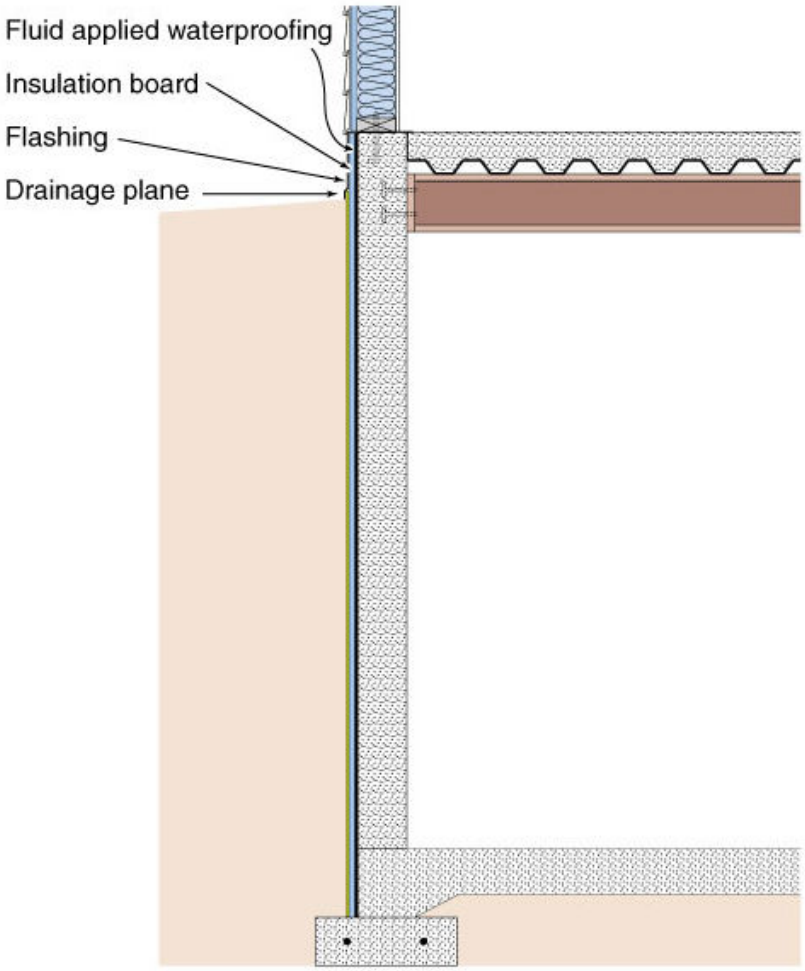
Walls, Below Grade

Inspection Requirements	Verify R-Value of insulation on below grade walls reflects the value(s) in the COM*check* Compliance Certificate (if applicable).
Details	**Insulation on below grade walls is NOT REQUIRED in Climate Zones 2 or 3.**

Prescriptive Values

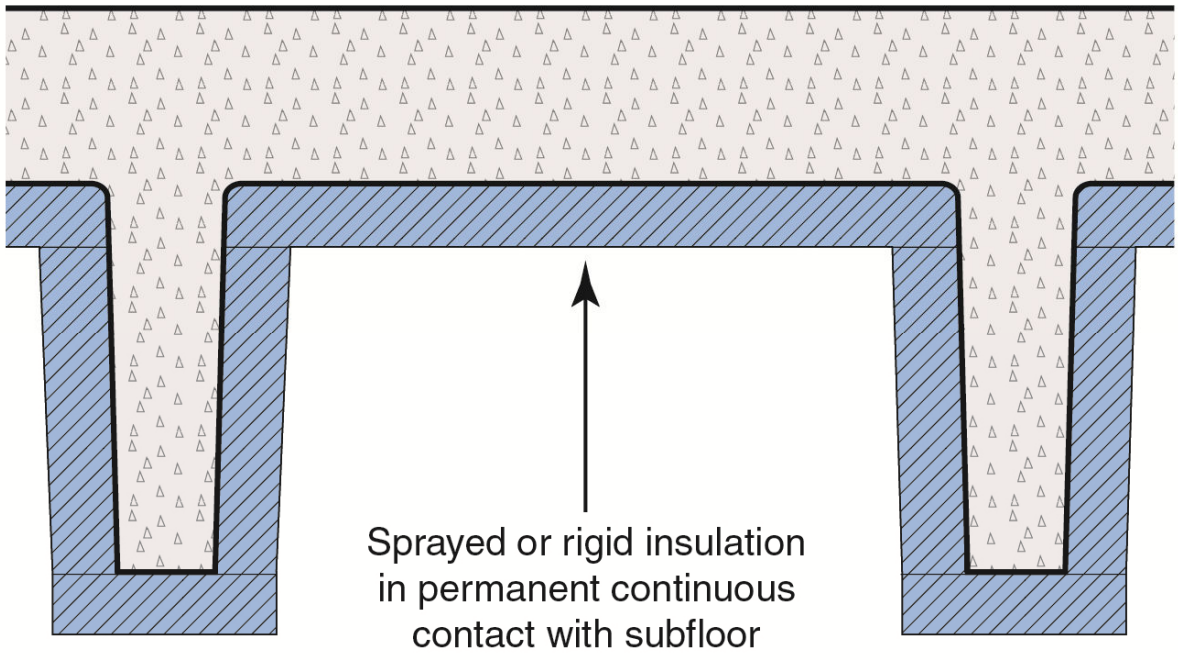
Climate Zone	Non-Residential	Residential	Semi-Heated
2	N/A	N/A	N/A
3	N/A	N/A	N/A

Code Reference ASHRAE 90.1-2007—Section 5.5.3.3



Floors—Mass

Inspection Requirements	Verify R-Value of continuous insulation on the mass floors reflects the value in the COM*check* Compliance Certificate (if applicable).			
Details	Insulation should cover completely, with no structure visible.			
Prescriptive Values	**Climate Zone**	**Non-Residential**	**Residential**	**Semi-Heated**
	2	R-6.3 c.i.	R-8.3 c.i.	N/A
	3	R-6.3 c.i.	R-8.3 c.i.	N/A
Code Reference	ASHRAE 90.1-2007—Section 5.5.3.4			



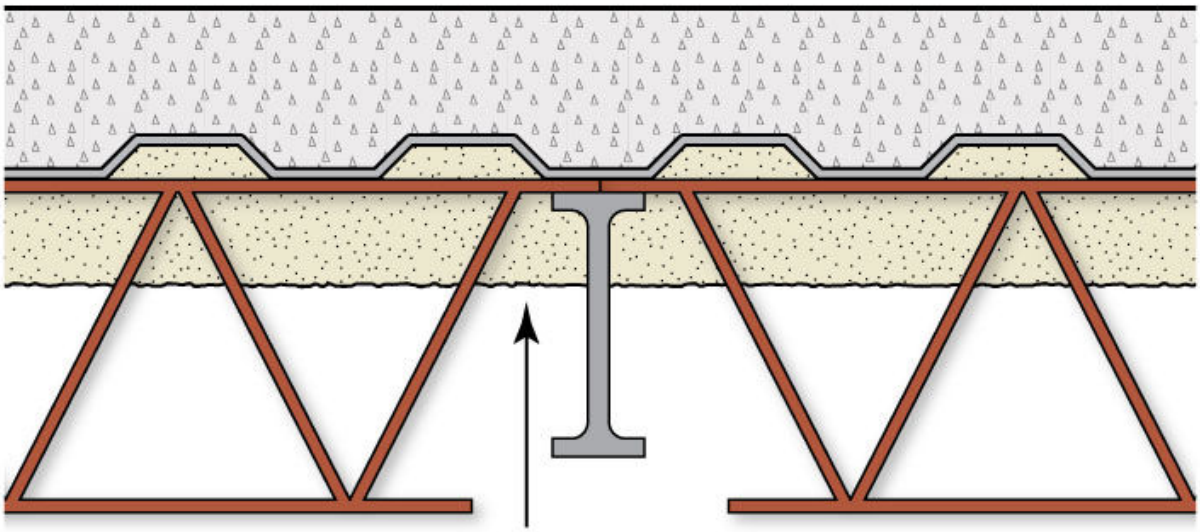
Floors, Steel-Joist

Inspection Requirements	Verify R-Value of joist cavity insulation reflects the value in the COMcheck Compliance Certificate and insulation is in permanent continuous contact with the underside of the floor deck.
Details	Air spaces created by floor insulation that has dropped from direct contact with the underside of a floor will allow convective air flow and negate the thermal benefits of the insulation.

Prescriptive Values

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

Code Reference ASHRAE 90.1-2007—Section 5.5.3.4



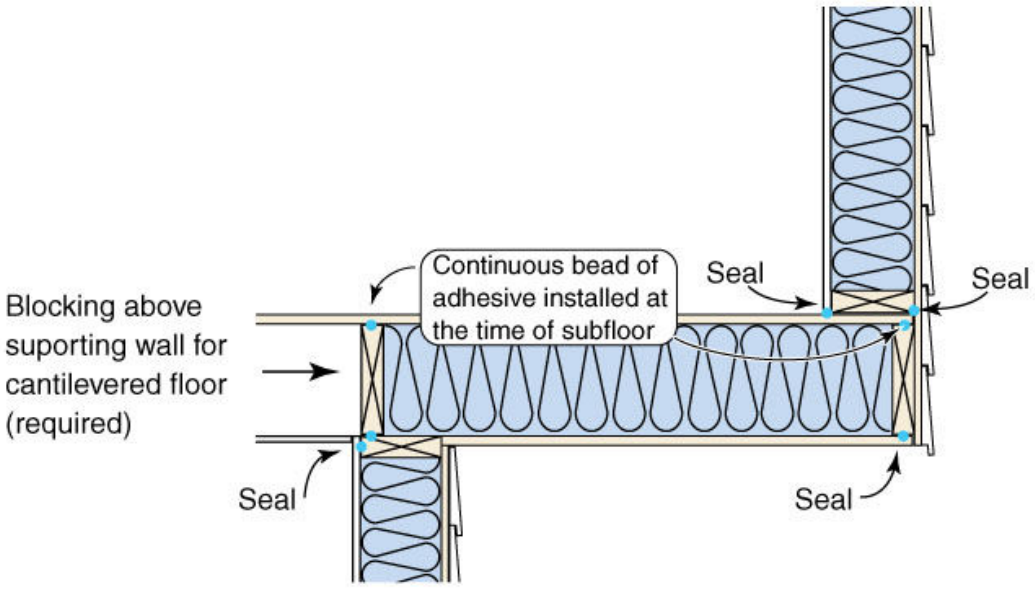
Floors, Wood-Framed

Inspection Requirements	Verify R-Value of floor joist cavity insulation reflects the value in the COMcheck Compliance Certificate and insulation is in permanent continuous contact with the underside of the floor deck.
Details	Air spaces created by floor insulation that has dropped from direct contact with the underside of a floor will allow convective air flow and negate the thermal benefits of the insulation. Cantilevered floors must be insulated and the joist cavities blocked above the supporting exterior wall.

Prescriptive Values

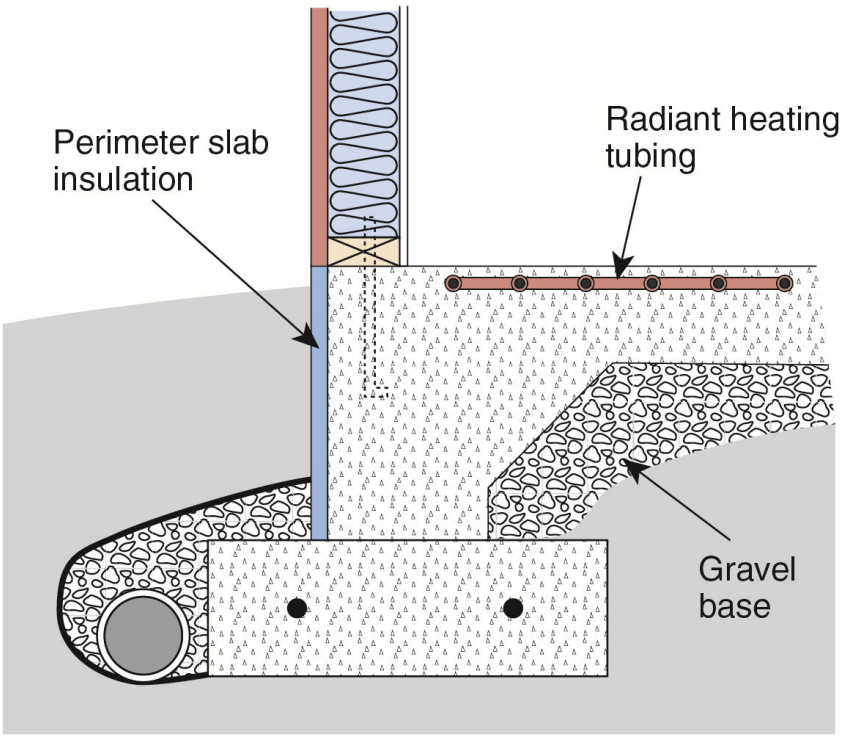
Climate Zone	Non-Residential	Residential	Semi-Heated
2	R-19	R-30	R-13
3	R-19	R-30	R-13

Code Reference ASHRAE 90.1-2007—Section 5.5.3.4



Floors, Slab-On-Grade—Heated Floors

Inspection Requirements	Verify R-Value and extent of slab perimeter insulation reflects the value(s) in the COMcheck Compliance Certificate.			
Details	Heat loss at slab edge is minimized by slab perimeter insulation installed per ASHRAE 90.1-2007 Tables 5.5-2 thru 5.5-4. Unheated slab-on-grade floors do not require slab perimeter insulation in Climate Zones 2 or 3.			
Prescriptive Values	**Climate Zone**	**Non-Residential**	**Residential**	**Semi-Heated**
	2	R-7.5 for 12 in.	R-7.5 for 12 in.	R-7.5 for 12 in.
	3	R-10 for 24 in.	R-10 for 24 in.	R-7.5 for 12 in.
Code Reference	ASHRAE 90.1-2007—Section 5.5.3.5			



Note: Insulation under slab is not required nor useful in CZs 2 & 3.

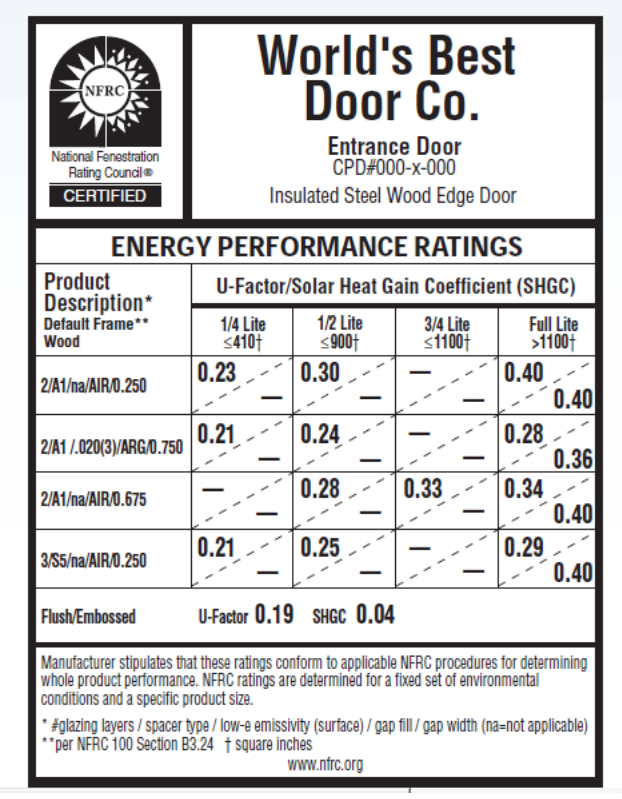
Opaque Doors, Swinging

Inspection Requirements	Verify assembly U-value as stamped on product is no higher than the value in the COMcheck Compliance Certificate.
Details	Labeling of U-values on doors is not industry practice, so ask for documentation demonstrating compliance if no label is present. Maximum U-Factor (0.70) is same for all building types in Climate Zones 2 & 3.

Prescriptive Values

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

Code Reference	ASHRAE 90.1-2007—Section 5.5.3.6



National Fenestration Rating Council® CERTIFIED

World's Best Door Co.

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

ENERGY PERFORMANCE RATINGS

Product Description* Default Frame** Wood	U-Factor/Solar Heat Gain Coefficient (SHGC)			
	1/4 Lite ≤410†	1/2 Lite ≤900†	3/4 Lite ≤1100†	Full Lite >1100†
2/A1/na/AIR/0.250	0.23 / —	0.30 / —	— / —	0.40 / 0.40
2/A1 /.020(3)/ARG/0.750	0.21 / —	0.24 / —	— / —	0.28 / 0.36
2/A1/na/AIR/0.675	— / —	0.28 / —	0.33 / —	0.34 / 0.40
3/S5/na/AIR/0.250	0.21 / —	0.25 / —	— / —	0.29 / 0.40

Flush/Embossed U-Factor 0.19 SHGC 0.04

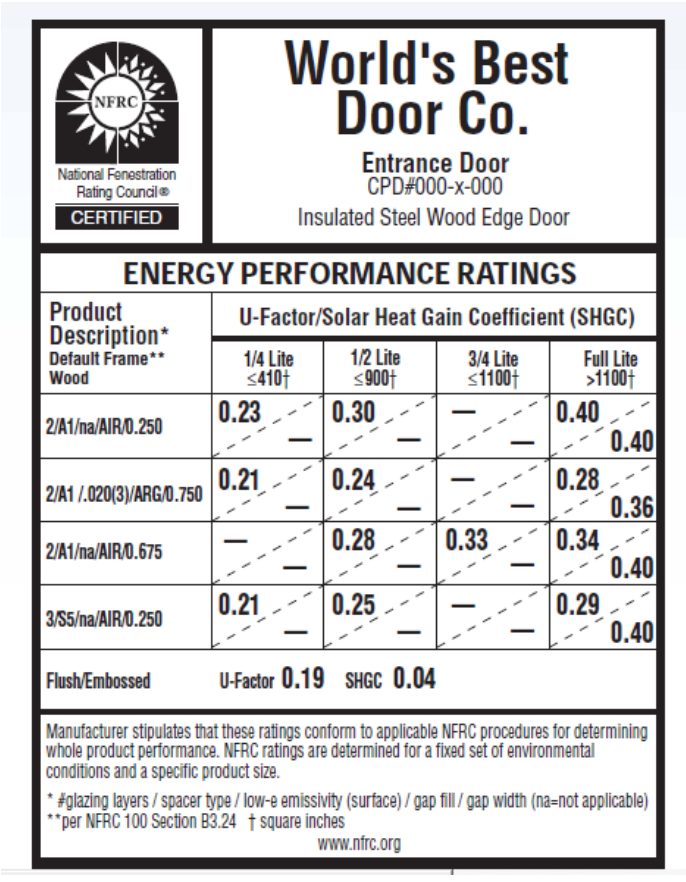
Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size.

* #glazing layers / spacer type / low-e emissivity (surface) / gap fill / gap width (na=not applicable)
**per NFRC 100 Section B3.24 † square inches

www.nfrc.org

Opaque Doors, Nonswinging

Inspection Requirements	Verify assembly U-value as stamped on product is no higher than the value in the COMcheck Compliance Certificate.			
Details	Labeling of U-values on doors is not industry practice, so ask for documentation demonstrating compliance if no label present.			
Prescriptive Values	**Climate Zone**	**Non-Residential**	**Residential**	**Semi-Heated**
	2	U-1.45	U-0.50	U-1.45
	3	U-1.45	U-0.50	U-1.45
Code Reference	ASHRAE 90.1-2007—Section 5.5.3.6			



National Fenestration Rating Council®
CERTIFIED

World's Best Door Co.

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

ENERGY PERFORMANCE RATINGS

Product Description* Default Frame** Wood	U-Factor/Solar Heat Gain Coefficient (SHGC)			
	1/4 Lite ≤410†	1/2 Lite ≤900†	3/4 Lite ≤1100†	Full Lite >1100†
2/A1/na/AIR/0.250	0.23 / —	0.30 / —	— / —	0.40 / 0.40
2/A1 /.020(3)/ARG/0.750	0.21 / —	0.24 / —	— / —	0.28 / 0.36
2/A1/na/AIR/0.675	— / —	0.28 / —	0.33 / —	0.34 / 0.40
3/S5/na/AIR/0.250	0.21 / —	0.25 / —	— / —	0.29 / 0.40
Flush/Embossed	U-Factor 0.19 SHGC 0.04			

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size.

* #glazing layers / spacer type / low-e emissivity (surface) / gap fill / gap width (na=not applicable)
**per NFRC 100 Section B3.24 † square inches

www.nfrc.org

Vertical Glazing, 0% - 40% of Wall Area

Inspection Requirements	Verify assembly U-value & SHGC as stamped on product are no higher than the values in the COMcheck Compliance Certificate.
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. Assembly U-value & SHGC can be verified either with a factory installed label or by a certificate from the manufacturer. SHGC in Climate Zone 2 & 3 can be difficult to achieve.

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-0.70, SHGC-0.25	U-0.70, SHGC-0.25	U-1.20, Not required
3	U-0.60, SHGC-0.25	U-0.60, SHGC-0.25	U-1.20, Not required

Prescriptive values above are for metal framing (curtainwall / storefront). For other vertical glazing prescriptive values refer to ASHRAE 90.1-2007 Tables 5.5-2 thru 5.5-4.

Code Reference ASHRAE 90.1-2007—Sections 5.5.4 & 5.8.2


National Fenestration Rating Council®
CERTIFIED

World's Best Window Co.

Millennium 2000+
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: **Vertical Slider**

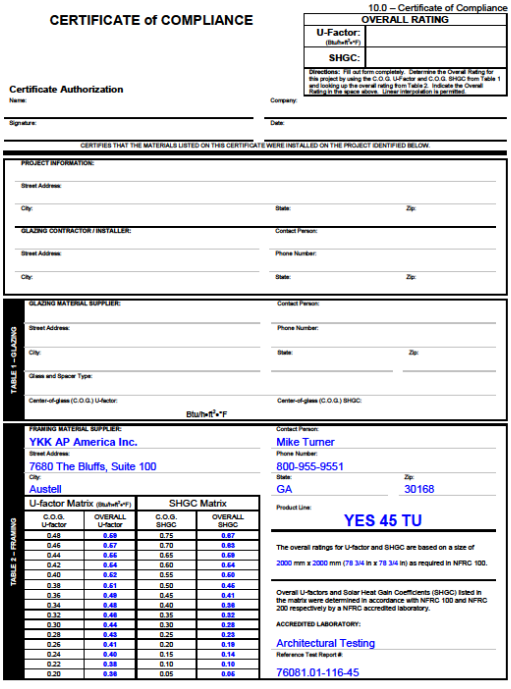
ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.30

ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.
www.nfrc.org


CERTIFICATE of COMPLIANCE

10.0 – Certificate of Compliance

OVERALL RATING
U-Factor: (Btu/hr•ft²•°F)
SHGC:

Certificate Authorization

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

PROJECT INFORMATION:

GLAZING CONTRACTOR / INSTALLER:

TABLE 1 – GLAZING

GLAZING MATERIAL SUPPLIER:

Btu/hr•ft²•°F

TABLE 2 – FRAMING

FRAMING MATERIAL SUPPLIER: YKK AP America Inc.
7680 The Bluffs, Suite 100
Austell
Contact Person: Mike Turner
Phone Number: 800-955-9551
State: GA
Zip: 30168
Product Line: YES 45 TU

U-factor Matrix (Btu/hr•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	0.65
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	0.46
0.36	0.48	0.45	0.41
0.34	0.46	0.40	0.36
0.32	0.44	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

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

COM*check* ENVELOPE COMPLIANCE CERTIFICATE

Skylights

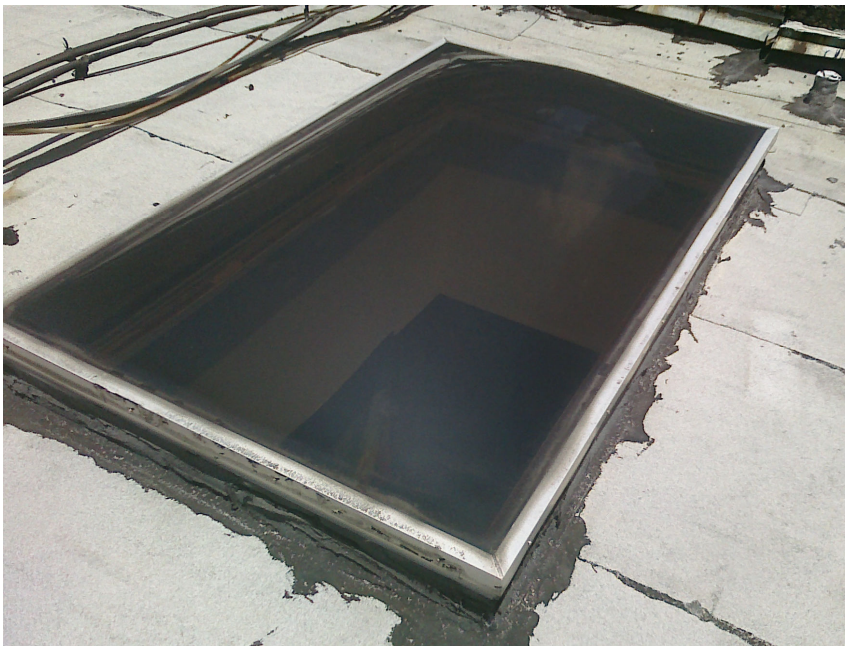
Inspection Requirements	Verify assembly U-value & SHGC as stamped on product are no higher than the values in the COMcheck Compliance Certificate.
Details	The Prescriptive Building Envelope Option is applicable only if the total skylight area is less than 5% of the total roof area for each space-conditioning category. Assembly U-value & SHGC can be verified either with a factory installed label or by a certificate from the manufacturer. SHGC in CZ 2 & 3 can be difficult to achieve.

Prescriptive Values

Climate Zone	Non-Residential	Residential	Semi-Heated
2	U-1.98, SHGC-0.36	U-1.98, SHGC-0.19	U-1.98
3	U-1.17, SHGC-0.39	U-1.17, SHGC-0.36	U-1.98

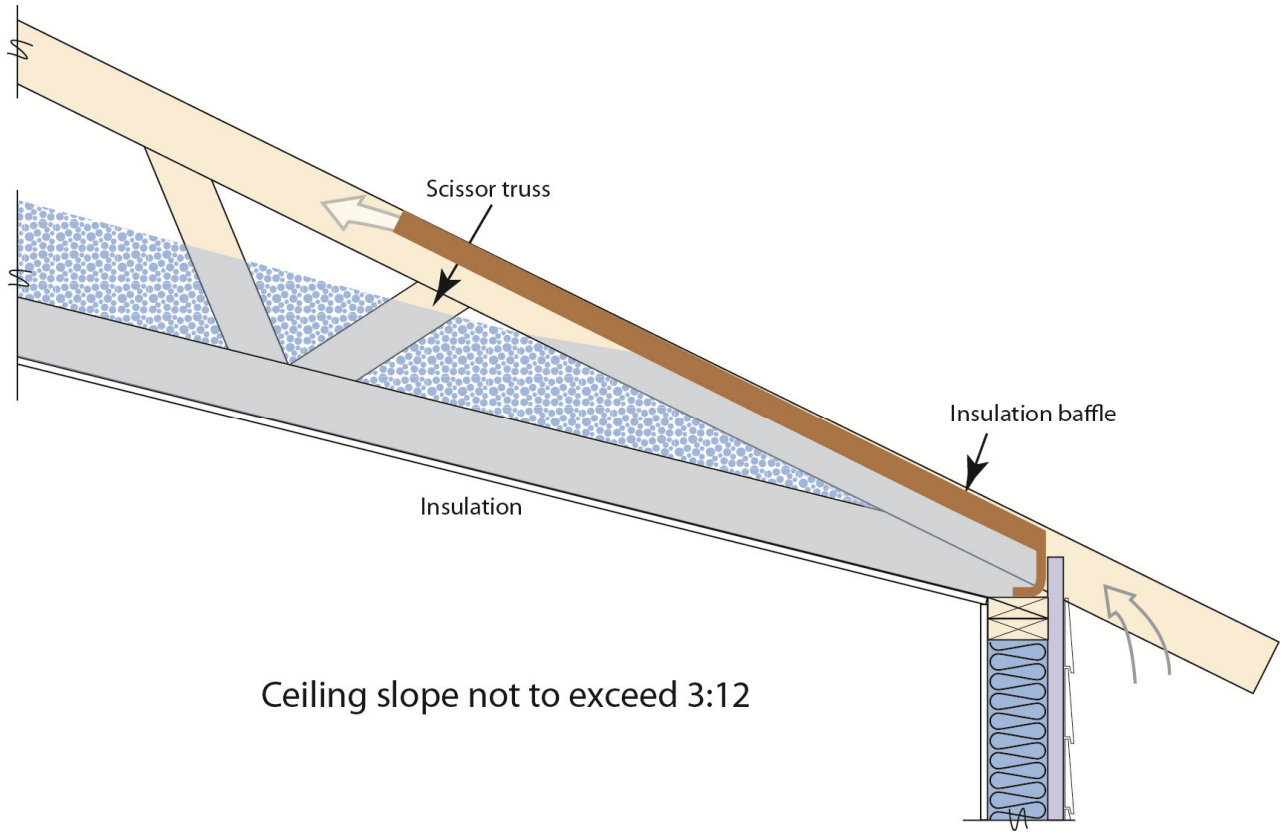
Prescriptive values above are for glass skylights comprising less than 2% of roof area per space category. For other vertical glazing prescriptive values refer to ASHRAE 90.1-2007 Tables 5.5-2 thru 5.5-4.

Code Reference ASHRAE 90.1-2007—Sections 5.5.4 & 5.8.2



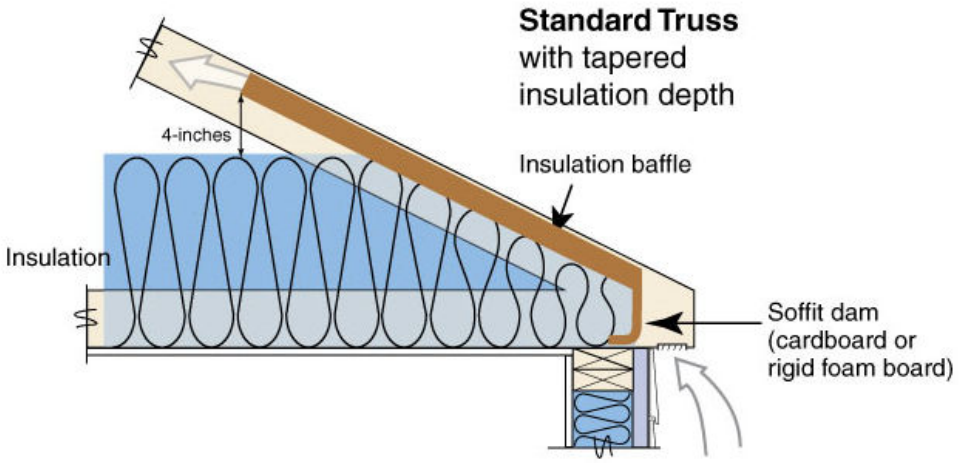
Open-blown or poured loose-fill insulation in attics

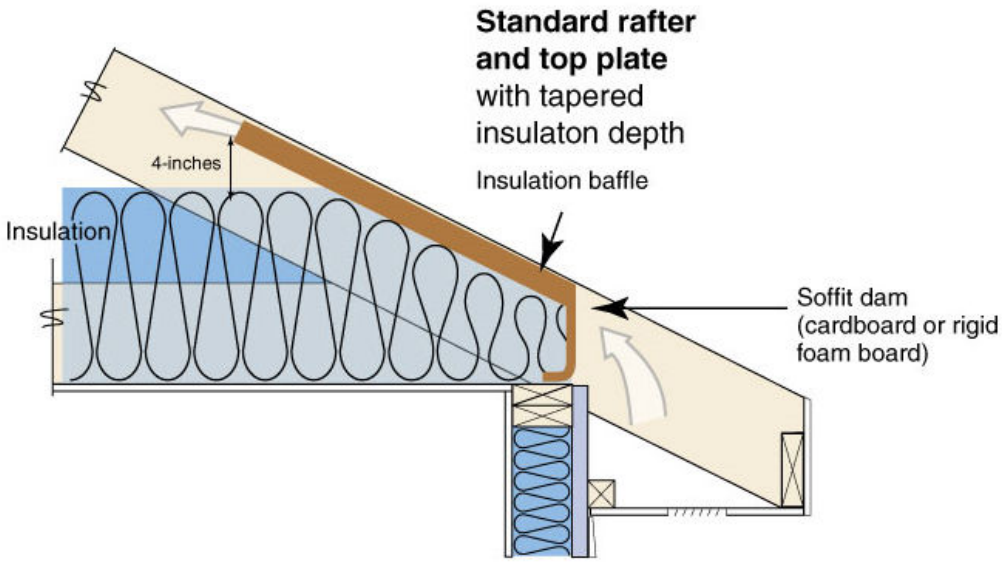
Inspection Requirements	Verify that open-blown or poured loose-fill insulation are not used in attic roof spaces over ceilings with slope greater than 3:12.
Details	Loose insulation over ceilings sloped steeper than 3:12 will not maintain a uniform thickness or coverage.
Code Reference	ASHRAE 90.1-2007—Section 5.8.1.3



Vent baffles in attics

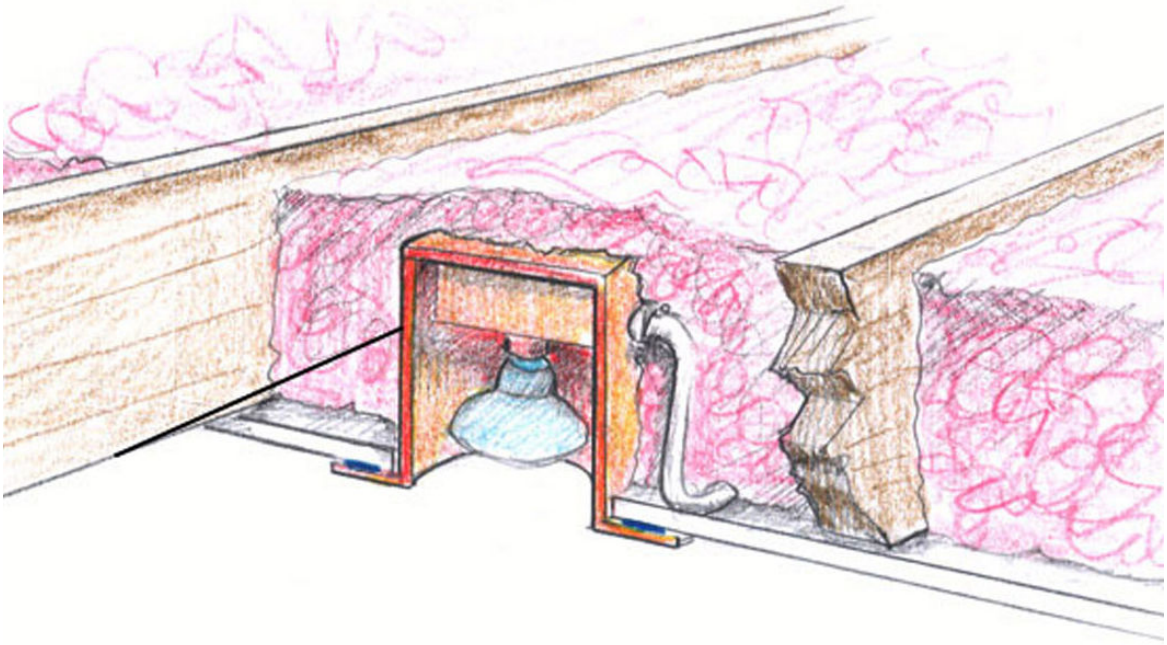
Inspection Requirements	Verify that wherever vents occur, they are baffled to deflect incoming air above insulation.
Details	Batt and loose insulation can be blown out of place by wind passing through vents. Also, the resistance to energy transfer by batt and loose insulation is greatly diminished by convective air flow (often referred to as “wind-washing”).
Code Reference	ASHRAE 90.1-2007—Section 5.8.1.4





Insulation Thickness

Inspection Requirements	Verify that recessed lights, equipment and ducts do not affect insulation thickness.
Details	Insulation depth should be maintained above can lights, and below ducts and equipment placed in an attic. Compressed batt and/or loose insulation will not meet prescribed R-values. Recessed lighting in an insulated ceiling should be airtight and insulation contact (IC) rated.
Code Reference	ASHRAE 90.1-2007—Section 5.8.1.6



Depth not maintained above recessed light

Suspended ceilings

Inspection Requirements	Verify that roof insulation is not installed on a suspended ceiling with removable ceiling panels.
Details	Suspended ceilings are not an effective air barrier. Furthermore, insulation supported by a suspended ceiling will often be disturbed by maintenance activities, which decreases effectiveness.
Code Reference	ASHRAE 90.1-2007—Section 5.8.1.8

Envelope insulation may not be installed on top of suspended ceiling panels.

Exterior insulation protection

Inspection Requirements	Verify that all exterior insulation is covered with protective material.
Details	Exterior insulation shall be covered with a protective material to prevent damage from sunlight, moisture, landscaping operations, equipment maintenance and wind. In attics and mechanical rooms, a way to access equipment that prevents damaging or compressing the insulation shall be provided. Foundation vents shall not interfere with the insulation. Insulation materials in ground contact shall have a water absorption rate no greater than 0.3%.
Code Reference	ASHRAE 90.1-2007—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 weatherseals

Inspection Requirements	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 at cargo and loading dock doors are NOT REQUIRED in Climate Zones 2 & 3.**
Code Reference	ASHRAE 90.1-2007—Section 5.4.3.3

Labeled Fenestration

Inspection Requirements	Verify that windows and skylights are labeled and certified by the manufacturer for U-factor and SHGC.
Details	A compliance certificate from the manufacturer is also acceptable documentation.
Code Reference	ASHRAE 90.1-2007—Section 5.8.2.4 & 5.8.2.5

Unlabeled Fenestration Products

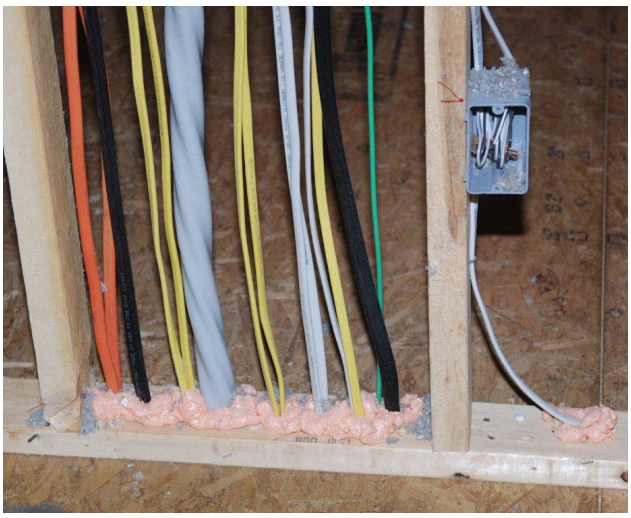
Inspection Requirements	Verify fixed windows and skylights and other vertical fenestration, operable and fixed, that are unlabeled by the manufacturer have been site labeled using the default U-factor and SHGC. Verify no credit has been given for metal frames with thermal breaks, low-emissivity coatings, gas fillings, or insulating spacers.
Details	Default U-factor and SHGC will not meet the Prescriptive Path Method.
Code Reference	ASHRAE 90.1-2007—A8.1 & A8.2

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

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 (specifically the air barrier) can be sources of considerable infiltration and exfiltration, resulting in drastic losses of conditioned air when considered cumulatively. The following areas of the building envelope shall 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
Code Reference	ASHRAE 90.1-2007—Section 5.4.3.1



Fenestration Air Leakage Certification

Inspection Requirements	Verify that windows, doors and skylights are certified as meeting leakage requirements.
Details	If air leakage information is not labeled on product, it is available from manufacturer.
Code Reference	ASHRAE 90.1-2007—Section 5.4.3.2

Component Labels / 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	If the COM*check* compliance certificate uses built-up wall, roof or floor assemblies, make sure each component (such as plywood sheathing or brick) is labeled or that some documentation is provided to demonstrate compliance
Code Reference	ASHRAE 90.1-2007—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	Building entrances that separate conditioned space from the exterior shall be protected with an enclosed vestibule with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. Interior and exterior doors in the closed position shall be no less than 7 ft apart. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. The interior and exterior envelope of unconditioned vestibules shall comply with the requirements of a semiheated space. Exceptions: • 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 Climate Zone 2. • Building entrances in buildings located in Climate Zone 3 that are less than four stories above grade and < 10,000 ft^2 in area. • Doors that open directly from a space that is < 3000 ft^2 in area and is separate from the building entrance.
Details	The use of vestibules helps to reduce the loss of conditioned air (either heated or cooled) when exterior doors are open. Building entrances are defined in Section 3.2 as the means ordinarily used to gain access to the building, so this does not include exits from fire stairwells or the handicapped access doors that might be adjacent to a revolving door. Access to mechanical and electrical rooms are not considered building entrances. While similar, the vestibule requirements in IECC Chapter 5 are not identical to ASHRAE 90.1-2007.
Code Reference	ASHRAE 90.1-2007—Section 5.4.3.4

Lighting and Power Calculation

Inspection Requirements	Verify that square footage and space categories are correct under Section 2: Interior Lighting and Power Calculation.
Details	The lighting and power budgets are based on space or building types (use) and may be calculated using either the Building Area Method or Space-by-Space Method.
Code Reference	ASHRAE 90.1-2007—Section 9.2

Space-by-Space Method

Section 2: Interior Lighting and Power Calculation

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts (B x C)
Common Space Types:Conference/Meeting/Multipurpose	300	1.3	390
Retail:Sales Area	800	1.7	1360
Common Space Types:Restrooms	600	0.9	540
Common Space Types:Electrical/Mechanical	125	1.5	188
Common Space Types:Inactive Storage	60	0.3	18
Common Space Types:Office - Enclosed	150	1.1	165
Common Space Types:Lounge/Recreation	190	1.2	228
Common Space Types:Office - Open Plan	300	1.1	330
		Total Allowed Watts =	3219

Lighting Budget via Space-by-Space Method

Building Area Method

Section 2: Interior Lighting and Power Calculation

A	B Floor Area	C Allowed Watts / ft2	D Allowed Watts
Retail	2525	1.5	3788
		Total Allowed Watts =	3788

Lighting Budget via Building Area Method

Note: If the Building Area Method is utilized, the COMcheck options for Building Type are limited, therefore the code official should verify the designation selected by the project team is appropriate. The "Building Type" designation can greatly impact whether a project passes or fails.

Interior Lighting Fixture Schedule

Inspection Requirements	Verify that COMcheck Interior Lighting Fixture Schedule matches construction documents and what is installed in the field.
Details	Verify installed lamp type, wattage per lamp and ballast type and wattage match COMcheck Interior Lighting & Power Compliance Certificate.
Code Reference	ASHRAE 90.1-2007—Section 9.1.4

LIGHTING FIXTURE SCHEDULE

TYPE	DESCRIPTION	MOUNT	VOLTS	LAMPS	MANUFACTURER
A1	AVante Sconce Prong 10" x 12" 2 lamp contact FLUORESCENT FIXTURE WITH 2- 12W LAMPS.	WALL	120	12W FLUORESCENT	LITHONIA AVSP 2 13TT MDR 120
A2	AV Sconce Prong 10" x 12" 2 lamp contact FLUORESCENT FIXTURE WITH 2- 12W LAMPS. WITH EMERGENCY BALLAST	WALL	120	12W FLUORESCENT	LITHONIA AVSP 2 13TT MDR 120
A3	1x1 AVante Recessed Wall Sconce METAL DIFFUSER AND ACRYLIC OVERLAY	WALL	120	25W FLUORESCENT	LITHONIA AVSR 1 26TRT MDR 120
A4	1x1 AVante Recessed Wall Sconce METAL DIFFUSER AND ACRYLIC OVERLAY WITH EMERGENCY BALLAST	WALL	120	25W FLUORESCENT	LITHONIA AVSR 1 26TRT MDR 120
B1	8" OPEN DOWNLIGHT WITH SPECULAR REFLECTOR	RECESSED	120	26W FLUORESCENT	LITHONIA AFV 26TRT 6AR 120
B2	8" OPEN DOWNLIGHT WITH SPECULAR REFLECTOR WITH EMERGENCY BALLAST	RECESSED	120	26W FLUORESCENT	LITHONIA AFV 26TRT 6AR 120
C	RECESSED TROFFER, 1' X 4' CLEAR ACRYLIC PRISMATIC DIFFUSER	RECESSED	120	26W FLUORESCENT	LITHONIA RT5 1 2S PSN
D	INDUSTRIAL FIXTURE WITH LOW PROFILE-DIRECT T5 SPECULAR ALUM REFLECTOR EMERG BALLAST	RECESSED	120	54W FLUORESCENT	LITHONIA MS5 2 54T 5HO SMR PERF SAR95
E	12" TRACK LIGHT W/EXTRUDED HBG, SPECULAR REFL., 8-CELL LOUVER	SURFACE	120	26W FLUORESCENT	LITHONIA LTD CFWW 1/26TRT 12AP 120
E2	20" TRACK LIGHT W/EXTRUDED HBG, SPECULAR REFL., 8-CELL LOUVER	SURFACE	120	32W FLUORESCENT	LITHONIA LTD CFWW 2/32TRT 20AP 120
F	LOW PROFILE WRAPAROUND, 10" X 4' 2LP T8 PRISMATIC ACRYLIC PRISMATIC DIFFUSER	SURFACE	120	32W FLUORESCENT	LITHONIA LB 2 32 120
G1	PRECEDENT WALL BRACKET 4' 1 LAMP T8 ELEC	SURFACE	120	32W FLUORESCENT	LITHONIA 11933 WH 1 32 / WP 1 32 TUB

Sample interior lighting fixture schedule from construction documents.

Lighting Wattage Compliance

Inspection Requirements	Verify that total proposed interior lighting wattage does not exceed that allowed per COMcheck Compliance Certificate.
Details	Verify that Section 4, Item 1 of COMcheck Interior Lighting & Power Compliance Certificate indicates 'YES' under 'Complies'.
Code Reference	ASHRAE 90.1-2007—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

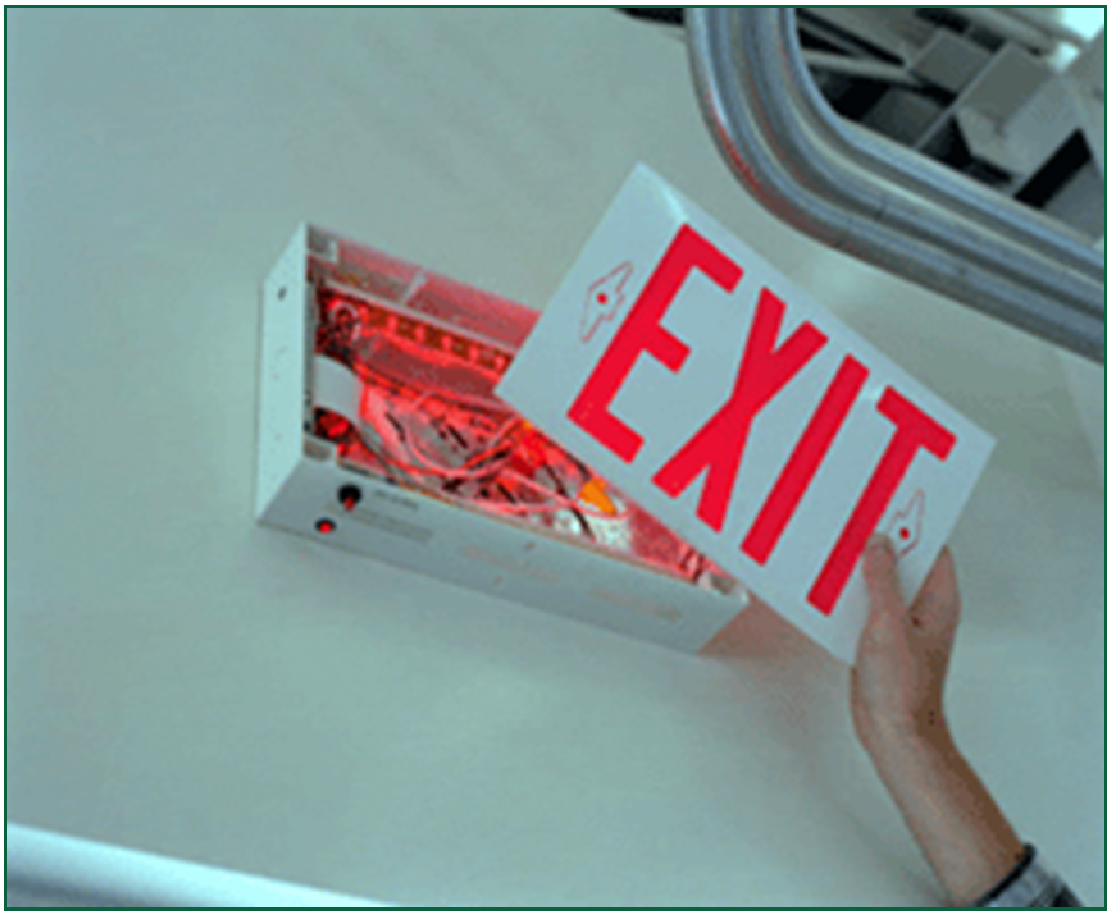
Lighting Wattage:

☐ 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 EXIT signs are 5 watts or less per side.
Details	Without explicitly stating it, this maximum wattage can essentially only be met by installing LED lamps.
Code Reference	ASHRAE 90.1-2007—Section 9.4.3



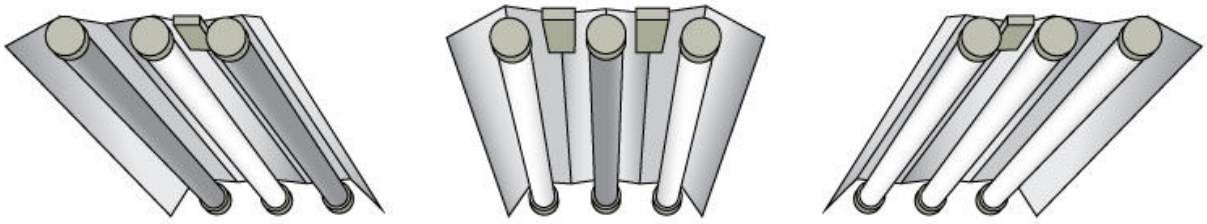
Space Controls

Inspection Requirements	Verify that independent manual or occupancy sensing controls have been installed for each space (remote switch with indicator allowed for safety or security).
Details	Each space enclosed by ceiling height partitions shall have at least one control device to independently control the general lighting within the space. Each manual 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.)
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.2

Occupancy Sensors

Inspection Requirements	Verify occupancy / vacancy sensing controls have been installed in classrooms, conference / meeting rooms and employee lunch and break rooms. Exceptions: • Spaces with multi-scene control • Shop classrooms • Laboratory classrooms • Preschool through 12th grade classrooms
Details	Spaces with multiple switches (multi-scene control) also meet this requirement. Classrooms, meeting rooms, etc. are often "unclaimed" areas that benefit from automatic shutoff when unoccupied. Occupancy sensors provide AUTO ON / AUTO OFF control. Vacancy sensors provide MANUAL ON / AUTO OFF control.
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.2

Multi-scene Lighting Control



Inboard lamp only | Outboard lamps only | Full on

Automatic Shutoff Controls

Inspection Requirements	Verify automatic shutoff lighting controls have been installed in buildings over 5,000 ft^2 (time of day device, occupant sensor, or other automatic control). Exceptions: • 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
Details	These automatic control devices shall function on either: • 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 ft^2 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.
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.1

Hotel / Motel Master Switch

Inspection Requirements	If hotel / motel guest room, verify master switch has been installed at entry to room.
Details	Hotel and motel guest rooms and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.4

Special Use Lighting Controls

Inspection Requirements	Verify separate control device has been installed for display /accent lighting, case lighting, task lighting, nonvisual lighting, lighting for sale and demonstration lighting.
Details	Any lighting not considered general lighting should be switched separately.
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.4

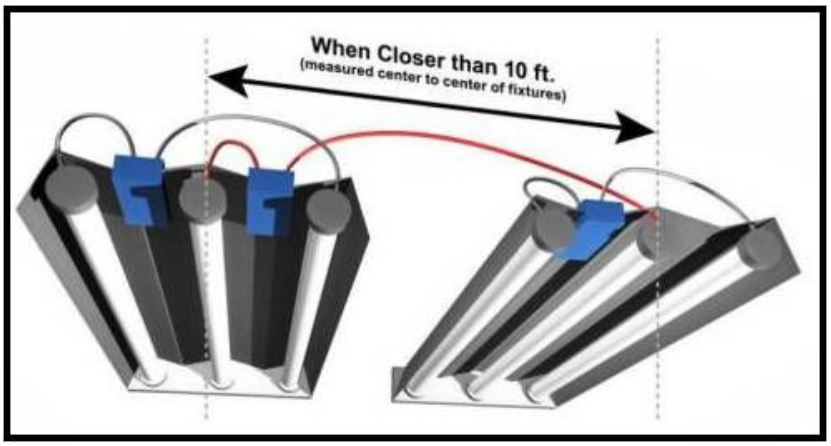
Display / accent lighting must be controlled independently from general space lighting.

Ballasts

Inspection Requirements	Verify that no ballasted light fixtures are single lamp unless 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 90.1-2007—Section 9.4.2

Electromagnetic ballast

Electronic ballast



Feeder & Branch Conductors

Inspection Requirements	Verify feeder conductors have been designed for a max. voltage drop of 2%. **AND** Verify branch conductors have been designed for a max. voltage drop of 3%.
Details	Voltage needed, phase and length of circuit dictate wire size. Verify information during plan review.
Code Reference	ASHRAE 90.1-2007—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 - we typically calculate the drop per 1000 ft lengths)
CM (Circular Mils of Wire - measure of the diameter (thickness) of the wire - again 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

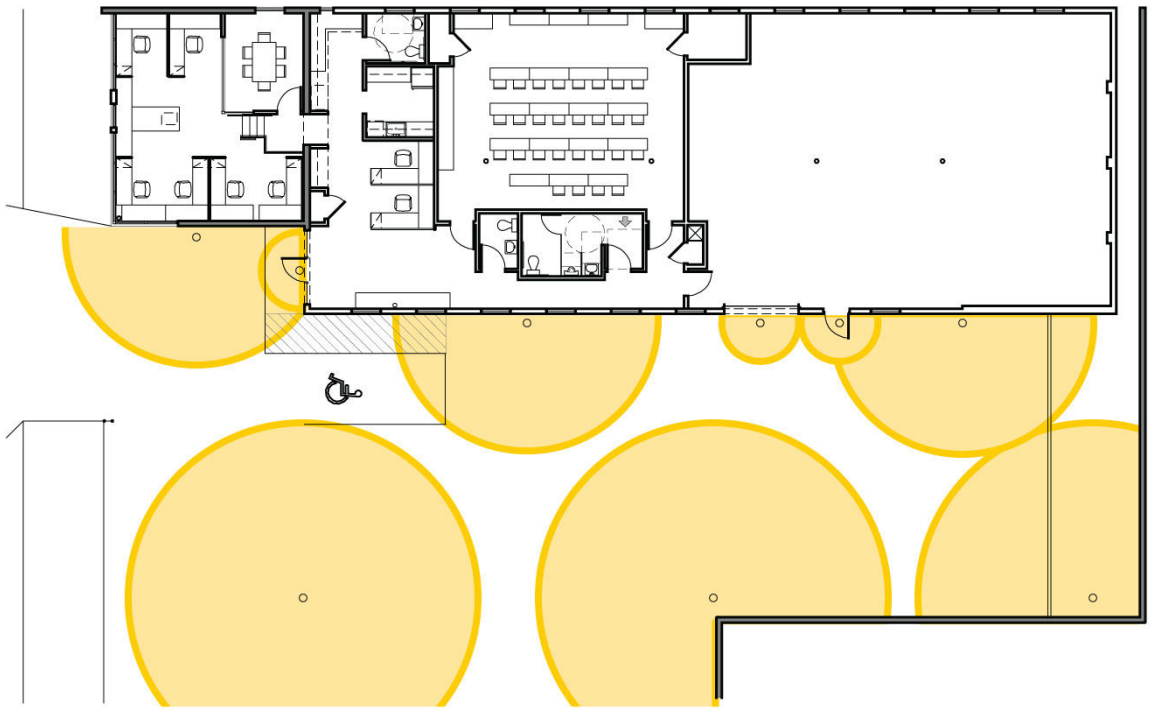
Exterior Lighting Area / Surface Power Calculation

Inspection Requirements	Verify that Exterior Areas/Surfaces are correctly identified and sized in Section 2: Exterior Lighting Area/Surface Power Calculation.
Details	Confirm that square footage of exterior illuminated areas is accurate per site drawings, and that area / surface designations are logical.
Code Reference	ASHRAE 90.1-2007—Section 9.4.5

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.



Fixture Schedule

Inspection Requirements	Verify that COMcheck Exterior Lighting Fixture Schedule matches construction documents.
Details	Verify installed lamp type, wattage per lamp and ballast type and wattage match COMcheck Exterior Lighting & Power Compliance Certificate.
Code Reference	ASHRAE 90.1-2007—Section 9.4.5

LUMINAIRE SCHEDULE

Symbol	Label	Qty	Catalog Number	Description	Lamp	File	Lumens	LLF	Watts
	OA1	1	WSR 26DTT MD	ARCHITECTURAL SCONCE WITH MEDIUM THROW DISTRIBUTION WITH CLEAR, FLAT GLASS LENS.	ONE 26-WATT TWIN TUBE COMPACT FLUORESCENT, HORIZONTAL POSITION.	LTL11983.IES	1800	0.71	29
	OB	2	EH16/EM17 175M MED GCF SR5	EUROTIQUE ARCHITECTURAL LUMINAIRE WITH SR5 REFLECTOR, CLEAR FLAT GLASS LENS.	ONE 175-WATT CLEAR ED17 METAL HALIDE, HORIZONTAL POS.	Ltl10241.ies	12800	0.54	214.3
	OC	7	M4534 50M MILS180	Border Light	1 50W MH	LTL11984.IES	2200	0.00	56
	OD	2	4452 B 13TT 2PIN LLV	Step Light	1 13TT Fluorescent	LTL11983.IES	765	0.00	29
	OE	6	VGR4C 2/26TRT (CEILING MOUNT) DNAT	GATEWAY DEEP CAST ROUND CEILING MOUNTED WITH OPAL LENS.	TWO 26-WATT TRIPLE TUBE COMPACT FLUORESCENT, TILTED 15-DEG DOWN FROM HORIZONTAL.	LTL7710.IES	1800	0.71	69

Sample exterior lighting fixture schedule from construction documents.

Lighting Wattage Compliance

Inspection Requirements	Verify that total proposed lighting wattage does not exceed that allowed per COMcheck Exterior Lighting Area/Surface Power Calculation.
Details	Verify that Section 4, Item 1 of COMcheck Exterior Lighting Compliance Certificate indicates "Passes" next to Compliance.
Code Reference	ASHRAE 90.1-2007—Section 9.4.5

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 to total allowed watts.

Compliance: Passes.

Exemption Claims—Exterior Fixtures

Inspection Requirements	Verify all exemption claims are associated with fixtures that have a control device independent of the control of the nonexempt lighting. Exemption claims may include lighting used for the following exterior applications: • Specialized signal, directional, and marker lighting associated with transportation. • Advertising signage or directional signage. • Lighting integral to equipment or instrumentation and installed by its manufacturer. • Lighting for theatrical purposes, including performance, stage, film production, and video production. • Lighting for athletic playing areas. • Temporary lighting. • Lighting for industrial production, material handling, transportation sites, and associated storage areas. • Theme elements in theme/amusement parks. • Lighting used to highlight features of public monuments and registered historic landmark structures or buildings.
Details	Exterior lighting that is exempt from the total exterior lighting power allowance must be equipped with a control device, whether manual or automatic, that is independent of all other exterior lighting circuits.
Code Reference	ASHRAE 90.1-2007—Section 9.4.5

Daylight Controls

Inspection Requirements	Verify all exterior lighting fixtures are controlled by a photosensor or timeclock capable of automatically turning off the fixture when sufficient daylight is available or lighting is not required. Exception (if independently controlled): Covered vehicle entrance / exit areas requiring lighting for safety, security and eye adaptation
Details	Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or photosensor. All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least ten hours.
Code Reference	ASHRAE 90.1-2007—Section 9.4.1.3

Exterior Luminaires

Inspection Requirements	Verify all exterior building grounds luminaires operating at greater than 100W have minimum efficacy of 60 lumen / watt. Exceptions (if independently controlled): • Lighting claimed as exempt • Lighting required by a health or life safety regulation • Emergency lighting that is automatically off during normal business operation • Lighting controlled by motion sensor
Details	Metal halide or HID (high intensity discharge) luminaires will typically meet this efficacy. Confirm on Exterior Lighting Schedule in construction documents.
Code Reference	ASHRAE 90.1-2007—Section 9.4.4

Light Source	Efficacy (Lumens/Watt)	Average Lamp Life (Hours)	Color Rendering Index
Standard Incandescent	5–20	750–1000	100
Tungsten-Halogen	15–25	2000–4000	100
Compact Fluorescent	20–55	10,000	88
Tubular Fluorescent	60–100	15,000–24,000	50–90
Mercury Vapor	25–50	Up to 24,000	15–30
Metal Halide	45–100	10,000–20,000	60–90
High Pressure Sodium	45–110	Up to 24,000	9–70
Light-Emitting Diode (LED)	26–150	50,000	85

Motion sensor on pole-mounted floodlight.

Scope

The simplified approach is an optional path for compliance when the following conditions are met:

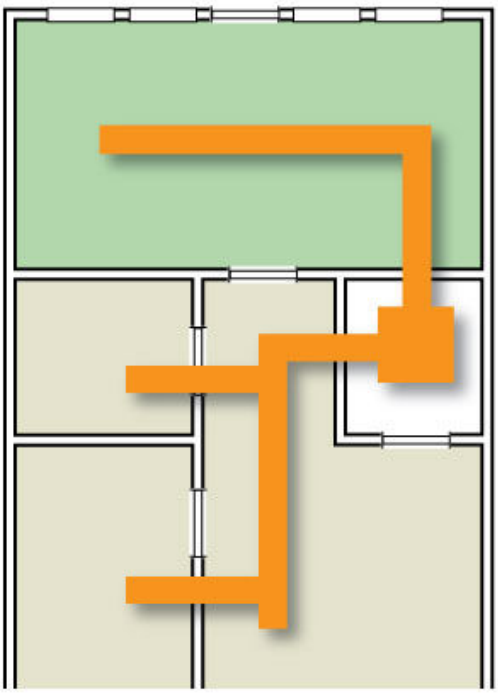
a. building is two stories or fewer in height
b. gross floor area is less than 25,000 ft2
c. each HVAC system in the building complies with the 15 requirements

Small Commercial Office Building — an excellent candidate for the simplified Compliance approach

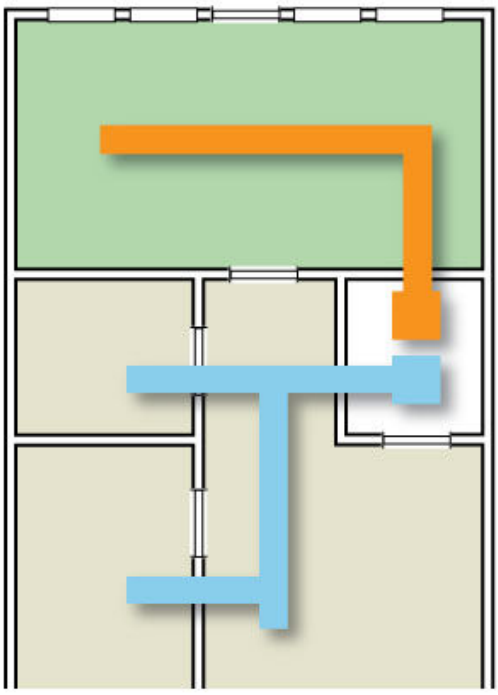
1. Single Zone

Inspection Requirements	The 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. Multizone mechanical systems would not meet this requirement but separate mechanical systems serving each zone would.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

Improperly zoned spaces



Properly zoned spaces



2. Cooling Equipment

Inspection Requirements	Cooling (if any) 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 90.1-2007 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.
Details	Verify that construction documents indicate air-cooled or evaporatively-cooled equipment meeting minimum efficiencies. Please note that evaporatively-cooled equipment is rarely found in the Southeast. For example, a 5-ton or smaller heat pump or air conditioner must be a 13.0 SEER or higher. Verify that field installation matches construction documents.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

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	

3. Economizers

Inspection Requirements	The 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. Where the cooling efficiency meets or exceeds the efficiency requirement in Table 6.3.2, no economizer is required. Outdoor air dampers for economizer use shall be provided with blade and jamb seals.
Details	**Air economizers are NOT REQUIRED in Climate Zones 2, 3 or 4.**
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

Rooftop Package Unit with Economizer

4. Heating Equipment

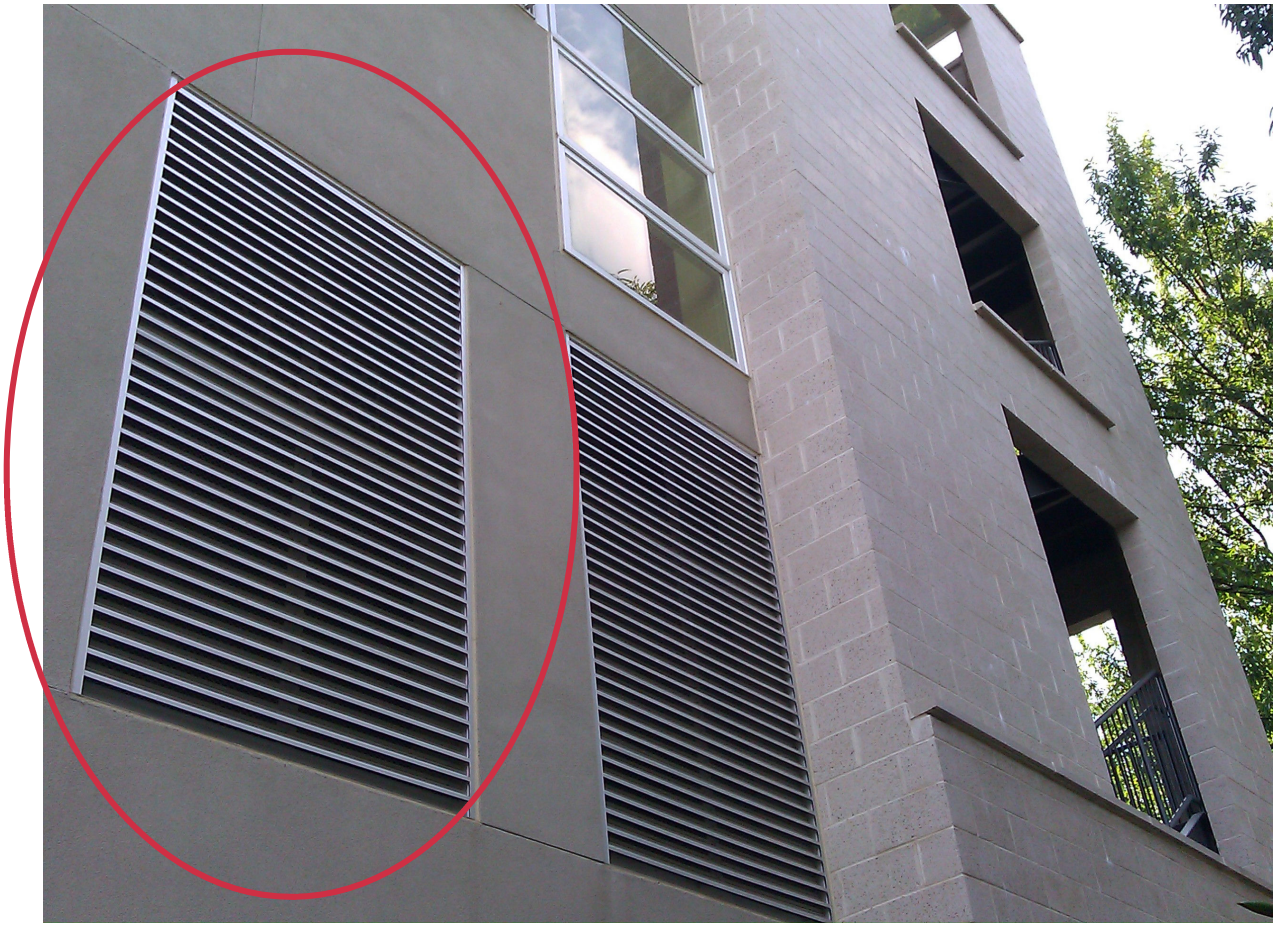
Inspection Requirements	Heating (if any) shall be provided by a unitary packaged or split-system heat pump that meets the applicable efficiency requirements shown in ASHRAE 90.1-2007 Table 6.8.1B (heat pumps) or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps), a fuel-fired furnace that meets the applicable efficiency requirements shown in Table 6.8.1E (furnaces, duct furnaces, and unit heaters), an electric resistance heater, or a baseboard system connected to a boiler that meets the applicable efficiency requirements shown in Table 6.8.1F (boilers).
Details	Verify that construction documents indicate heating equipment meeting minimum efficiencies. For example, a 5-ton heat pump must have a minimum HSPF of 7.7. Verify that field installation matches construction documents.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air cooled (cooling mode)	<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, cooling mode)	≤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, cooling mode)	< 65,000 Btu/h[c]	All	Split system	10 SEER	
Air cooled (cooling mode)	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER (as of 1/1/2010)	ARI 340/360
		All other	Split system and single package	10.8 EER (as of 1/1/2010)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and single package	10.6 EER (as of 1/1/2010)	
		All other	Split system and single package	10.4 EER (as of 1/1/2010)	
	≥240,000 Btu/h	Electric resistance (or none)	Split system and single package	9.5 EER (as of 1/1/2010) 9.2 IPLV	
		All other	Split system and single package	9.3 EER (as of 1/1/2010) 9.0 IPLV	

5. Outdoor Air

Inspection Requirements	The outdoor air quantity supplied by the system shall be less than or equal to 3000 cfm and less than 70% of the supply air quantity at minimum outdoor air design conditions unless an energy recovery ventilation system is provided in accordance with the requirements in ASHRAE 90.1-2007 Section 6.5.6.
Details	This is not normally found in simple buildings. Typical outside air percentage in an office environment is 8-15% of supply air. So, 70% outside air would only apply to building types with high outside air needs (e.g. laboratories).
Code Reference	ASHRAE 90.1-2007—Section 6.3.2



The outdoor air quantity supplied by the system shall be less than or equal to 3000 cfm and less than 70% of the supply air quantity at minimum outdoor air design conditions unless an energy recovery ventilation system is provided in accordance with the requirements in ASHRAE 90.1-2007 Section 6.5.6.

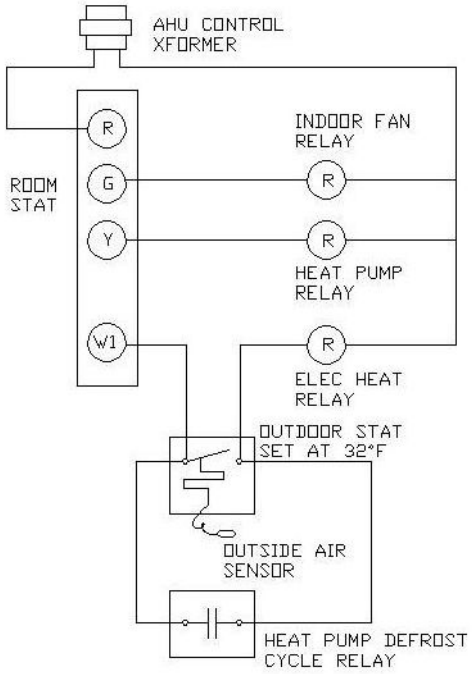
6. Thermostats

Inspection Requirements	The system shall be controlled by a manual changeover or dual setpoint thermostat.
Details	A typical programmable thermostat will meet these requirements.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

7. Supplemental Heat

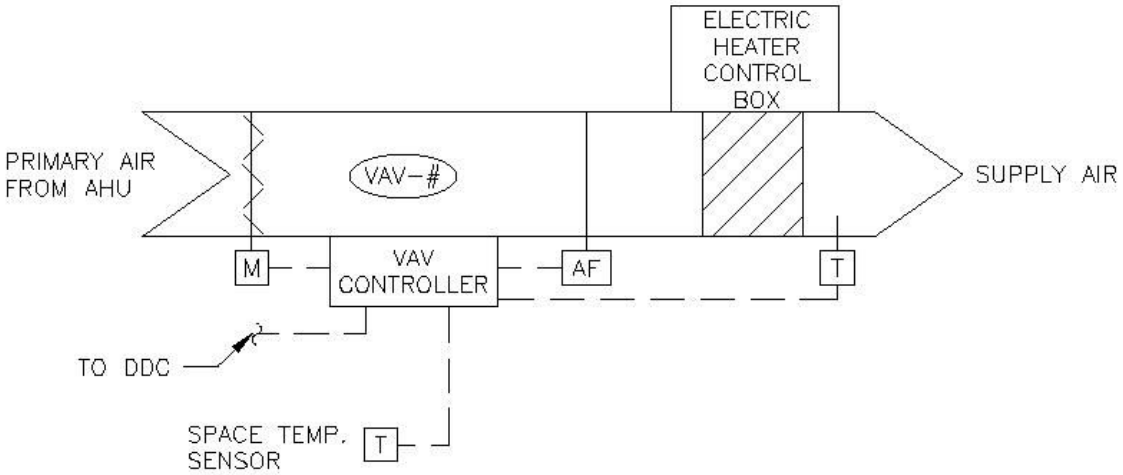
Inspection Requirements	If a heat pump equipped with auxiliary internal electric resistance heaters is installed, controls shall be provided that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles. Two means of meeting this requirement are: (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 outside air temperature is less than 40°F. Heat pumps whose minimum efficiency is regulated by NAECA and whose HSPF rating both meets the requirements shown in ASHRAE 90.1-2007 Table 6.8.1B and includes all usage of internal electric resistance heating are exempted from the control requirements of this part (Section 6.3.2[g]).
Details	This requirement is only applicable if heat pumps are installed. If so, projects must use either a heat pump thermostat or multi-stage thermostat with an outside air temperature sensor.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

Sample Wiring Schematic for Electric Heat Lockout on Heat Pumps



8. Reheat

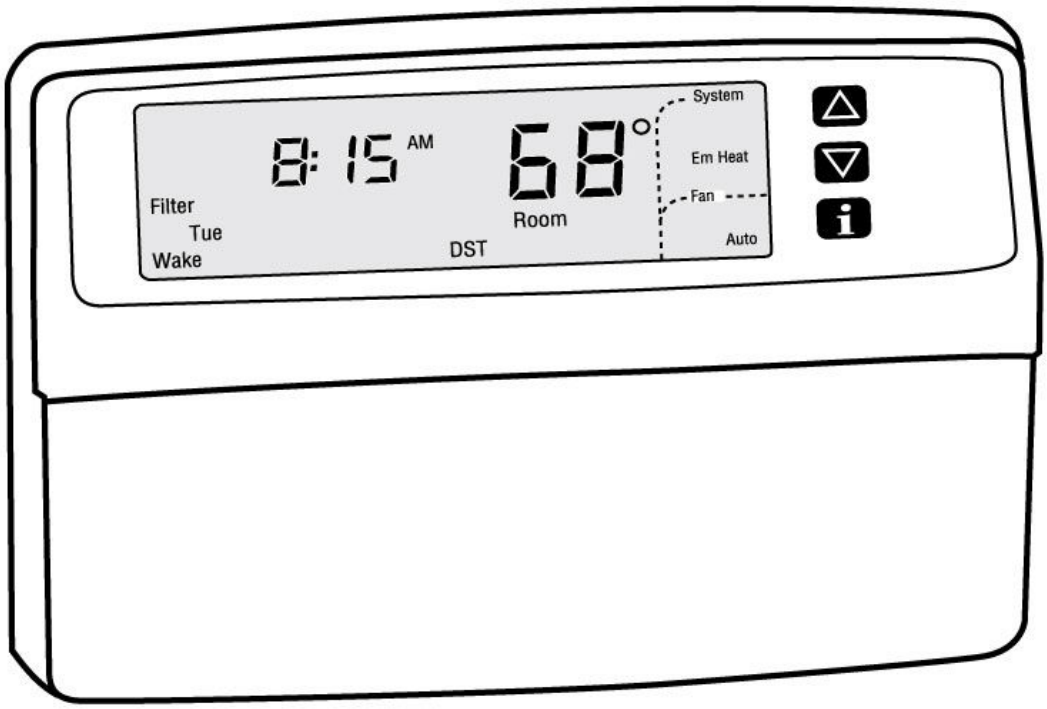
Inspection Requirements	The system controls shall not permit reheat or any other form of simultaneous heating and cooling for humidity control.
Details	A system may not cool then reheat air to control humidity. An example of this is commonly seen in schools where a 100% outside air rooftop unit cools 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 90.1-2007—Section 6.3.2



1 M502.0 TYPICAL VAV BOX WITH ELECTRIC REHEAT CONTROL DIAGRAM
SCALE: NONE

9. Timeclock Control

Inspection Requirements	Systems serving spaces other than hotel/motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than 3/4 hp, shall be provided with a time clock that: (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, and (5) is capable of temperature setup to 90°F during off hours.
Details	A 7-day programmable thermostat will meet this requirement. A small motel unit (≤15,000 Btu/h) would be exempt.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2



10. Pipe Insulation

Inspection Requirements	Except for piping within manufacturers' units, HVAC piping shall be insulated in accordance with Table 6.8.3. Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation.
Details	Refrigerant piping requires insulation and must be protected from the elements. A common example is white water and UV retardant paint over insulation.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

11. Duct Insulation

Inspection Requirements	Ductwork and plenums shall be insulated in accordance with ASHRAE 90.1-2007 Tables 6.8.2A and 6.8.2B and shall be sealed in accordance with Table 6.4.4.2A.
Details	Ductwork insulation is dependent upon type (heating only, cooling only, or combined) and location (exterior, ventilated attic, unconditioned space, etc.). R-6 will satisfy all conditions in Climate Zones 2 & 3.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

TABLE 6.8.2A Minimum Duct Insulation R-Value,[a] Cooling and Heating Only Supply Ducts and Return Ducts

Climate Zone	Duct Location						
	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic with Roof Insulation[a]	Unconditioned Space[b]	Indirectly Conditioned Space[c]	Buried
Heating-Only Ducts							
1, 2	none	none	none	none	none	none	none
3	R-3.5	none	none	none	none	none	none
4	R-3.5	none	none	none	none	none	none
5	R-6	R-3.5	none	none	none	none	R-3.5
6	R-6	R-6	R-3.5	none	none	none	R-3.5
7	R-8	R-6	R-6	none	R-3.5	none	R-3.5
8	R-8	R-8	R-6	none	R-6	none	R-6
Cooling-Only Ducts							
1	R-6	R-6	R-8	R-3.5	R-3.5	none	R-3.5
2	R-6	R-6	R-6	R-3.5	R-3.5	none	R-3.5
3	R-6	R-6	R-6	R-3.5	R-1.9	none	none
4	R-3.5	R-3.5	R-6	R-1.9	R-1.9	none	none
5, 6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
7, 8	R-1.9	R-1.9	R-1.9	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

12. Air Balancing Report

Inspection Requirements	Construction documents shall require a ducted system to be air balanced in accordance with industry-accepted procedures.
Details	Verify that construction documents require an air balance report to be provided to the building owner or their representative for all HVAC systems. Request report at mechanical final inspection.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

AIRE-BAL

AIR MOVING EQUIPMENT TEST SHEET

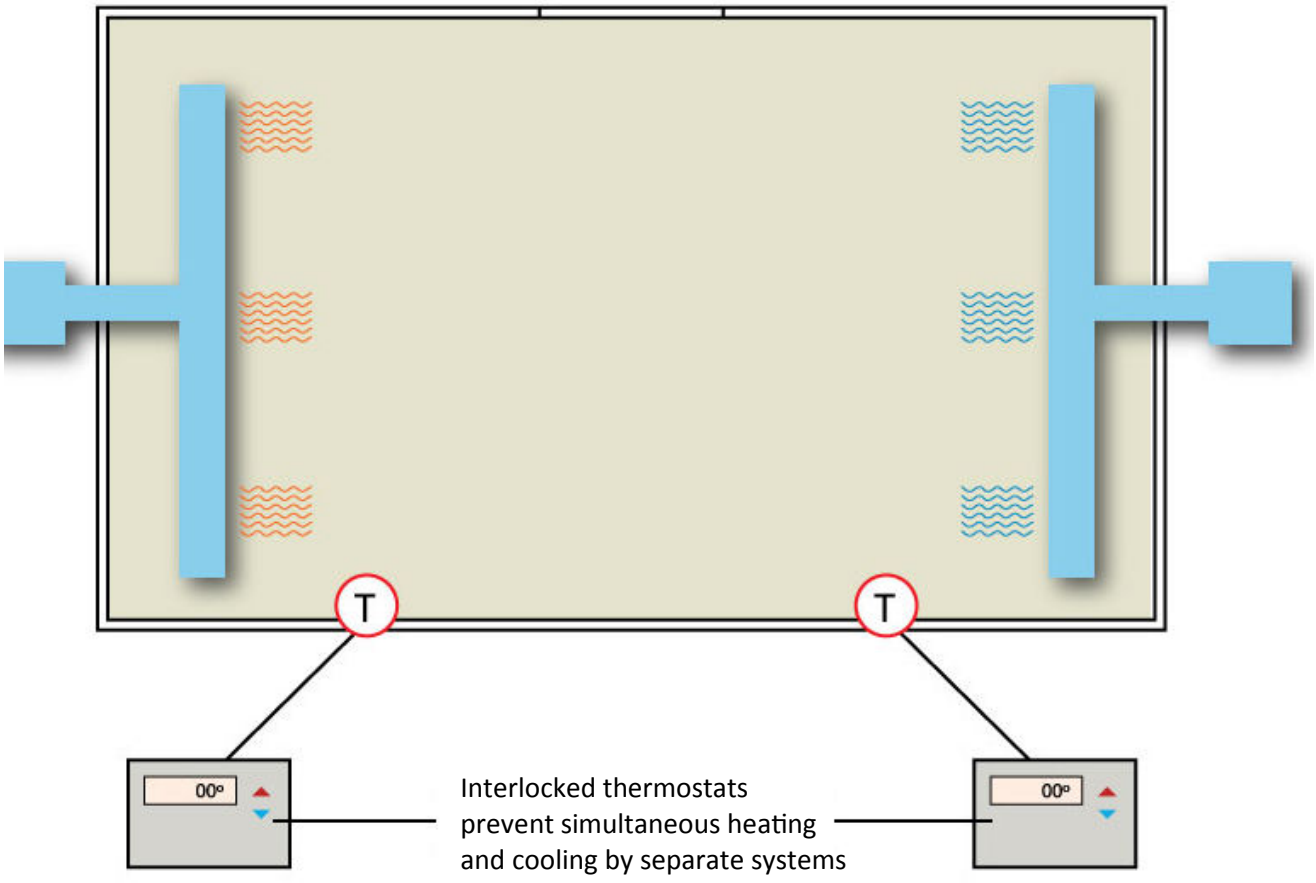
Project: Chastain Tennis Center Location: Fulton Co., GA Date: 8/23/10

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

Sample Test & Balance Report

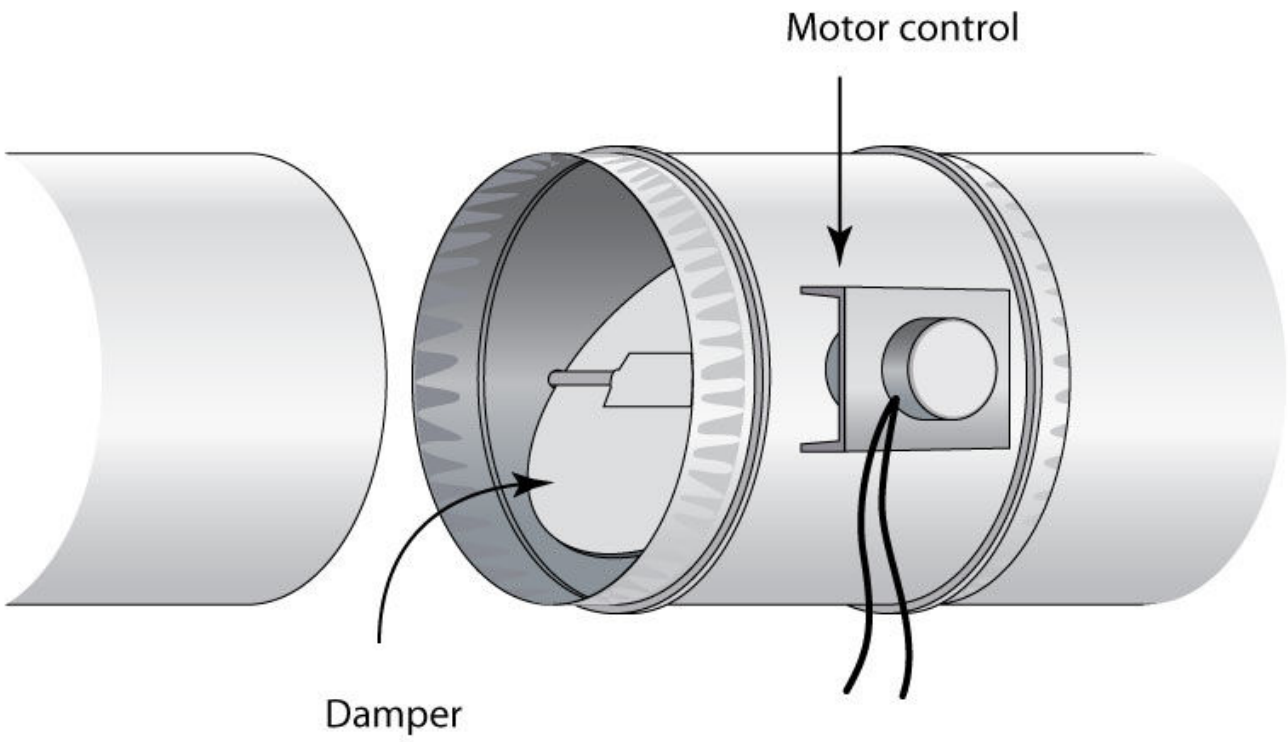
13. Interlocked Thermostats

Inspection Requirements	Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.
Details	Verify that thermostat systems in the same zone have the ability to be interlocked. An example where this would be applicable is a conference / training room served by two mechanical systems.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2



14. Automatic Dampers

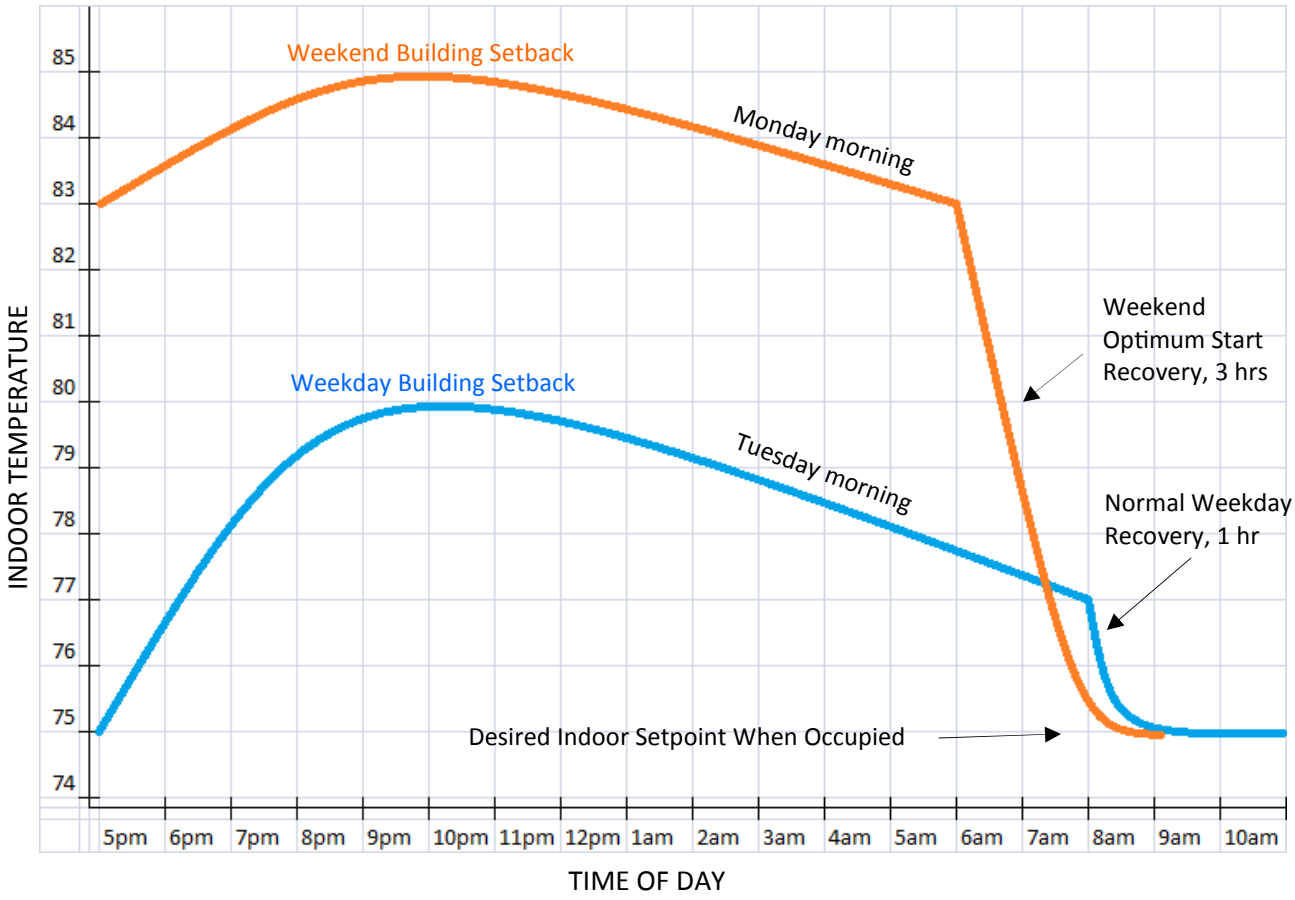
Inspection Requirements	Exhausts with a design capacity > 300 cfm on systems that do not operate continuously shall be equipped with gravity or motorized dampers that will automatically shut when the systems are not in use.
Details	Verify that large exhaust systems (typically not small bathroom exhausts) have a gravity or motorized damper.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2



15. Optimum Start Controls

Inspection Requirements	Systems with a design supply air capacity > 10K cfm shall have optimum start controls.
Details	A 10,000 cfm system will typically be 25 cooling tons or larger. These systems require a thermostat or control system to provide optimum start control. 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.
Code Reference	ASHRAE 90.1-2007—Section 6.3.2

Cooling Season Optimum Start Recovery



Inspection Requirements	Confirm that: • Minimum efficiency matches COMcheck Mechanical Compliance Certificate • Hot water system is sized per manufacturer's sizing guide • First 8ft 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 deg F or lower (lavatory faucet outlet temperature in public restrooms is limited to 110 deg F) • Heat traps are provided on inlet and outlet of storage tanks.
Details	No efficiency requirements for water heaters with storage capacity less than 20 gallons.
Code Reference	ASHRAE 90.1-2007—Section 7.4

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