2009 IECC®
Fundamentals

Based on the 2009 International Conservation Energy Code®

Your Instructor today is:

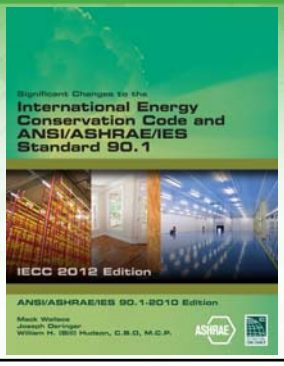
2

VILLAGE OF OAK BROOK
OAK BROOK, ILL.

3

Standards Technical Panel for Energy Management Equipment, STP 916
Fire Tests of Insulated Wall Construction and Interior Finish Material STP 1040

4



Accreditation

- The International Code Council has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET).
  - As a result of their Authorized Provider accreditation status, ICC is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.
- You will obtain full CEUs for this course, if you actively participate in the training activities and stay for the entire session. Evidence of this will be the sign out sheet.

6

Pre-Test

- This short pre-test is designed to measure content areas covered in this class and will indicate what you already know about these areas.
- At the end of this class, you will be asked to take it again in order to measure your learning.

7 2009

1. The IECC definition of a "Residential Building" is:

a. Identical to the Group "R" occupancy as defined by Chapter 3 of the International Building Code©.
b. Limited to structures governed by the International Residential Code©.
c. For this code, includes R-3 buildings, as well as R-2 and R-4 buildings three stories or less in height above grade.
d. For this code, all structures not included in the definition of "Commercial buildings."

8

2. Match the paraphrased definitions with the code/standard

	ABOVE-GRADE WALL.		CODE/STANDARD
a.	A wall more than 50 percent above grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.	i.	ANSI/ASHRAE/IES STANDARD 90.1-2007
b.	Above-grade walls are those walls covered…on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.	ii.	2009 IECC- RESIDENTIAL PROVISIONS
c.	That portion of a wall that is not entirely below finish grade and in contact with the ground.	iii.	2009 IECC- COMMERCIAL PROVISIONS

9

3. The 2009 IECC regulates the following building systems:

a. Building thermal envelope, Indoor air quality, Building site location, Water utilization.
b. Building orientation, HVAC, Electrical, Service water heating.
c. Building thermal envelope, HVAC, Process electrical loads, Service water heating.
d. Building thermal envelope, HVAC, Electrical, Service water heating.

10

4. A design professional may choose to demonstrate building thermal envelope compliance under the 2009 IECC, while the MEP compliance conforms to ANSI/ASHRAE/IES STANDARD 90.1-2007.

a. Always
b. Sometimes
c. Never

11

5. Please identify the type of compliance that each of these paths demonstrate:

Compliance Path	Prescriptive	Performance
Simulated Performance Alternative		
R-value Computation		
UA Alternative		
Total UA		
Total Building Performance		
RESCheck		

12

6. A building built and operated in compliance with the 2009 IECC will have approximately ____% energy cost savings over the same building built and operated in compliance with the 2006 IECC.

13

Ok, there were 6 questions, but you've got to admit that #6 is a good one.

14

Seminar Goal

The goal of this seminar is for participants to apply the 2009 IECC to increase the efficient use of energy in the construction of new buildings and alterations to existing buildings.

Seminar Objectives

Upon completion of this seminar, participants will be better able to:

- Locate general topics in the 2009 IECC.
- Locate applicable tables in the 2009 IECC for specific situations.
- Apply code requirements to real-world situations.
- Explain the intent behind a code requirement.

Seminar Objectives (cont.)

Upon completion of this seminar, participants will be better able to:

- Identify borderline scenarios as compliant or noncompliant
- Identify essential code components for designing energy-efficient building thermal envelopes, energy-efficient mechanical design principles and electrical power and lightning systems.

General Framework

- Contains energy provisions
- Allows use of materials, products and methods of construction that can increase the level of energy efficiency for a new building

General Organization

Chapter 1 – Administration and Enforcement

Chapter 2 – Definitions

Chapter 3 – Climate Zones

Chapter 4 – Residential Energy Efficiency

Chapter 5 – Commercial Energy Efficiency

Chapter 6- Referenced Standards

Objectives of the Code

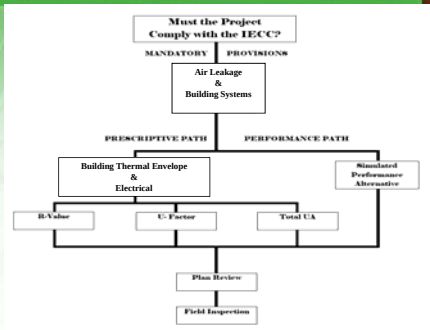
The following are regulated:

- Building Envelope
- Mechanical Systems
- Electrical Systems
- Service Water Heating Systems

Code Compliance Process

1. Determine if the project must comply with the IECC
2. Determine if the project is residential or commercial
3. Compliance documentation submitted
4. Plan reviewer is to ensure the documentation is clearly identified and code compliant.
5. Confirm that energy-using features of the building's are installed per the approved plans and documentation

IECC Residential Compliance Process



2009 IECC® Fundamentals Workbook Page 7 22

IECC Commercial Compliance Process

2009 IECC® Fundamentals Workbook Page 8 23

Conclusion

1. Name 2 out of the 4 systems the 2009 IECC regulates for effective and efficient use of energy.

   Building envelope,
   Mechanical system,
   Electrical system
   Service water heating system

2009 IECC® Fundamentals Workbook Page 9 24

Conclusion

2. Name the five steps in the IECC compliance process.

   1. Determine if the project must comply with the IECC.
   2. Determine if the project is residential or commercial.
   3. Compliance documentation must be submitted to jurisdiction.
   4. Documentation must clearly identified and energy feature meets or exceeds code.
   5. Energy using feature installed per plans and documentation.

Conclusion

3. The designer can combine the IECC and the ASHRAE standard when completing the IECC Commercial Compliance Process.

True False

False

The designer must chose IECC or Standard 90.1.

You cannot mix the process

Chapter 1

Administration and Enforcement

101 – Scope and General Requirements

- 101.2 – Scope

The provisions apply to several different project types:

- Newly conditioned space
- New construction in existing buildings
- Additions, alterations and repairs to existing buildings
- Mixed use buildings
- Change in occupancy

101 – Scope and General Requirements

Newly Conditioned Space – New Buildings

New Construction - Hotel

101 – Scope and General Requirements

Newly Conditioned Space – Previously Unconditioned

101 – Scope and General Requirements

101.3 – Intent

Life safety, health and environmental requirements take precedence over energy provisions.

101 – Scope and General Requirements

- 101.4 – Applicability
- 101.4.2 – Historic buildings

Historic Building, Possibly Exempt

101 – Scope and General Requirements

101.4.3 – Additions, alterations, renovations or repairs

- Where change increases energy use
- Applies to alteration as if it were new construction
- Exceptions
  - Storm windows over existing fenestration.
  - Glass only replacements in existing frame.
  - Existing ceiling, wall or floor cavities filled with insulation.
  - Where existing roof, wall or floor cavity is not exposed.

101 – Scope and General Requirements

101.4.3 – Additions, alterations, renovations or repairs (cont.)

Exceptions

- Reroofing.
- Replacement of existing doors
- Replacement of less than 50 percent of the luminares do not increase the lighting power.
- Replacement of only the bulb and ballast of the luminares provided they do not increase the lighting power

101 – Scope and General Requirements

101.4.4 – Change in Occupancy

An alteration that increases demand for fossil fuel or electrical energy onsite as a result of a change must comply with the code.

Where the use in a space changes from one use in Table 505.5.2 to another use in Table 505.5.2, the installed lighting wattage shall comply with Section 505.5.

101 – Scope and General Requirements

101.4.5 – Change in space conditioning

Any conditioned space that is altered to become conditioned space, must meet the requirements of the code.

101 – Scope and General Requirements

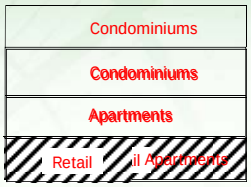
101.4.6 – Mixed occupancy Commercial building

New Strip Shopping Center

101 – Scope and General Requirements

101.4.6 Mixed-Use building

- Each occupancy shall be separately considered as residential or commercial



Building is now 4 stories. Commercial Provisions throughout

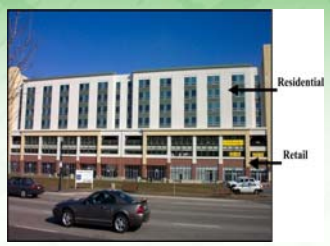
Residential

Residential

Commercial / Residential

101 – Scope and General Requirements

101.4.6 – Mixed Occupancy Mixed-use building



Mixed Hotel/Motel and Commercial

101 – Scope and General Requirements

101.5.2 – Low Energy Buildings

- Buildings designated as exempt include buildings that use less than 1 watt/ft^2 (10.7 W m^2) or 3.4 Btu/h ft^2 (10.7 W m^2) for space conditioning.
- Buildings, or portions thereof, that are not conditioned are exempt **from thermal envelope requirements.**

102 Alternative Materials – Methods of Construction Design or Insulating Systems

102.1.1 – Above code program

- Authority to approve "above code" program is vested in the code official.
- Language does not guarantee alternative programs exceed the performance required by IECC
- Burden of proof to establish equivalency is on the applicant.

Administration

1. What parts of commercial occupancies must comply with the envelope provisions of the IECC?

A. Warehouse heated to 45°F (7°C) for protection of a sprinkler system.
B. Data center dehumidified to 40-percent relative humidity.
C. An unheated warehouse building.
D. Conditioned office building and warehouse heated to 70°F (21°C) for human occupancy.

Administration

2. How must energy code compliance be determined for a three-story building with the first floor occupied for retail space and the second and third floors occupied for multiple-family residential use?

The first floor will need to comply with the commercial provisions of the IECC (Chapter 5). The multiple-family building will need to comply with the residential provisions of the IECC (Chapter 4).

Administration

3. What occupancies are considered residential under the code?

One- and two-family dwellings, residential buildings, Group R-2 and Group R-4 less than three stories in height above grade and townhomes (Section 101.2).

Administration

4. What parts of a residential building must comply with the residential provisions of the code?

A. Unconditioned garage
B. Conditioned basement
C. Unconditioned attached sunroom
D. Unconditioned attic

Administration

5. Name two of the new exceptions from the code compliance Section 101.4.3 Additions, Alternations renovations and repairs.

- Reroofing where neither the sheathing nor the insulation is removed.
- Replacement of existing doors separating conditioned from nonconditioned spaces will not require the installation of a vestibule or revolving door.
- Replacement of less than 50 percent of the luminaires in a space provided they do not increase the lighting power.
- Replacement of only the bulb and ballast of the luminaires in a space provided they do not increase the lighting power.

Workbook Page 20

Chapter 2
Definitions

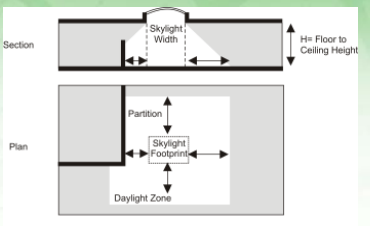
202 – General Definitions

Building Thermal Envelope	Exterior Wall
Commercial Building	Heated Slab
Conditioned Space	Residential Building

Workbook Page 23-24

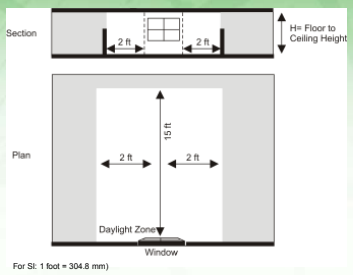
202 – General Definitions

- Daylight Zone Under Skylight

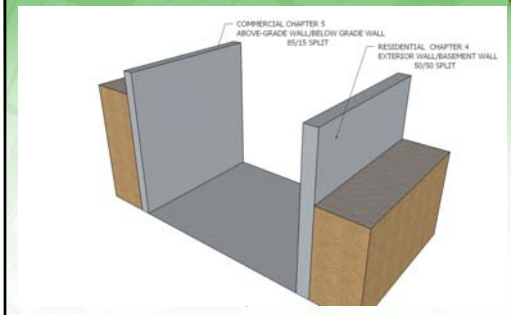


202 – General Definitions

- Daylight Zone Adjusted to Vertical Fenestration



202 – General Definitions



Definitions

A plan reviewer is asked to determine if an occupancy should comply with the residential or commercial provisions of the IECC. How should the plan reviewer reply?

		Residential	Commercial
1	A stand-alone office building.		Commercial
2	Four-story apartment building.		Commercial
3	Two floors of retail space in a three-story building having one floor of apartments.		Commercial
4	An apartment unit located above retail in a two-story building.	Residential	

Definitions

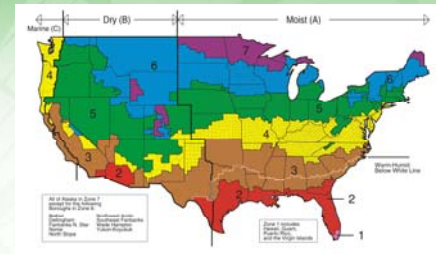
A plan reviewer is asked to determine if an occupancy should comply with the residential or commercial provisions of the IECC. How should the plan reviewer reply?

		Yes	No
5	Wall between the house and the garage.	Yes	
6	Wall between a conditioned bedroom and a kitchen.		No
7	Wall greater than 50 percent below grade between a conditioned basement and the ground.	Yes	
8	A skylight shaft wall.	Yes	
9	Party wall between row houses.		No

Chapter 3
Climate Zones

Climate Zones

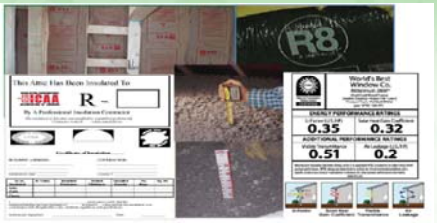
Three separate moisture regimes overlay the eight climate zones



303 – Materials, Systems, and Equipment

303.1 – Identification

Requires materials to be labeled on site with the rated *R*-value



303 – Materials, Systems, and Equipment

303.1.3 – Fenestration product rating

303 – Materials, Systems, and Equipment

- Table 303.1.3(1)
  Default Glazed Fenestration *U*-Factor
- Table 303.1.3(2)
  Default Door *U*-Factors
- Table 303.1.3(3)
  Default Glazed Fenestration SHGC

303 – Materials, Systems, and Equipment

Table 303.1.3(1)
Default Glazed Fenestration *U*-Factor

TABLE 303.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

303 – Materials, Systems, and Equipment

Table 303.1.3(2)
Default Door *U*-Factors

TABLE 303.1.3(2)
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

303 – Materials, Systems, and Equipment

Table 303.1.3(3)
Default Glazed Fenestration SHGC

TABLE 303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		
Clear	Tinted	Clear	Tinted	GLAZED BLOCK
0.8	0.7	0.7	0.6	0.6

Climate Zones

1. What is the climate zone for Winnebago County, Illinois, according to Figure 301.1 and Table 301.1?

From Table 301.1: Winnebago County, Illinois is in Climate Zone 5

Climate Zones

2. How many different climate zones are in Texas?

From Figure 301.1: Three (2, 3 and 4)

Climate Zones

3. Using the climate zone map, is Louisiana considered a warm-humid climate?

Yes

Materials, Systems and Equipment

1. What Standards are used to determine the *U*-factor and SHGC for fenestration?

Section 303.1.3: NFRC 100 and NFRC 200

Materials, Systems and Equipment

2. What is the default U-factor for a double-glazed, fixed window with a metal thermally broken frame?

From Table 303.1.3(1) the default *U-factor is 0.65.*

Materials, Systems and Equipment

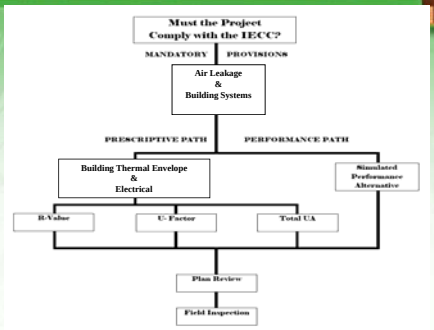
3. How must the *U*-factors of fenestration be determined?

The *U-factors shall be determined in accordance with NFRC 100 or Table* 303.1.3(1) (Section 303.1.3).

Workbook Page 31

Chapter 4
Residential Energy Efficiency

Residential Energy Efficiency



Workbook Page 7

Poorly Insulated House

Photo courtesy of State of Illinois Department of Commerce and Economic Opportunity
Bruce Selway – Energy Efficiency Program Specialist

Compliance Methods for Insulation and Fenestration

402.1.2 – Compliance by *R*-value computation

Table 402.1.1 – Insulation and Fenestration Requirements by Component

402.1.3 – *U*-factor alternative

Table 402.1.3 – Equivalent *U*-Factors

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
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a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

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f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

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c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

through 3 for heated slabs.

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i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones through 3 for heated slabs.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

TABLE 402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

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1	1.2	0.75	0.30	30	13	3/4	13	0	0	0
2	0.65[j]	0.75	0.30	30	13	4/6	13	0	0	0
3	0.50[j]	0.65	0.30	30	13	5/8	19	5/13[f]	0	5/13
4 except Marine	0.35	0.60	NR	38	13	5/10	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10/13	10, 2 ft	10/13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	15/19	10, 4 ft	10/13
7 and 8	0.35	0.60	NR	49	21	19/21	38[g]	15/19	10, 4 ft	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the *International Residential Code* or Section 1608.1.2 of the *International Building Code*, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

Table 402.1.3

TABLE 402.1.3
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR[c]
1	1.20	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.65	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.50	0.65	0.035	0.082	0.141	0.047	0.091[c]	0.136
4 except Marine	0.35	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.057	0.087	0.033	0.059	0.065
6	0.35	0.60	0.026	0.057	0.060	0.033	0.050	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.028	0.050	0.065

a. Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.
b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.10 in Zone 4 except Marine, and the same as the frame wall *U*-factor in Marine Zone 4 and Zones 5 through 8.
c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure 301.1 and Table 301.1.

Compliance Methods for Insulation and Fenestration

Determining compliance

An assembly *U*-factor must be calculated for each applicable assembly type proposed for the project.

The ASHRAE *Handbook of Fundamentals* is an excellent source of information on how to calculate an assembly *U*-factor.

Compliance Methods for Insulation and Fenestration

Calculating assembly *U*-factors

- The calculation must include the effects of framing.
- An *R*-value must be determined for each different material in the assembly.
- The *R*-values are then totaled to determine the total *R*-value through each thermal path of the assembly.

Compliance Methods for Insulation and Fenestration

Calculating assembly *U*-factors (cont.)

- The total *R*-values are then converted to *U*-factors by taking the reciprocal of the *R*-value.
- An area-weighted average *U*-factor is calculated for the wall system that takes into account the effects of framing.

Workbook Page 36

Compliance Methods for Insulation and Fenestration

Sample calculation—Walls

$$U_{ow} = \frac{(U_{w1} x A_{w1}) + (U_{w2} x A_{w2}) + \ldots}{A_{w1} + A_{w2} + \ldots}$$

Where

- U_{ow} = U-factor of Opaque Wall
- U_{wl} = *U*-factor of opaque wall number 1
- A*wl* = Area of opaque wall number 1
- U_{w2} = *U*-factor of opaque wall number 2
- A_{w2} = Area of opaque wall number 2

Workbook Page 37

Compliance Methods for Insulation and Fenestration

402.1.4 – Total UA alternative

- The building envelope design is permitted to deviate from *R*-values or *U*-factors in Tables 402.1.1 or 402.1.3, respectively, provided the total thermal transmittance (*UA*) is the same or less as the very same building envelope geometry designed to code.

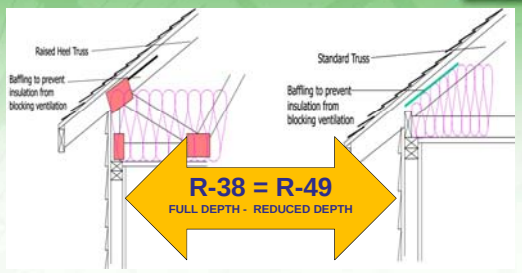
Workbook Page 37

Compliance Methods for Insulation and Fenestration

- 402.1.4 – Total UA alternative
  - The UA alternative is offered to provide trade-offs between parts of the building that do not comply with the *U*-factors listed in Table 402.1.3 and those that over comply with the code.

Compliance Methods for Insulation and Fenestration

402.2.1 – Ceilings with attic spaces



Compliance Methods for Insulation and Fenestration

Mass and framed walls

Any wall between conditioned and unconditioned space and the outdoors will count in the exterior wall area.

This includes:

- Attic kneewalls.
- Skylight shaft walls.
- Below-grade nonbasement walls.
- Perimeter joists between floors.

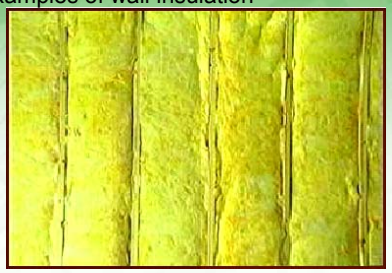
Compliance Methods for Insulation and Fenestration

Examples of wall insulation

Blown-in, Loose-fill Insulation

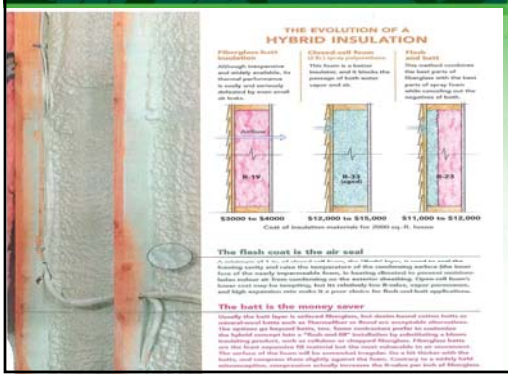
Compliance Methods for Insulation and Fenestration

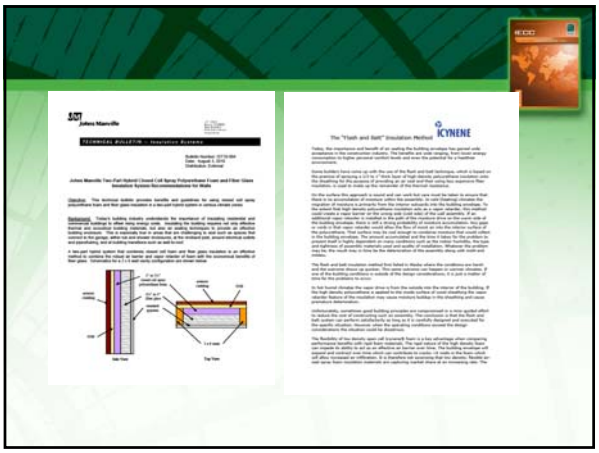
Examples of wall insulation



Unfaced-batt Insulation

Compliance Methods for Insulation and Fenestration





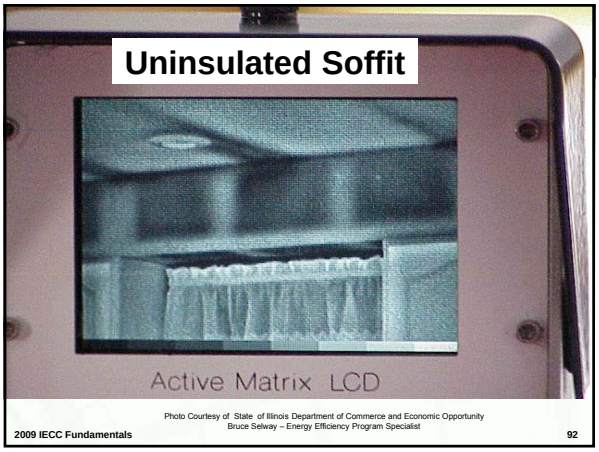
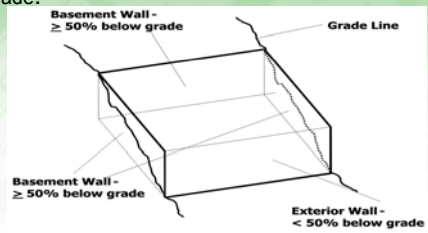


Photo Courtesy of State of Illinois Department of Commerce and Economic Opportunity
Bruce Selway – Energy Efficiency Program Specialist

Compliance Methods for Insulation and Fenestration

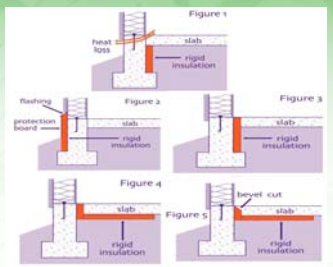
- 402.2.7 – Residential Basement walls
  - Defined as walls greater than or equal to 50 percent below grade.



Workbook Page 43

Compliance Methods for Insulation and Fenestration

402.2.7 – Slab-on-grade floors



Workbook Page 43

Compliance Methods for Insulation and Fenestration

402.2.9 – Crawl space walls

Criteria to meet code requirements:

- Must be insulated to the *R*-value specified in the energy code
- May not have ventilation openings that communicate directly with outside air.
- Must be mechanically ventilated or supplied with conditioned air.
- Exposed earth floors must be covered with an approved vapor retarder material, which extends up the stem wall and then sealed and taped to the wall.

Workbook Page 44

Compliance Methods for Insulation and Fenestration

402.2.11, 402.3.5 – Thermally isolated sunrooms

To condition the sunroom, the following requirements must be met:

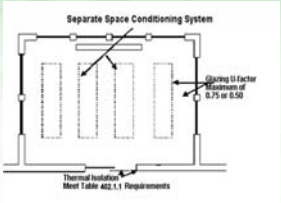
- A separate space conditioning system.
- The glass used must have a maximum *U*-factor of 0.75 in climate zones 1-3 and 0.50 inches in climate zones 4-8.
- Minimum ceiling *R*-value shall be R-19 in zones 1-4 and R-24 in zones 5-8.
- Minimum wall *R*-value shall be R-13.
- Must maintain thermal isolation.

Workbook Page 45

Compliance Methods for Insulation and Fenestration

402.1.10, 402.3.5 – Thermally isolated sunrooms

Thermal Isolation - A separation of conditioned spaces between a sunroom addition and a dwelling unit consisting of existing or new wall(s), doors and/or windows.



Compliance Methods for Insulation and Fenestration

402.3 – Fenestration (prescriptive)

402.3.1 *U*-factor

- Area weighted average *U*-factors and SHGCs may be used to comply with Table 402.1.1.
- Up to 15 ft^2 (1.4 m^2) of glazed fenestration per dwelling unit can be exempted from *U*-factor and SHGC requirements.

Compliance Methods for Insulation and Fenestration

402.3.2 – Glazed fenestration SHGC

The SHGC measures how well a window or translucent product blocks heat caused by sunlight. SHGC is expressed as a number between 0 and 1. The lower the number, the lower the amount of heat that passes into the building through the glazing.

Fenestration must be rated using NFRC 200 or a default SHGC value is to be assigned from Table 303.1.3(3).

Compliance Methods for Insulation and Fenestration

402.3.3 Glazed fenestration SHGC &
402.3.3 Glazed fenestration exemption

Note that up to 15 square feet (1.4 m^2) of glazed fenestration per dwelling unit can be exempted from *U*-factor and SHGC requirements in its entirety, if using the R-value computation method.

Workbook Page 46

Compliance Methods for Insulation and Fenestration

402.3.4 Opaque door exemption:

- One hinged opaque door up to 24 square feet (2.22m^2) is also exempt from the code, if using R-value computation.

402.3.6 Replacement fenestration

- Replacement windows and skylights must comply with the fenestration *U*-factor requirements of Table 402.1.1.

Workbook Page 46

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4 – Air Leakage (mandatory)
402.4.1 – Building thermal envelope
402.4.2 – Air Sealing and Insulation

- Building envelope air tightness and insulation shall be demonstrated in one of two ways.

Workbook Page 47-48

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4.2.1 Testing option

Requires testing at specific air changes per hour at a specific air pressure.

There are 7 things that are required to be done during the test.

1. Exterior windows and doors, fireplaces and stove doors closed, but not sealed
2. Dampers shall be closed but not sealed
3. Interior doors open

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4.2.1 Testing option (cont)

4. Exterior openings for continuous ventilation systems and heat recovery ventilators closed and sealed
5. Heating and cooling systems turned off
6. HVAC ducts shall not be sealed
7. Supply and return registers shall not be sealed.

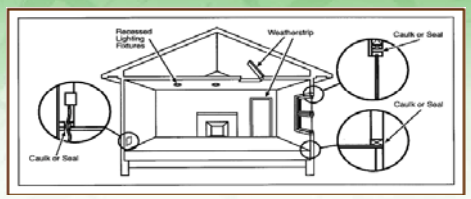
402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4.2.2 Visual inspection option

– This option requires the field inspector to conduct a rigorous insulation and air sealing inspection in accordance with Table 402.4.2.

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4.4 – Fenestration air leakage



Windows no more than 0.3 cfm per square foot (1.5 L/s/m^2).
Swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m^2).

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.4.5 – Recessed lighting

IC – rated and labeled to ASTM E 283.

402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

Polyethylene Sheeting

Kraft-paper Backed Insulation

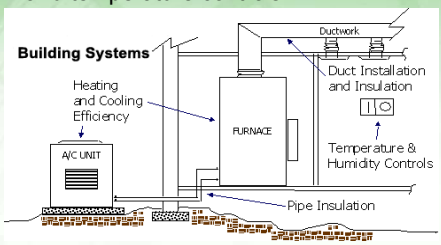
402.4, 402.5, 403 – Mandatory Requirements for all Residential Buildings

402.5 – Maximum fenestration *U*-factor and SHGC (mandatory)

Limits the maximum area-weighted *U*-factor and SHGC that can be traded-off among opaque envelope components for the purpose of envelope compliance.

403 – Building Systems

The building systems addressed consist of a heating and/or cooling system, a distribution system and temperature controls.



403 – Building Systems

- Mechanical equipment efficiency
- Water heater efficiency
- 403.1.1 – Programmable Thermostat
- 403.1.2 – Heat pump supplementary heat (Mandatory)
- 403.2 – Ducts
- 403.2.1 - Insulation

403 – Building Systems

403.2.2 – Sealing (Mandatory)

All ducts are required to be sealed with:

- Listed and labeled tapes
- Gaskets
- Mastics (adhesives)
- Mastic-plus-embedded fabric systems or
- Other approved closure systems

Workbook Page 52

403 – Building Systems

403.2.2 – Sealing (Mandatory)

Duct tightness shall be verified by verified by either of the following:

1. Post construction test:
   a. Leakage to outdoors ≤ 8cfm/100 s.f.
   b. Total Leakage ≤ 12cfm/100 s.f
2. Rough in test:
   a. Total Leakage ≤ 6 cfm/100 s.f. –including air handler
   b. Total Leakage ≤ 4 cfm/100 s.f – w/o air handler

Exception: Duct tightness test is not required if the air handler and all ducts are located within conditioned space.

Workbook Page 52

403 – Building Systems

403.3 – Mechanical system insulation

403.4 – Circulating water systems

Workbook Page 53

403 – Building Systems

403.6 – Equipment sizing

IECC refers to the provisions of the IRC to require heating and cooling load calculations for the optimal sizing of equipment.

The following guidelines apply:

- Use Design conditions specified in IECC Chapter 3.
- "Part IV—Mechanical" of the IRC refers specifically to the Air Conditioning Contractors of America (ACCA) Manual J for building loads (IRC Section M1401.3).
- "Part IV—Mechanical" of the IRC refers specifically to the Air Conditioning Contractors of America (ACCA) Manual S for sizing equipment (IRC Section M1401.3).

403 – Building Systems

403.6 – Equipment sizing

Oversized Air Conditioning Equipment Results in Short Cycling

Impacts of oversizing are:

- Reduces equipment life
- Reduces efficiency (SEER)- costs more to operate
- Results in poor dehumidification
- Reduces filter effectiveness
- Higher initial cost

403 – Building Systems

403.8 - Snow melt system controls (Mandatory).

- Snow- and ice-melting systems shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C), no precipitation is falling and the outdoor temperature is above 40°F (4°C).

403 – Building Systems

- 403.9 - Pools (Mandatory).
- 403.9.1 Pool heaters.
  - All pool heaters shall be equipped with a readily accessible on-off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas or LPG shall not have continuously burning pilot lights.

403 – Building Systems

- 403.9.2 Time switches.
  - Time switches to automatically turn off and on heaters and pumps according to a preset schedule shall be installed on swimming pool heaters and pumps. The two exceptions address public health standards and circumstances where the pumps serve pools with solar-waste-heat recovery heating systems.

403 – Building Systems

403.9.3 Pool covers.

- Heated pools shall be equipped with a vapor-retardant pool cover on or at the water surface. Pools heated to more than 90°F (32°C) shall have a pool cover with a minimum insulation value of R-12.

403 – Building Systems

- 404.1 Lighting equipment (Prescriptive)
  - A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps.

Compliance Methods and Building Systems

1. Is a vapor retarder required in an unvented wall system in Dimmit County, Texas?

No. Section 402.5 and Tables 301.1 and 301.2: Lee County, Texas is considered a warm and humid climate zone and does not require a vapor retarder.

Vapor retarded is covered in the IRC

Compliance Methods and Building Systems

2. Ductwork will be installed in the floor joist cavities located between two conditioned floors. What is the minimum duct insulation R-value for the duct insulation?

Section 403.2.1: Ducts are not required to be insulated if located in conditioned spaces.

Compliance Methods and Building Systems

3. What is the minimum duct insulation for supply ducts located in a naturally ventilated attic in Climate Zone 3?

Section 403.2.1: R-8.

Compliance Methods and Building Systems

4. Which of the following duct sealing methods are approved under the IECC for low-pressure ductwork?
   A. Duct tape
   B. Tight-fitting joints
   C. Zip ties
   D. Mastic

Compliance Methods and Building Systems

5. A proposed single-family home is located in Climate Zone 3. A radiantly heated slab-on-grade foundation is proposed. What minimum R-value is required for the slab edge?

Note d, Table 402.1.1: R-5.

Compliance Methods and Building Systems

6. A single-family home is proposed for a climate zone having 6,500 CDD (cooling degree days). The house will have a raised floor over a crawl space with insulation installed in the floor. What is the maximum equivalent U-factor for the floor assembly using the U-factor alternative approach?

6500 CDD 59 F = Climate Zone 2 from Table 301.3(2)
Table 402.1.3 requires a *U-factor less than or equal to 0.064.*

Compliance Methods and Building Systems

7. A proposed building has the following building assemblies and levels of efficiency:

A.	Opaque Wall:	Net Area -	1048 ft^2 (97m^2)	U-0.065
B.	Glazing:	Net Area -	192 ft^2 (8.5 m^2)	U-0.50
C.	Door:	Net Area -	40 ft^2 (3.7 m^2)	U-0.35
D.	Roof:	Net Area -	1500 ft^2 140 m^2)	U-0.035
E.	Floor:	Net Area -	1500 ft^2 (140 m^2)	U-0.065

Using the Total *UA* alternative, calculate the *UA* for the proposed building.

COMPLIANCE METHODS AND BUILDING SYSTEMS

Figure 502.2(4): U-0.07.

(a) Opaque Wall: Net Area - 1048 ft^2 (97 m^2) × U – 0.065 = 68.12
(b) Glazing: Net Area - 192 ft^2 (19m^2) × U – 0.500 = 96.00
(c) Door: Net Area - 40 ft^2 (3.8 m^2) × U – 0.350 = 14.00
(d) Roof: Net Area- 1500 ft^2 (140 m^2) × U – 0.035 = 52.50
(e) Floor: Net Area - 1500 ft^2 (140 m^2)× U – 0.065 = 97.50
328.12

The UA for the building is greater than 328.12 (see calculation above).

Compliance Methods and Building Systems

8. A proposed single-family dwelling will use a standard truss system in a marine zone (Climate Zone 4) with a window area of 19 percent of the exterior wall area. What is the minimum ceiling *R*-value required for the building by *R*-value computation?

Table 402.1.1: R-38.

Workbook Page 56

Compliance Methods and Building Systems

9. A single-family dwelling is proposed for Climate Zone 1. The proposed building will have a window area of 21 percent of the exterior wall area. What is the minimum *R*-value for the exterior wall if it is framed with metal studs using *R*-value computation?

Table 402.1.1: Wood frame wall *R-value = 13*

Table 402.2.4: Cold-formed steel equivalents = R-13+5, R-15+4, or R-21+3.

Workbook Page 56

Compliance Methods and Building Systems

10. A proposed building has the following building assemblies and levels of efficiency:

A. Window *U*-factor = 0.50

B. Wall *R*-value = R-11

C. Ceiling *R*-value = R-38

D. Floor *R*-value = R-19

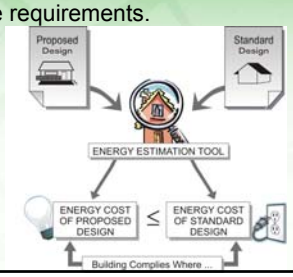
Does the proposed house comply using the R-value computation method?

Table 402.1.1: No. The minimum wall *R-value must be R-13.*

Workbook Page 56

405 – Simulated Performance Alternative

An energy estimation tool is used to compare the energy use of the proposed design with that of the standard design building, just meeting the minimum code requirements.



405 – Simulated Performance Alternative

405.4 – Documentation

A comparative compliance report which clearly depicts the annual energy costs of both standard and proposed designs must accompany all submittals demonstrating compliance under the simulated performance alternative.

405 – Simulated Performance Alternative

405.5.2 – Residence specifications

Table 405.5.2(1) - Specifications for the Standard Reference and Proposed Designs

- Building Component
- Standard Reference Design
- Proposed Design

TABLE 405.5.2(1)
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame Gross area: same as proposed U-factor: from Table 402.1.3 Solar absorptance = 0.75 Remittance = 0.90	As proposed As proposed As proposed As proposed As proposed
Basement and crawl space walls	Type: same as proposed Gross area: same as proposed U-factor: from Table 402.1.3, with insulation layer on interior side of walls.	As proposed As proposed As proposed
Above-grade floors	Type: wood frame Gross area: same as proposed U-factor: from Table 402.1.3	As proposed As proposed As proposed
Ceilings	Type: wood frame Gross area: same as proposed U-factor: from Table 402.1.3	As proposed As proposed As proposed
Roofs	Type: composition shingle on wood sheathing Gross area: same as proposed Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed
Attics	Type: vented with apertures = 1 ft² per 300 ft² ceiling area	As proposed
Foundations	Type: same as proposed foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed As proposed
Doors	Area: 40 ft² Orientation: North U-factor: same as fenestration from Table 402.1.3.	As proposed As proposed As proposed
Glazing[a]	Total area[b] = (a) The proposed glazing area, where proposed glazing area is less than 15% of the conditioned floor area. (b) 15% of the conditioned floor area, where the proposed glazing area is 15% or more of the conditioned floor area. Orientation: equally distributed to four cardinal compass orientations (N, E, S & W). U-factor: from Table 402.1.3 SHGC: From Table 402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: Summer (all hours when cooling is required) = 0.70 Winter (all hours when heating is required) = 0.85[c] External shading: none	As proposed As proposed As proposed As proposed Same as standard reference design As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

2009 IECC Fundamentals

136

TABLE 405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Specific leakage area (SLA)[d] = 0.00036 assuming no energy recovery	For residences that are not tested, the same as the standard reference design For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 7.1, the measured air exchange rate[e] but not less than 0.35 ach[f] For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 7.1, the measured air exchange rate[e] combined with the mechanical ventilation rate, f which shall not be less than $0.01 \times (CFA + 7.5 \times (N_{br}+1))$ where: CFA = conditioned floor area N_{br} = number of bedrooms
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $kWh/yr = 0.0194 \times CFA + 29.565 \times (N_{br}+1)$ where: CFA = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	$IGain = 17,900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[g] but not integral to the building envelope or structure
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air For masonry basement walls, as proposed, but with insulation required by Table 402.1.3 located on the interior side of the walls For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed As proposed As proposed
Heating system[h]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Cooling system[h]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Service water heating[i, j, k]	As proposed Use: same as proposed design	As proposed gal/day = $30 + (10 \times N_{br})$
Thermal distribution systems	A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct insulation, from Section 403.2.1. For tested duct systems, the leakage rate shall be the applicable maximum rate from Section 403.2.2.	As tested or as specified in Table 403.2.2(2) if not tested
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

2009 IECC Fundamentals

137

TABLE 405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Specific leakage area (SLA)[d] = 0.00036 assuming no energy recovery	For residences that are not tested, the same as the standard reference design For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 7.1, the measured air exchange rate[e] but not less than 0.35 ach[f] For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 7.1, the measured air exchange rate[e] combined with the mechanical ventilation rate, f which shall not be less than $0.01 \times (CFA + 7.5 \times (N_{br}+1))$ where: CFA = conditioned floor area N_{br} = number of bedrooms
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $kWh/yr = 0.0194 \times CFA + 29.565 \times (N_{br}+1)$ where: CFA = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	$IGain = 17,900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[g] but not integral to the building envelope or structure
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air For masonry basement walls, as proposed, but with insulation required by Table 402.1.3 located on the interior side of the walls For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed As proposed As proposed
Heating system[h]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Cooling system[h]	As proposed Capacity: sized in accordance with Section M1401.3 of the *International Residential Code*	As proposed
Service water heating[i, j, k]	As proposed Use: same as proposed design	As proposed gal/day = $30 + (10 \times N_{br})$
Thermal distribution systems	A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct insulation, from Section 403.2.1. For tested duct systems, the leakage rate shall be the applicable maximum rate from Section 403.2.2.	As tested or as specified in Table 403.2.2(2) if not tested
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

2009 IECC Fundamentals

138

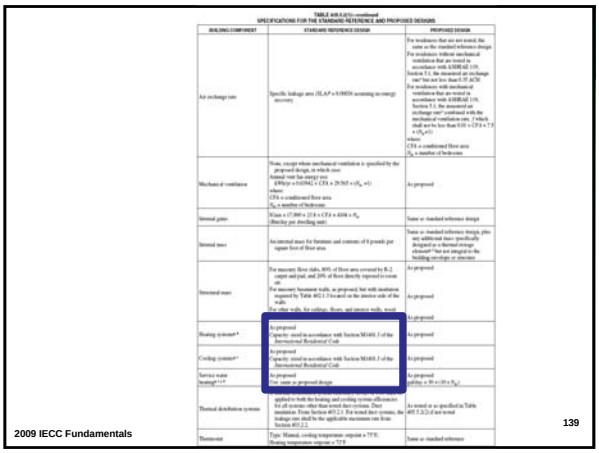


TABLE 405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

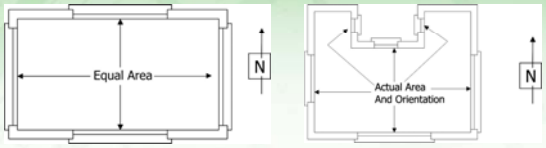
BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Specific leakage area (SLA)[a] = 0.00036 assuming no energy recovery	For residences that are not tested, the same as the standard reference design For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[b] but not less than 0.35 ACH For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5.1, the measured air exchange rate[b] combined with the mechanical ventilation rate, which shall not be less than $0.03 \times (CFA \times 7.5 + (N_{br}+1))$ where CFA = conditioned floor area N_{br} = number of bedrooms
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use $kWh/yr = 0.03942 \times CFA \times 29.565 \times (N_{br}+1)$ where CFA = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	$Btu/day = 17,900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[c] but not integral to the building envelope or structure
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air For masonry basement walls, as proposed, but with insulation required by Table 402.1.3 located on the interior side of the walls For other walls, for ceilings, floors, and interior walls, wood	As proposed As proposed As proposed
Heating system[d, e]	As proposed Capacity sized in accordance with Section M1401.3 of the International Residential Code	As proposed
Cooling system[d, e]	As proposed Capacity sized in accordance with Section M1401.3 of the International Residential Code	As proposed
Service water heating[d, e, f]	As proposed Use same as proposed design	As proposed $gal/day = 30 + (10 \times N_{br})$
Thermal distribution systems	applicable to both the heating and cooling system efficiencies for all systems other than wood duct systems. Duct insulation: From Section 403.2.1. For wood duct systems, the leakage rate shall be the applicable maximum rate from Section 403.2.2.	As tested or as specified in Table 403.2.2(2) if not tested
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

2009 IECC Fundamentals

139

405 – Simulated Performance Alternative

Table 405.5.2(1) – Glazing



Workbook Page 62

2009 IECC® Fundamentals

140

405 – Simulated Performance Alternative

Table 405.5.2(1) – Skylights and thermally isolated sunrooms

Table 405.5.2(1) – Orientation for groups of buildings

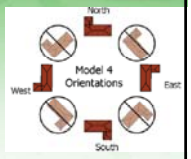


Table 405.5.2(1) – Fenestration system solar heat gain coefficient, standard design

Workbook Page 62-63

2009 IECC® Fundamentals

141

405 – Simulated Performance Alternative

Tables 405.5.2(1) and 405.5.2(2) – Thermal distribution system efficiency (DSE)

Table 405.5.2(2) – Default Distribution System Efficiencies for Proposed Designs

Table 405.5.2(1) – Air exchange rate

Workbook Page 63-64

405 – Simulated Performance Alternative

Table 405.5.2 (2)
Default Distribution System efficiencies for Proposed Design

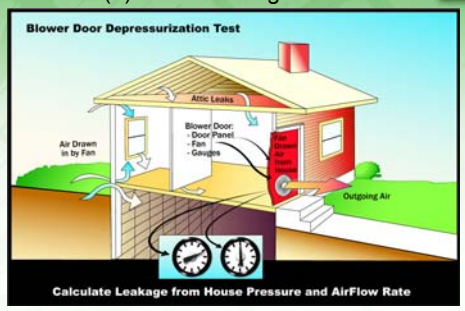
TABLE 405.5.2(2)
DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in unconditioned space	—	0.95
Untested distribution systems entirely located in conditioned space[c]	0.88	1
"Ductless" systems[d]	1	—

For SI: 1 cubic foot per minute = 0.47 L/s; 1 square foot = 0.093 m²; 1 pound per square inch = 6895 Pa; 1 inch water gauge = 3250 Pa.
a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer's air handler enclosure.

405 – Simulated Performance Alternative

Table 405.2 (1) – Air Exchange Rate



Simulated Performance Alternative

1. What *U*-factor must be used for the standard design wall assembly for a residence built in a climate with 6,500 HDD?

Table 404.5.2(1); above-grade walls: *U-factor: From Table 402.1.3 – Zone 5:* U-0.060.

Workbook Page 65

Simulated Performance Alternative

2. What orientation(s) must be used to demonstrate the worst-case condition for a group of proposed buildings with identical designs under the 2009 IECC?

Table 405.5.2(1); Glazing; Orientation: "Equally distributed to four cardinal compass orientations (N, E, S and W)."

Workbook Page 65

Simulated Performance Alternative

3. Can exterior shading be used by Chapter 4 to trade off the 0.40 SHGC in climates less than 3,500 HDD?

Yes, in accordance with Table 405.2(1); Glazing; External shading: None compared to "as proposed" for Proposed Design.

Workbook Page 65

Simulated Performance Alternative

4. When establishing the Standard design, glazing must be assumed to be placed equally on what exposure under the 2009 IECC?

   A. North, Northeast, East, Southeast, South, Southwest, West and Northwest
   B. North, West, South, East
   C. Northwest, Northeast, Southwest, Southeast
   D. West, South, East

.

Workbook Page 65

Simulated Performance Alternative

5. The proposed design specifies a 90-percent Annual Fuel Utilization Efficiency (AFUE) gas furnace for the heat source. Under the 2009 IECC, what furnace efficiency must be used to determine the standard design budget?

Table 405.5.2(1); Heating systems; As proposed, the standard design shall use a 90-percent AFUE furnace.

Workbook Page 65

Residential

- A Single family residential structure is being built in Vail, Colorado.
- The contractor has submitted plans and specifications along with a permit application for this single family home.

Workbook Page 66

Residential

- The home is built using insulated concrete form type construction with more than half the insulation on the exterior side of the wall, and is a slab on grade structure, with two skylights in a roof truss system.

Workbook Page 66

Residential

1. What is the climate zone for this building?

   Climate Zone 6 (Section 301 and Table 301.1)

2. What is the maximum fenestration *U*-factor for window and skylights?

   0.35 for windows and 0.60 for skylights. (Table 402.1.1)

Workbook Page 66

Residential

3. What is the minimum insulation *R*-value for the roof assembly?

   R-49 (Table 402.1.1)

4. What is the minimum exterior wall *R*-value?

   15 (see Footnote i of Table 402.1.1)

Workbook Page 66

Residential

5. What is the Minimum requirements for the foundation *R*-value and depth of insulation?

R-10 to a depth of 4 feet (1219 mm) (Table 402.1.1)

Workbook Page 66

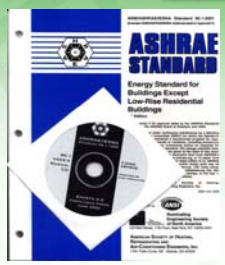
Chapter 5
Commercial Energy Efficiency

501 - General

501.1 – Scope

Standard 90.1

Commercial buildings shall meet either the requirements of ASHRAE/IESNA Standard 90.1 or the requirements contained in this chapter.



Workbook Page 69

501 - General

Structure of Standard 90.1-2007:

- Section 5 - Building Envelope
- Section 6 - Heating, Ventilating, and Air Conditioning
- Section 7 - Service Water Heating
- Section 8 - Power
- Section 9 – Lighting
- Appendix A Assembly U-factor, C-factor, and F-factor determination
- Appendix B Building Envelope Criteria
- Appendix C Trade-off Option
- Appendix D Climate Data

501 - General

501.2 – Application

502 – Building Envelope Requirements

The building envelope requirements focus on three types of provisions:

- Insulation (prescriptive) – Section 502.2
- Fenestration (prescriptive) – Section 502.3
- Air leakage (mandatory) – Section 502.4

502 – Building Envelope Requirements

502.2 – Specific insulation requirements (prescriptive)

Based on:

- Climate zone
- Window wall ratio and
- Construction assembly

All components must meet or exceed building envelope requirements.

Workbook Page 72

502 – Building Envelope Requirements

Table 502.2(1) – Building envelope requirements – Opaque assemblies

- Determine the climate zone
- Each assembly will have maximum *U*-factor and SHGC requirements and minimum *R*-value requirements
- *R*-value requirements apply to the insulation only

Workbook Page 73

502 – Building Envelope Requirements

Table 502.1.2 Building Envelope Requirements Opaque

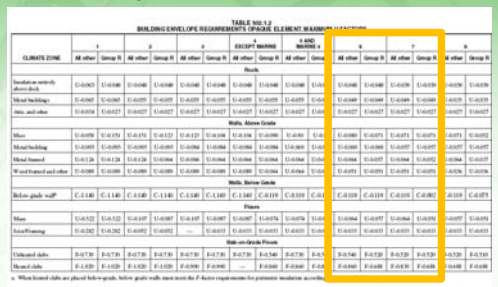
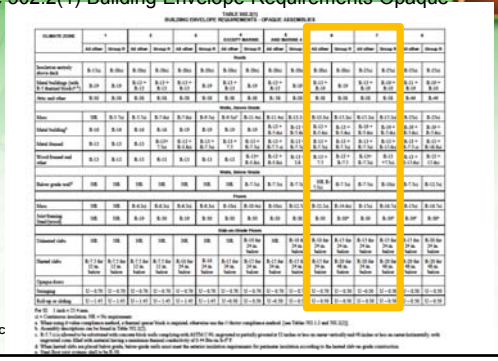


TABLE 502.1.2
BUILDING ENVELOPE REQUIREMENTS OPAQUE ELEMENT MAXIMUM U-FACTORS

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		4 AND MARINE 4		5		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																		
Insulation entirely above deck	U-0.063	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039
Metal buildings[a]	U-0.065	U-0.065	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.049	U-0.039	U-0.039
Attic and other	U-0.034	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Walls, Above Grade																		
Mass	U-0.090	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.071	U-0.071	U-0.071	U-0.071	U-0.071	U-0.071	U-0.052
Metal building	U-0.095	U-0.095	U-0.095	U-0.095	U-0.094	U-0.094	U-0.094	U-0.094	U-0.069	U-0.069	U-0.069	U-0.069	U-0.057	U-0.057	U-0.057	U-0.057	U-0.057	U-0.057
Metal framed	U-0.124	U-0.124	U-0.124	U-0.094	U-0.094	U-0.094	U-0.094	U-0.094	U-0.094	U-0.094	U-0.094	U-0.057	U-0.057	U-0.057	U-0.057	U-0.052	U-0.044	U-0.037
Wood framed and other	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.089	U-0.084	U-0.084	U-0.084	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.036	U-0.036
Walls, Below Grade																		
Below-grade wall[b]	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-0.119	C-0.119	C-0.1	C-0.119	C-0.119	C-0.119	C-0.119	C-0.092	C-0.119	C-0.119	C-0.119
Floors																		
Mass	U-0.322	U-0.322	U-0.107	U-0.087	U-0.107	U-0.087	U-0.087	U-0.074	U-0.074	U-0.1	U-0.084	U-0.057	U-0.084	U-0.057	U-0.057	U-0.057	U-0.057	U-0.033
Joist/Framing	U-0.282	U-0.282	U-0.052	U-0.052	—	U-0.033	U-0.033	U-0.033	U-0.033	U-0.1	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033
Slab-on-Grade Floors																		
Unheated slabs	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.730	F-0.540	F-0.730	F-0.5	F-0.540	F-0.520	F-0.520	F-0.520	F-0.520	F-0.520	F-0.510	F-0.510
Heated slabs	F-1.020	F-1.020	F-1.020	F-1.020	F-0.990	F-0.990	—	F-0.860	F-0.860	F-0.8	F-0.860	F-0.680	F-0.820	F-0.820	F-0.820	F-0.680	F-0.680	F-0.680

a. When heated slabs are placed below-grade, below-grade walls must meet the *F*-factor requirements for perimeter insulation according

Table 502.2(1) Building Envelope Requirements Opaque



2009 IECC

163

502 – Building Envelope Requirements

502.2.1 – Roof assembly

Roof insulation requirements based on:

- Assembly Type
- Insulation Placement
- Cavity Insulation
- Continuous Insulation

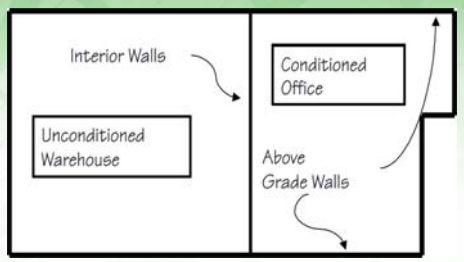
2009 IECC® Fundamentals

Workbook Page 74

164

502 – Building Envelope Requirements

502.2.2 – Classification of walls



2009 IECC® Fundamentals

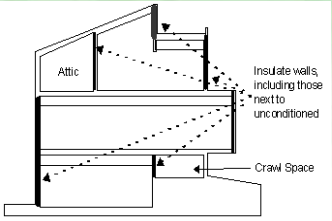
Workbook Page 74

165

502 – Building Envelope Requirements

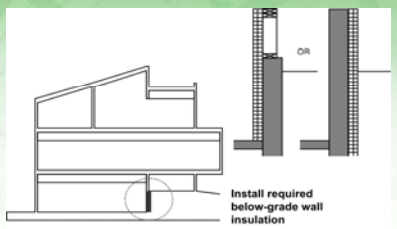
502.2.3 – Above-grade walls

All walls between conditioned spaces and the outdoors or unconditioned spaces must be insulated.



502 – Building Envelope Requirements

502.2.4 – Below-grade walls



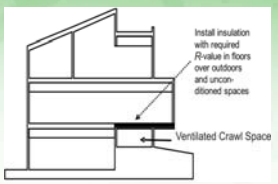
Insulation on below-grade walls

502 – Building Envelope Requirements

502.2.5 – Floors over outdoor air or unconditioned space

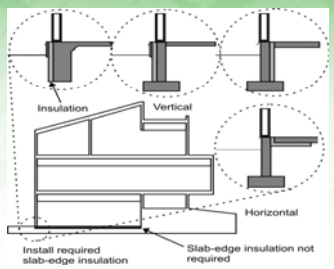
The requirements for floor insulation are based on:

- Assembly type
- Insulation placement
- Cavity insulation
- Continuous insulation



502 – Building Envelope Requirements

502.2.6 – Slabs on grade



Poor Insulation Installation

Gapped Fiberglass Ceiling Insulation

Photo courtesy of Brian Kumer, Thermal Imaging Service of Central Illinois, Inc.

Moved Ceiling Insulation

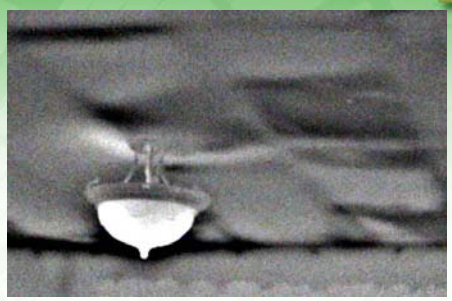


Photo courtesy of Brian Kumer, Thermal Imaging Service of Central Illinois, Inc.

Removed Insulation at Thermostat

Photo courtesy of Brian Kumer, Thermal Imaging Service of Central Illinois, Inc.

502 – Building Envelope Requirements

502.2.7 – Opaque doors

(Opaque = doors having less than 50% glass area – Section 502.2.7)

All are required to meet the *U*-factor requirement for doors as specified in Table 502.2(1).

Includes overhead coiling and metal roll-up doors used for conditioned loading docks.

Workbook Page 76

502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

The gross wall area includes:

- Above-grade walls
- Band and rim joists and spandrel area between floors
- Area of **ALL** doors and windows

Workbook Page 77

502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	4 MARINE	5 AND MARINE	6	7	8
Vertical fenestration (40% maximum of above-grade wall)									
U-factor									
Framing materials other than metal with or without metal reinforcement or cladding									
U-factor	1.20	0.75	0.65	0.40	0.35		0.35	0.35	0.35
Metal framing with or without thermal break									
Curtain wall/storefront U-factor	1.0	0.70	0.60	0.50	0.45		0.45	0.40	0.40
Entrance door U-factor	1.20	1.10	0.90	0.85	0.80		0.80	0.80	0.80
All other U-factor[a]	1.20	0.75	0.65	0.55	0.55		0.55	0.45	0.45
SHGC: all frame types									
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40		0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR		NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR		NR	NR	NR
Skylights (3% maximum)									
U-factor	0.75	0.75	0.65	0.60	0.60		0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40		0.40	NR	NR

NR = No requirement.
PF = Projection factor (see Section 502.3.2).
a. All others includes operable windows, fixed windows and nonentrance doors.

502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

Vertical fenestration (40% maximum of above-grade wall)									
U-factor									
Framing materials other than metal with or without metal reinforcement or cladding									
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
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Curtain wall/storefront U-factor	1.0	0.70	0.60	0.50	0.45	0.45	0.40	0.40
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All other U-factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC: all frame types									
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)									
U-factor	0.75	0.75	0.65	0.60	0.60	0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.
PF = Projection factor (see Section 502.3.2).
a. All others includes operable windows, fixed windows and nonentrance doors.

502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration (40% maximum of above-grade wall)								
U-factor								
Framing materials other than metal with or without metal reinforcement or cladding								
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain wall/storefront *U*-factor	1.0	0.70	0.60	0.50	0.45	0.45	0.40	0.40
Entrance door *U*-factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All other *U*-factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC: all frame types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
U-factor	0.75	0.75	0.65	0.60	0.60	0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.
PF = Projection factor (see Section 502.3.2).
a. All others includes operable windows, fixed windows and nonentrance doors.

2009 IECC Fundamentals 178

502 – Building Envelope Requirements

502.3 – Fenestration (prescriptive)

Solar Heat Gain Coefficient (SHGC)

TABLE 303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		
Clear	Tinted	Clear	Tinted	GLAZED BLOCK
0.8	0.7	0.7	0.6	0.6

Workbook Page 77-78

2009 IECC® Fundamentals 179

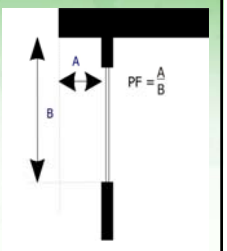
502 – Building Envelope Requirements

502.3 – Fenestration (prescriptive)

Projection Factor

A = depth from the leading edge of the overhang to the face of the glass

B = height from the bottom of leading edge of overhang to top o the windowsill



2009 IECC® Fundamentals Workbook Page 78 180

502 – Building Envelope Requirements

Table 502.3 – Building Envelope Requirements: Fenestration

TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration (40% maximum of above-grade wall)								
U-factor								
Framing materials other than metal with or without metal reinforcement or cladding								
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain wall/storefront *U*-factor	1.0	0.70	0.60	0.50	0.45	0.45	0.40	0.40
Entrance door *U*-factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All other *U*-factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC: all frame types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
U-factor	0.75	0.75	0.65	0.60	0.60	0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.
PF = Projection factor (see Section 502.3.2).
a. All others includes operable windows, fixed windows and nonentrance doors.

502 – Building Envelope Requirements

Proposed:

A new commercial structure is to be built in Sangamon County, Illinois (Climate Zone 5). The office building has a projection factor of 0.20, the roof assembly is all-wood joist trusses and it is slab-on-grade with a concrete slab floor extending over the covered parking garage. The above-grade walls are metal framed with cavity and rigid board insulation.

502 – Building Envelope Requirements

It is determined that the total combined window and door area is less than 40 percent of the above-grade wall area. A review of Tables 502.2(1) and 502.3 determine the following insulation levels are required:

- Slab Insulation – NR.
- Window and Glass Door – SHGC 0.4
- Window and Glass Door – *U-Factor 0.35.*
- Roof Insulation between Framing Joists – R-30, Continuous Insulation R-20 ci.
- Slab over Parking Garage Insulation – R-10 ci.
- Above-Grade Wall Insulation – R-13 + 3.8.

502 – Building Envelope Requirements

What is the projection factor of an overhang that extends 3 feet (914 mm) out and is 6 feet (1829 mm) above the windowsill?

The projection factor is “A” divided by “B” (see Figure 48). If “A” is 3 feet (914 mm) and “B” is 6 feet (1829 mm), the projection factor is 3/6 or 0.5.

502 – Building Envelope Requirements

502.3 – Fenestration (prescriptive)

Fenestration maximum *U*-factor

- Laboratory measurement of the overall thermal performance of a fenestration product
- Table 303.1.3(1) – Default Glazed Fenestration *U*-factor or
- Table 303.1.3(2) – Default Door *U*-factor

502 – Building Envelope Requirements

Table 303.1.3(1) – Default Glazed Fenestration *U*-factor

TABLE 303.1.3(1)
DEFAULT GLAZED FENESTRATION *U*-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

502 – Building Envelope Requirements

Table 303.1.3(2) – Default Door *U*-factor

TABLE 303.1.3(2)
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

502 – Building Envelope Requirements

502.3 – Fenestration (prescriptive)

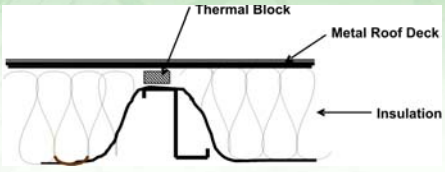
Skylights

- A skylight *U*-factor is based on the interior surface area of the entire skylight assembly, including glazing, sash, curbing and other framing elements.

502 – Building Envelope Requirements

502.3 – Fenestration (prescriptive)

Metal buildings

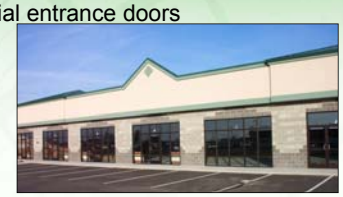


502 – Building Envelope Requirements

502.4 – Air Leakage (mandatory)

502.4.1 – Window and door assemblies

502.4.2 – Curtain wall, storefront glazing, and commercial entrance doors



Storefront Glazing

Workbook Page 81

502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

Workbook Page 81-82

502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

- Exterior joints around windows and door frames.
- Between wall sole plates, floors, and exterior wall panels.
- Openings for plumbing, electricity, refrigerant and gas lines in exterior walls, floors, and roofs.

Workbook Page 81-82

502 – Building Envelope Requirements

502.4.3 – Sealing of the building envelope

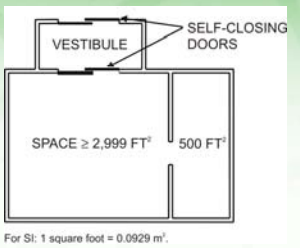
- Openings in the attic floor (such as where ceiling panels meet interior and exterior walls and masonry fireplaces).
- Service and access doors or hatches.
- All similar openings in the building envelope.

Sealing the building envelope reduces air infiltration in the building.

502 – Building Envelope Requirements

502.4.6 – Loading dock weatherseals

502.4.7 – Vestibules



502 – Building Envelope Requirements

502.4.8 – Recessed luminaries

Look for Rating Sticker

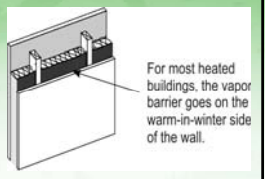
Seal Edges of Penetration into Attic Space

Air-lock, Air-tight or Air-seal Fixture

502 – Building Envelope Requirements

Moisture control (See IBC Sections 1405.3 and IRC Section R601.3)

- General requirements for control of moisture vapor entering the building have been relocated to the construction requirements of the IBC an IRC.



Building Requirement Envelope

1. What compliance options are available for a commercial building where the window and glazed door area is greater than 40 percent of the gross area of above-grade walls?

Section 501: Section 506 or Standard. 90.1

Building Requirement Envelope

2. A wall is located between conditioned space and unconditioned space. What type of wall is this considered to be to determine the minimum *R*-value?

An above-grade wall. Section 502.2.3: Use the requirements for “above grade walls,” Table 502.2(1).

Building Requirement Envelope

3. For a commercial building located in Zone 4, what is the required *R*-value of an above-grade, metal-framed wall with a window and glazed door area of 40 percent in Climate Zone 4?

Table 502.2(1) column for Zone 4, Row "metal framed" R-13 and R-7.5.

Building Requirement Envelope

4. According to Chapter 5, what is the required *R*-value of an above-grade, metal-framed wall with a window and glazed door area of 40 percent in Climate Zone 4?

Table 502.2(1): R-13

Building Requirement Envelope

5. For a commercial building located in Zone 5, what is the required continuous *R*-value of an above-grade 10-inch (254 mm) concrete masonry unit (CMU) wall with a window and glazed door area of 15 percent?

Table 502.2(1): R-11.4 ci

Building Requirement Envelope

6. According to Chapter 5, what is the required *R*-value of continuous insulation in a roof assembly using metal purlins without thermal blocks and a window and glazed door area of 40 percent Zone 4?

Table 502.2(1): R-13 +13

Building Requirement Envelope

7. If calculations using Equation 5-1 determine a window projection factor (PF) of 0.45, what is the allowable SHGC for a window in Climate Zone 4 with a window area of 15 percent?

Table 502.3: SHGC, no requirement

Building Requirement Envelope

8. What is the maximum allowable skylight percentage to roof area for a commercial building located in Climate Zone 5 with 40 percent of the gross wall area glazed?

Table 502.3: 3 percent or Section 501.1: 5 percent Standard 90.1

Building Requirement Envelope

9. A 10,000 square-foot building located in Climate Zone 5 will have a primary entrance door leading from a 2,500 square-foot (232 m^2) space to the exterior. A swinging door with a self-closing device will be installed. Does the door comply with the code?

Section 502.4.6: Yes. No vestibule is required on primary entrance doors leading to spaces less than 3,000 square feet (279 m^2).

Workbook Page 85

Building Requirement Envelope

10. A metal building is proposed in Climate Zone 4. The building will have 25 percent of the gross exterior wall area glazed and will use a metal purlin system without thermal blocks. R-30 insulation is proposed to be installed between the framing members. Does this installation comply with the IECC?

Table 502.2(1). Not enough information. Consult ASHRAE 90.1 Appendix Table A2.3 for Metal Building Roofs.

Workbook Page 85

503 – Building Mechanical Systems

Seven key elements to ensure HVAC system design is efficient:

- Equipment efficiency
- Proper equipment sizing and selection
- Distribution losses
- Transmission losses
- Controls
- Free-cooling
- Heat recovery

Equipment efficiency terminology

Simple and complex systems

Workbook Page 86-88

503 – Building Mechanical Systems

- 503.2.1 – Calculation of heating and cooling loads
  - Designers must perform heating and cooling load calculations before sizing and selecting HVAC
  - HVAC systems must be sized based on the heating and cooling loads calculated in Section 503.2.1.
  - When the cooling load is predominant the system must be sized to not exceed that load.

503 – Building Mechanical Systems

503.2.2 – Equipment and system sizing

- "Shall not exceed the loads calculated."
- Equipment selected to meet space cooling loads must select capacity for heating based on smallest size within available equipment options.
- Standby equipment to have controls and devices to operate automatically when primary equipment is not operating.
- Multiple units with combined capacities that exceed design load shall have controls to sequence operation.

503 – Building Mechanical Systems

503.2.3 – HVAC equipment performance requirements
- Equipment efficiency

Table 503.2.3(7) – Water Chilling Packages, Minimum Efficiency Requirements

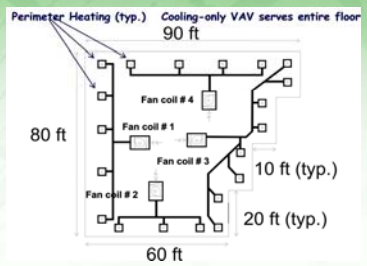
503.2.4 – HVAC system controls

2009 IECC Fundamentals

211

503 – Building Mechanical Systems

503.2.4.1 – Thermostatic controls



For SI: 1 foot = 304.8 mm.

2009 IECC® Fundamentals

Workbook Page 91

212

503 – Building Mechanical Systems

503.2.4.4 – Shutoff damper controls

503.2.4.5 – Snow melt system controls

503.2.5 –Ventilation

2009 IECC® Fundamentals

Workbook Page 92

213

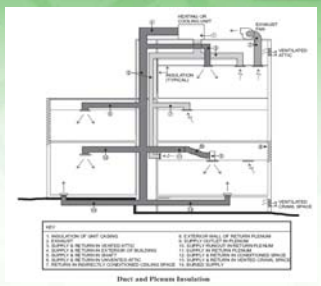
503 – Building Mechanical Systems

503.2.5.1 – Demand control ventilation

503.2.6 – Energy Recovery Ventilation System

503 – Building Mechanical Systems

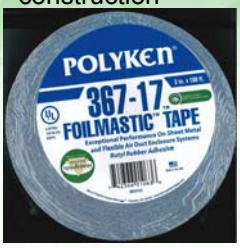
503.2.7 – Ducts and plenum insulation and sealing

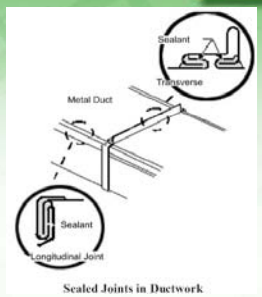


Duct and Plenum Insulation

503 – Building Mechanical Systems

503.2.7.1 – Duct construction





Sealed Joints in Ductwork

503 – Building Mechanical Systems

503.2.8 – Piping insulation

- Piping serving as part of heating or cooling systems must be insulated according to Table 503.2.8.
- Table 503.2.8, Minimum Pipe Insulation

503 – Building Mechanical Systems

- Table 503.2.8, Minimum Pipe Insulation

TABLE 503.2.8
MINIMUM PIPE INSULATION
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER	
	≤ 1.5[a]	> 1.5[a]
Steam	$1^1/_2$	3
Hot water	$1^1/_2$	2
Chilled water, brine or refrigerant	$1^1/_2$	$1^1/_2$

[a] For SI: 1 inch = 25.4 mm.

503 – Building Mechanical Systems

503.2.9 – HVAC system completion

503.2.9.1 – Air system balancing

503 – Building Mechanical Systems

503.2.9.2 – Hydronic system balancing

- Individual hydronic heating and cooling coils to be equipped with means for balancing and pressure test connectors.

503.2.9.3 - Manuals

503 – Building Mechanical Systems

503.3 – Simple HVAC systems and equipment

Simple systems are typically single-zone unitary systems with one control per system.

503 – Building Mechanical Systems

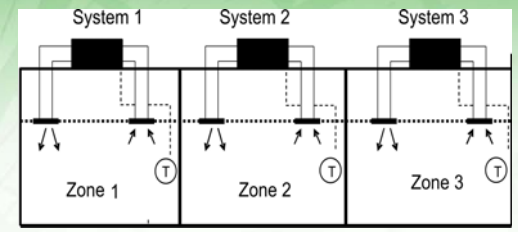
503.3 – Simple HVAC systems and equipment

They include:

- Unitary air conditioners and condensing units.
- Unitary and applied heat pumps electrically operated.
- Packaged terminal air conditioners.
- Packaged terminal heat pumps.
- Warm air furnaces.
- Warm air duct furnaces.
- Unit heaters.
- Two-pipe heating systems with no cooling installed.

503 – Building Mechanical Systems

503.3 – Simple HVAC systems and equipment



503 – Building Mechanical Systems

503.3.1 – Economizers

An air-side economizer is simply a collection of dampers, sensors, actuators, and logic devices that together decide how much outside air to bring into the building.

TABLE 503.3.1(1)
ECONOMIZER REQUIREMENTS

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B, 2A, 7, 8	No requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B	Economizers on all cooling systems ≥ 54,000 Btu/h[a]

For SI: 1 British thermal unit per hour = 0.293 W.

a. The total capacity of all systems without economizers shall not exceed 480,000 Btu/h per building, or 20 percent of its air economizer capacity, whichever is greater.

503 – Building Mechanical Systems

503.3.1 – Economizers

An air-side economizer is simply a collection of dampers, sensors, actuators, and logic devices that together decide how much outside air to bring into the building.

TABLE 503.3.1(1)
ECONOMIZER REQUIREMENTS

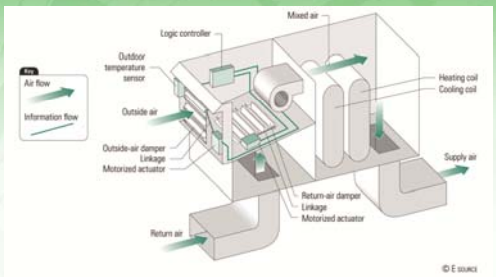
CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B, 2A, 7, 8	No requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B	Economizers on all cooling systems ≥ 54,000 Btu/h[a]

For SI: 1 British thermal unit per hour = 0.293 W.

a. The total capacity of all systems without economizers shall not exceed 480,000 Btu/h per building, or 20 percent of its air economizer capacity, whichever is greater.

503 – Building Mechanical Systems

503.3.1 – Economizers



Air-side Economizer

503 – Building Mechanical Systems

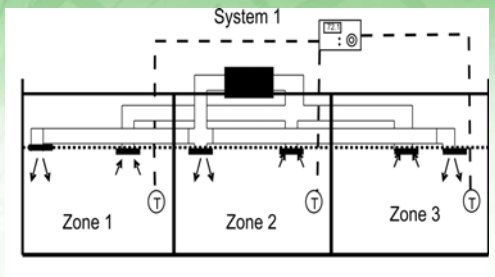
503.4 – Complex HVAC systems and equipment

Includes:

- Systems serving multiple zones.
- Hydronic steam heating and water chilling packages.
- Variable air volume (VAV) systems.
- Two-pipe changeover.
- Four-pipe systems.
- Hydronic (water loop) heat pump systems.

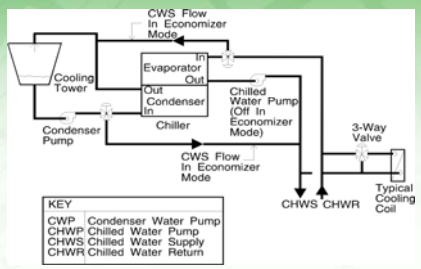
503 – Building Mechanical Systems

503.4 – Complex HVAC systems and equipment



503 – Building Mechanical Systems

503.4.1 – Economizers



503 – Building Mechanical Systems

503.4.2 – Variable air volume (VAV) fan control

503.4.3 – Hydronic systems controls

503 – Building Mechanical Systems

503.4.3.1 – Three-pipe systems

503.4.3.2 – Two-pipe changeover system

503 – Building Mechanical Systems

503.4.3.3 – Hydronic (water loop) heat pump systems

- Heat pumps connected to a water loop with central heat rejection and heat addition.
- Controls capable of providing 20°F (11.1°C) dead band outside air temperature between initiation of heat rejection and heat addition.

503 – Building Mechanical Systems

503.4.3.4 – Part load controls

503.4.3.5 – Pump isolation

- Chilled water plants with multiple chillers must have the capability to reduce flow automatically when a chiller shut down.
- Boiler plants must have the capability to reduce flow automatically when a boiler is shut down.

503 – Building Mechanical Systems

503.4.4 – Heat rejection equipment fan speed control

Fan Motors >7½ HP (5.6 kW) must have:

- Capability to operate fan at ≤ 2/3 of full speed or less, and
- Controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of heat rejection device.
- Exception: Factory installed heat rejection devices within HVAC equipment meeting equipment efficiency requirements.

503 – Building Mechanical Systems

503.4.5 – Requirements for complex mechanical systems serving multiple zones

Supply air systems must be VAV systems. Controls are required to reduce primary air to each space before allowing:

- Reheating
- Recooling
- Mixing

503 – Building Mechanical Systems

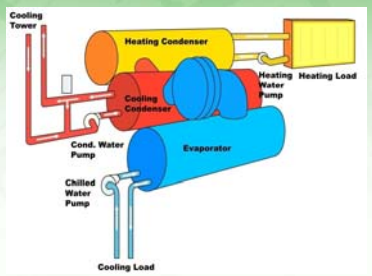
503.4.5 – Requirements for complex mechanical systems serving multiple zones

The primary air supply must be reduced by one of the following means before reheating, recooling, or mixing takes place:

- 30% of the maximum supply air flow to each zone.
- 300 cfm (142 L/s) where maximum flow rate is less than 10% of total fan system supply airflow rate.
- Minimum ventilation requirements of the International Mechanical Code® (IMC®).

503 – Building Mechanical Systems

503.4.6 – Heat recovery for service water heating



Building Mechanical Systems

1. How are design loads for simple HVAC systems and equipment determined?

Section 503.2.1: ASHRAE *Standard 183, equivalent computation procedure specified in IECC Chapter 3, or in accordance with ASHRAE HVAC systems and equipment handbook if using energy recovery systems.*

Building Mechanical Systems

2. When evaluating equipment compliance for a simple HVAC system, what is the minimum efficiency for a 6,000 Btu/h (1,757 Watt) single-package, unitary, air-cooled air conditioner?

Table 503.2.3(1): 13 SEER.

Building Mechanical Systems

3. When evaluating equipment compliance for a simple HVAC system, what is the minimum AFUE for a 100,000 Btu/h (29,281 Watt) gas-fired warm-air furnace?

Table 503.2.3(4): 78 percent AFUE.

Building Mechanical Systems

4. When is a VAV system required?

Section 503.4.5: VAV systems are required for complex systems serving multiple zones.

Building Mechanical Systems

5. A packaged heating and cooling system will serve a retail space in a strip shopping center. Heating and cooling loads were calculated to size the system. The cooling load was calculated at 75,000 Btu/h (21,961 Watt). The heating load was calculated at 45,000 Btu/h (13,188 Watt). Which system meets the equipment and system sizing requirements of the IECC?

   A. System 1 – cooling output 90,000 Btu/h (26,353 Watt) / heating capacity 40,000 Btu/h (11712 Watt).
   B. System 2 – cooling output 75,000 Btu/h (21,961 Watt) / heating capacity 55,000 Btu/h (16,105 Watt).
   C. System 3 – cooling output 90,000 Btu/h (26,353 Watt) / heating capacity 80,000 Btu/h (23,425 Watt).
   D. System 4 – cooling output 75,000 Btu/h (21,961 Watt) / heating capacity 42,000 Btu/h (12,298 Watt).

Building Mechanical Systems

6. A cooling system rated at 135,000 Btu/h (39,529 Watt)cooling capacity is proposed for an office building located in Zone 5. The proposed EER for the system will be 11. Is an economizer required for this system?

Table 503.3.1(1): Yes. Economizers are required on systems 54,000 Btu/h (15,826 Watt) and larger in Climate Zone 5.

Building Mechanical Systems

7. Of the following, which is approved for duct sealant for low-pressure duct systems?

   A. Duct tape
   B. Zip ties
   C. Mastics
   D. Tight-fitting joints

Building Mechanical Systems

8. What *R*-value must ducts be insulated to if they are located in unconditioned space?

Section 503 .2.7: R-5.

Building Mechanical Systems

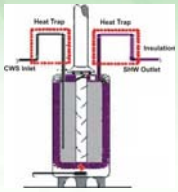
9. For Climate Zone 5A, which of the following cooling systems will require economizer controls under the code?
   A. System 1 – 135,000 Btu/h (39,529 Watt) serving a grocery store with open case refrigeration.
   B. System 2 – 75,000 Btu/h (21,961 Watt) serving an office building.
   C. System 3 – 139,000 Btu/h (40,701 Watt) serving a retail space.

504 – Service Water Heating

There are only a few provisions to be checked to ensure that the water heating system meets the requirements of the IECC.

504.4 – Heat traps

Manufactured Heat Trap Device



504 – Service Water Heating

504.5 – Pipe insulation

504.6 – Hot water system controls

504.7 – Pools

Service Water Heating

1. When are heat traps required to be installed?

Section 504.4: Heat traps are required or noncirculating water heaters and where an integral heat trap is not provided.

Service Water Heating

2. What is the minimum piping insulation thickness required on all non circulating water heating systems?

Section 504.5: 0.5 inch (12.7 mm).

Service Water Heating

3. What is the minimum piping insulation thickness required on all circulating water heating systems?

Section 504.5: 1.0 inch (25.4 mm).

505 – Electrical Power and Lighting Systems

Interior lighting plays a major role in the energy usage of a commercial building. An increased lighting load increases the capacity requirements for the cooling system.

The lighting requirements focus on these elements:

- Controls
- Light reduction methods
- Tandem wiring
- Interior and exterior lighting power

505 – Electrical Power and Lighting Systems

505.1 – General

The lighting requirements apply to the design of:

- New lighting systems in conditioned or unconditioned spaces
- Altered components/systems as part of alteration

.

505 – Electrical Power and Lighting Systems

505.1 – General

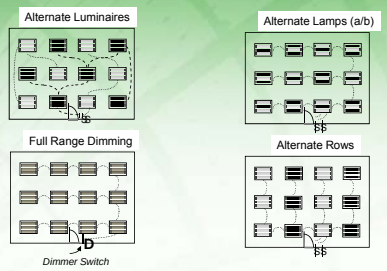
The lighting requirements apply to the design of:

- Any space where the use in a space changes from one use in Table 505.5.2 to another use in Table 505.5.2, the installed lighting wattage shall comply with Section 505.5
- Exterior lighting systems

505.2.1 – Interior lighting controls

505 – Electrical Power and Lighting Systems

505.2.2 – Additional controls



505 – Electrical Power and Lighting Systems

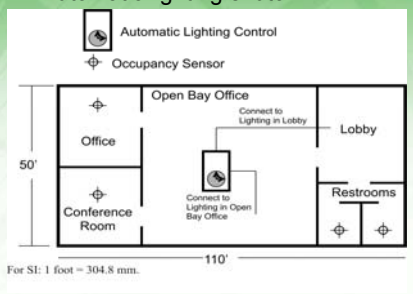
505.2.2.1 – Light reduction controls

Light reduction controls differ from switching controls in that instead of turning the lights off after a period of inactivity, these controls lower the light output, and therefore the energy consumed, when areas are unoccupied or when there is suitable light supplied from another source such as windows or skylights.

These controls can be either “dimming” or “switching” depending on the light source you are controlling and the area being controlled.

505 – Electrical Power and Lighting Systems

505.2.2.2 – Automatic lighting shutoff



505 – Electrical Power and Lighting Systems

- 505.2.2.2.1 – Occupant override

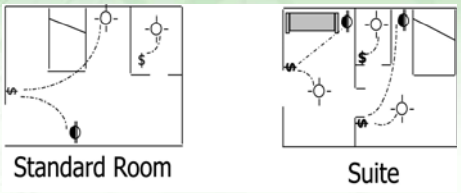
If an automatic time switch control is installed, it must have an occupant override, be readily accessible, and have the following:

- Be in view of the lights.
- Manually operated.
- Two-hour override limit.
- Controls area less than 5,000 square feet (465 m^2).
- Holiday scheduling feature.

505 – Electrical Power and Lighting Systems

505.2.3 – Sleeping units

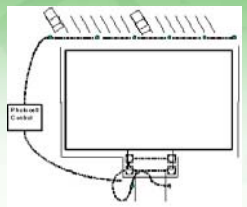
A master switch is required at the entry of each sleeping room.



505 – Electrical Power and Lighting Systems

505.2.4 – Exterior lighting controls

- Must be controlled so they are automatically shut off during daylight hours
- Seven day/seasonal daylight program
- Minimum 4-hour battery backup



505 – Electrical Power and Lighting Systems

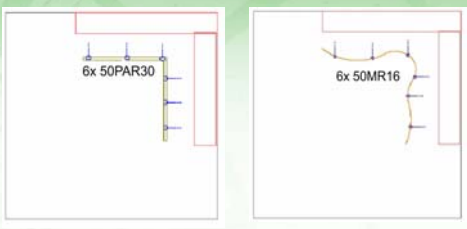
505.4 – Exit signs

505.5 – Interior lighting power requirement

505.5.1 – Total connected interior lighting power

Low Voltage vs. Line Voltage Track Lighting

505.1.4 – Low voltage vs. line voltage track lighting



505 – Electrical Power and Lighting Systems

505.5.2 – Interior lighting power

The lighting budget is determined by utilizing the watts/ft^2 value located in Table 505.5.2 using the predominant occupancy for the particular area type.

Steps to determine if a building complies to interior lighting power

- Determine the interior lighting power budget for the entire building or space.
- Verify the total connected power in watts for the proposed lighting using the construction documents.
- Compare and assess compliance.

TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	(W/ft²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare—clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail[b]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1

(continued)

TABLE 505.5.2—continued
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	(W/ft²)
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

a. In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.

b. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or additional lighting power as determined below shall be added to the interior lighting power determined in accordance with this line item.

Calculate the additional lighting power as follows:

Additional Interior Lighting Power Allowance = 1000 watts + (Retail Area 1 × 0.6 W/ft²) + (Retail Area 2 × 0.6 W/ft²) + (Retail Area 3 × 1.4 W/ft²) + (Retail Area 4 × 2.5 W/ft²).

where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is *approved* by the authority having jurisdiction.

505 – Electrical Power and Lighting Systems

Additional Lighting Power Allowances

- Table 505.5.2, Note b – Merchandise Display
- Merchandise Display - (Note b)

The additional lighting allowance for merchandise display lighting applies to:

- Retail sales

505 – Electrical Power and Lighting Systems

Additional Lighting Power Allowances

- When using the requirements for interior lighting out of table 505.5.5 for retail areas, the code allows the general lighting to be dimmed.
- Then the smallest actual wattage of lighting equipment installed is added to the wattage of lighting used (Table 505.5.2) to highlight specific merchandise.
- Additional lighting power is allowed for the examination of fine merchandise. This includes jewelry, china or silver. The area to be used is either the shelf area or the case area.

505 – Electrical Power and Lighting Systems

Additional Lighting Power Allowances

This lighting design and calculation must be shown on the lighting plans and/or submittal documents.

Calculate the additional lighting power as follows:

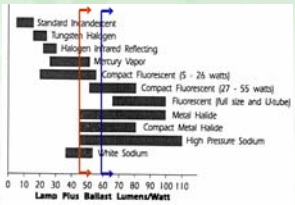
Additional lighting power allowance =
1000 watts + (Retail Area 1 × 0.06 watts per square foot)
+ (Retail Area 2 × 0.06 watts per square foot)
+ (Retail Area 3 × 1.4 watts per square foot)
+ (Retail Area 4 × 2.5 watts per square foot)

This number is then used to determine code compliance.

505 – Electrical Power and Lighting Systems

505.6.1 – Exterior building and grounds lighting

Energy-efficient lighting sources



505 – Electrical Power and Lighting Systems

505.6.2 – Exterior building lighting power

Table 505.6.2 – Lighting Power Densities for Building Exteriors

TABLE 505.6.2(1)
EXTERIOR LIGHTING ZONES

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

TABLE 505.6.2(2)
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance may be used in tradable or nontradable surfaces.)		500 W	600 W	750 W	1500 W
Tradable Surfaces (Lighting power allowances for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft²	0.06 W/ft²	0.10 W/ft²	0.13 W/ft²
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	1.0 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas, special feature areas	0.14 W/ft²	0.14 W/ft²	0.16 W/ft²	0.2 W/ft²
	Stairways	0.75 W/ft²	1.0 W/ft²	1.0 W/ft²	1.0 W/ft²
	Pedestrian tunnels	0.15 W/ft²	0.15 W/ft²	0.2 W/ft²	0.3 W/ft²
	Building Entrances and Exits				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft²	0.25 W/ft²	0.4 W/ft²	0.4 W/ft²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft²	0.6 W/ft²	0.8 W/ft²	1.0 W/ft²
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft²	0.25 W/ft²	0.5 W/ft²	0.7 W/ft²
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	20 W/linear foot	30 W/linear foot
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be used for any other general lighting surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.2 W/ft² for each vertical foot of building surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft² for each vertical foot of building surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft² for each vertical foot of building surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouses inspection stations at guarded facilities	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area	0.75 W/ft² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area
	Drive-up windows/drives	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

Electrical Power & Lighting Systems

1. According to the code, a manual interior lighting control system is required:

   A. In each building zone.
   B. For control of each 500 square feet (46.5 m^2) of building space.
   C. In each area enclosed by walls or floor-to-ceiling partitions.
   D. When automatic controls are not used.

Electrical Power & Lighting Systems

2. Are interior spaces designated as security or emergency areas subject to interior lighting control requirements?

Section 505.2.1, Exception 1: No

Electrical Power & Lighting Systems

3. Which of the following interior building areas are not required to have light reduction controls?

   A. Areas that are controlled by an occupant-sensing device.
   B. An enclosed office space.
   C. Areas designated as libraries.

Electrical Power & Lighting Systems

4. When calculating interior lighting power, what is the total allowable wattage of a 20,000 square-foot (1858 m^2) office building?

Table 505.5.2: 20,000 watts
[20,000 × 1.0 W/ft2 = 20,000 W].

Electrical Power & Lighting Systems

5. When calculating interior lighting power, what is the total allowable wattage of a building containing an 80,000 square-foot (7432 m^2) grocery and a 5,000 square-foot (464.5 m^2)restaurant?

Table 505.5.2: Retail = 120,000 watts dining: cafeteria/fast food = 7,000 watts [80,000 × 1.5 W/ft^2 + 5000 × 1.4 W/ft^2 = 127,000 W].

Electrical Power & Lighting Systems

6. A proposed building is 20,000 square feet (1858 m^2). Is this building subject to the automatic lighting shutoff control requirement?

Section 505.2.2.2: Yes.

Electrical Power & Lighting Systems

7. What switching requirements apply to hotel and motel guestrooms?

Section 505.2.3: Switched receptacles and connected lights must be master switched at the main entrance door to the room.

Electrical Power & Lighting Systems

8. How must exterior lighting be switched?

Section 505.2.4: Automatic switching or photocell controls must be installed.

Electrical Power & Lighting Systems

9. When documenting the total connected lighting power for a proposed building, what wattage should be used for a screw lamp holder under the code?

Section 505.5.1.1: Maximum labeled wattage of the luminare.

Electrical Power & Lighting Systems

10. What wattage should be documented for 8 feet (2438 mm) of track lighting with three 60-watt bulbs proposed for the track?

Section 505.5.1.4: 30 W/linear foot × 8 feet (2438 mm) = 240 watts.

Electrical Power & Lighting Systems

11. What is the maximum wattage allowed in a single occupancy building with the following task activities?

A. Office area: 14,500 ft^2 (1347 m^2)
B. Corridor: 1,000 ft^2 (93 m^2)
C. Restroom: 1,000 ft^2 (93 m^2)
D. Lobby: 500 ft^2 (46.5 m^2)

Electrical Power & Lighting Systems

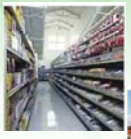
12. What is the minimum lighting efficacy for exterior lighting powered through the energy service of a building?

Section 505.6.1: 60 lumens per watt.

506 – Total Building Performance

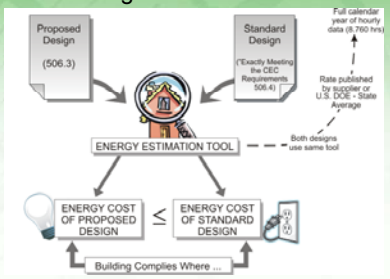
506.1 – General

The Total Building Performance Method allows trade-offs among the building envelope, mechanical systems, and lighting systems in commercial buildings.

506 – Total Building Performance

This diagram demonstrates the concept behind the Total Building Performance Method.



506 – Total Building Performance

506.4 – Documentation

The documentation that is required to support the analysis must provide the following information:

- Annual energy use and cost.
- List of building features.
- Output files showing energy use totals.
- Energy use by source and end use.
- Total hours that the space conditioning loads were not met.
- Software error messages or warnings.
- Written explanations of any error messages or warnings.

Total Building Performance

1. When should a Total Building Performance Method be considered?

When the glazed percentage of the above-grade wall area is greater than 40 percent. Also, when trade-offs of high-efficiency features are desired to offset building features that do not comply with the code on a prescriptive basis (e.g., trading off high glazing areas for a high-efficiency HVAC system).

Total Building Performance

2. Which building loads must be considered when demonstrating compliance with the Total Building Performance Method?

Section 506.2.6: Heating systems, cooling systems, fan systems, lighting systems, receptacle loads and process loads exceeding 1.0 W/ft^2 of floor area or space.

Total Building Performance

3. What information must be provided in the documentation to demonstrate compliance with the Total Building Performance Method?

Section 506.5: Annual energy use and associated costs; energy related features; input and output report(s); simulation tool error messages; written explanation(s); simulation tool capabilities.

Commercial

- A commercial contractor with the use of a design professional has submitted plans and specifications for a stand alone commercial building that will be a small retail jewelry store in Butte, Montana.
- The store is on the main street of town and has storefront glazing for customers to view the jewelry as they pass by on the street.

Commercial

- The designer and contractor have chosen to build this to the IECC and not to the ASHRAE Standard 90.1 as allowed in section 501 of the IECC.
- This building is all metal framing in the walls and the roof/ceiling system, with the insulation entirely above the roof deck.

Commercial

- It is built on a slab on grade with heated slab and has no below grade walls.
- The occupancy of this building is less than 50 and it only needs on exit from the building, located in the front of the store.

Commercial

- However, it does have an additional door out the back of the building to be used by store personnel only.
- The mechanical system is a very simple roof top system that provides both heating and cooling.

Commercial

1. What is the climate zone for this building?

(Section 301 and Table 301.1)

2. What is the R-value of the roof insulation?

R-20 ci (Table 502.2(1))

Commercial

3. What is the R-value of the metal framed walls?

R-13 = R 7.5ci (Table 502.2(1))

4. What is the R-value of the heated slab and for what depth?

R-15 for 24 inches (610 mm) below (Table 502.2(1))

Commercial

5. What is the maximum air leakage rate for the store front glazing?

1.57 pounds per square foot (2.34 Pa) or 75 pascals in accordance with ASTME 283

6. Does the 2009 IECC in this climate zone require an economizer for this building?

Yes (Table 503.3.1(1)

Commercial

7. What is the interior lighting power allowance for this store?

1.5 watts per square foot (Table 505.2)

1. The IECC definition of a "Residential Building" is:

a. Identical to the Group "R" occupancy as defined by Chapter 3 of the International Building Code©.
b. Limited to structures governed by the International Residential Code©.
c. For this code, includes R-3 buildings, as well as R-2 and R-4 buildings three stories or less in height above grade.
d. For this code, all structures not included in the definition of "Commercial buildings."

298

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299

2. Match the paraphrased definitions with the code/standard

	ABOVE-GRADE WALL.		CODE/STANDARD
a.	A wall more than 50 percent above grade and enclosing *conditioned space*. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.	i.	ANSI/ASHRAE/IES STANDARD 90.1-2007
b.	Above-grade walls are those walls covered…on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.	ii.	2009 IECC- RESIDENTIAL PROVISIONS
c.	That portion of a wall that is not entirely below finish grade and in contact with the ground.	iii.	2009 IECC- COMMERCIAL PROVISIONS

300

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302

2. Match the paraphrased definitions with the code/standard

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b.	Above-grade walls are those walls covered…on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.	ii.	2009 IECC- RESIDENTIAL PROVISIONS
c.	That portion of a wall that is not entirely below finish grade and in contact with the ground.	iii.	2009 IECC- COMMERCIAL PROVISIONS

303

3. The 2009 IECC regulates the following building systems:

a. Building thermal envelope, Indoor air quality, Building site location, Water utilization.
b. Building orientation, HVAC, Electrical, Service water heating.
c. Building thermal envelope, HVAC, Process electrical loads, Service water heating.
d. Building thermal envelope, HVAC, Electrical, Service water heating.

304

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b. Building orientation, HVAC, Electrical, Service water heating.
c. Building thermal envelope, HVAC, Process electrical loads, Service water heating.
d. Building thermal envelope, HVAC, Electrical, Service water heating.

305

4. A design professional may choose to demonstrate building thermal envelope compliance under the 2009 IECC, while the MEP compliance conforms to ANSI/ASHRAE/IES STANDARD 90.1-2007.

a. Always
b. Sometimes
c. Never

306

4. A design professional may choose to demonstrate building thermal envelope compliance under the 2009 IECC, while the MEP compliance conforms to ANSI/ASHRAE/IES STANDARD 90.1-2007.

a. Always
b. Sometimes
c. Never

307

5. Please identify the type of compliance that each of these paths demonstrate:

Compliance Path	Prescriptive	Performance
Simulated Performance Alternative		
R-value Computation		
UA Alternative		
Total UA		
Total Building Performance		
RESCheck		

308

5. Please identify the type of compliance that each of these paths demonstrate:

Compliance Path	Prescriptive	Performance
Simulated Performance Alternative		X
R-value Computation	X	
UA Alternative	X	
Total UA	X	
Total Building Performance		X
RESCheck	X	X

309

6. A building built and operated in compliance with the 2009 IECC will have approximately ____% energy cost savings over the same building built and operated in compliance with the 2006 IECC.

310

6. A building built and operated in compliance with the 2009 IECC will have approximately _15_% energy cost savings over the same building built and operated in compliance with the 2006 IECC.

311

Residential Case Study

An associate brought this rough sketch for your advice. The project involves a small, standard wood framed room addition onto an existing house.

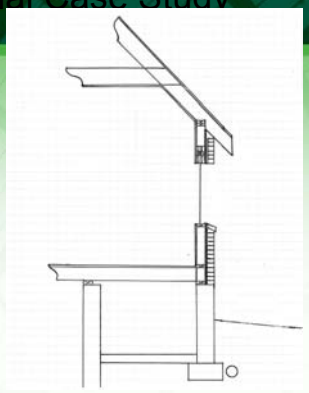
- Given:
  - Climate Zone 6
  - The addition will have a crawl space, cast in place concrete.
  - The existing house has a basement, cast in place concrete.
  - The walls are 2x6 with brick veneer.
  - The floor joists, ceiling joists, and rafters are 2x10.
  - The window is a fixed pane, wood frame.
  - The ceiling/ roof configuration is not negotiable due to client wishes and zoning restraints.

Workbook Page 71

2009 IECC Fundamentals Residential Provisions for Designers

312

Residential Case Study



Workbook Page 71

Residential Case Study

Please comment and provide design options regarding:

1. Compliance path and extent of compliance.

Choose compliance path:

a. Prescriptive
   i. R-Value
   ii. U-Factor
   iii. Total UA
b. Simulated Performance
c. Compliance for addition alone or full building?

Workbook Page 71

Residential Case Study

Please comment and provide design options regarding:

2. Ceilings without attic space.

a. Choose ventilated or unventilated
b. Choose insulation type, location and thermal performance
c. Choose vapor retarder

Workbook Page 71

Residential Case Study

Please comment and provide design options regarding:

3. Ceilings with attic space.

a. Choose ventilated or unventilated
b. Choose insulation type, location and thermal performance
c. Choose vapor retarder

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

4. Wall.

a. Choose insulation type, location(s) and thermal performance
b. Choose air barrier and vapor retarder

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

5. Window.

Specify U-factor

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

6. Crawl space.
   - a. Choose vented or unvented.
     - i. Unvented
       1. Wall insulation
          - a. Choose insulation type, location and thermal performance
          - b. Fastened to walls
          - c. Minimum 24 inches beyond grade
          - d. Thermal protection of foam is specified
       2. Vapor barrier if to be exposed earth
       3. Ventilation in accordance with Section R408.3

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

6. Crawl space.
   - a. Choose vented or unvented.
     - ii. Vented
       1. Vent size and location
       2. Floor insulation, type and thermal performance
       3. Thermal performance of the access hatch

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

7. Basement.
   - If the crawl space is unconditioned, the thermal performance of the basement wall should be considered.

Workbook Page 72

Residential Case Study

Please comment and provide design options regarding:

8. HVAC.

a. Manual J calculations to see if the new load will require an upgrade.

b. Will ductwork be installed in unconditioned crawl space or attic?

i. Insulation requirements

ii. Duct sealing requirements

iii. Duct tightness testing – if in unconditioned space

c. NOTE: It may be worthwhile to verify the location of the existing utility vents – it is not uncommon for an addition to be built on a wall where the direct vent furnace and water heaters discharge. Verify that the additional length will not exceed the manufacturer's specifications.

Workbook Page 73

Residential Case Study

Please comment and provide design options regarding:

9. Lighting equipment.

a. Recessed cans? If so: Type, IC, sealed and gasketed.

b. High-efficacy lamps

Workbook Page 73

Residential Case Study

Please comment and provide design options regarding:

10. Air leakage and testing.

Blower door or inspection?

Workbook Page 73

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