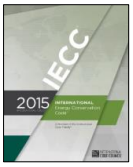
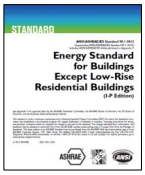
COMMERCIAL ENERGY CODE DIFFERENCES BETWEEN 2015 IECC & ASHRAE 90.1 -2013





Presented by Southface: Mike Barcik

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=> Education => Our Courses => Energy Code => GA Energy Code

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ABOUT SOUTHFACE

Building a Regenerative Economy, Responsible Resource Use & Social Equity Through a Healthy Built Environment for All

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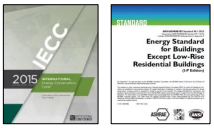
LEARNING OBJECTIVES



- Understand the major differences between **IECC 2015** and **ASHRAE 90.1-2013** in commercial buildings
- Apply design and construction strategies in building projects to comply with ASHRAE 90.1-2013 / IECC 2015
- Appreciate COMcheck software and its application in helping show compliance with either code

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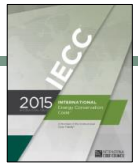
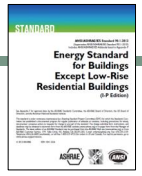
SIMILAR SCOPE FOR COMMERCIAL CODES





IECC 2015 Commercial

C1 – Scope and Admin

C2 – Definitions

C3 – General Requirements

C4 – Comm. Energy Efficiency

- Building Envelope Requirements
- Building Mechanical Systems
- Service Water Heating
- Lighting
- Total Building Performance

C5 – Referenced Standards

ASHRAE 90.1-2013

- Section 1-4 – General
- Section 5 – Building Envelope
- Section 6 – HVAC
- Section 7 – Water Heating
- Section 8-9 – Power & Lighting
- Section 10 – Other Equipment
- Section 11 – Energy Cost Budget Method

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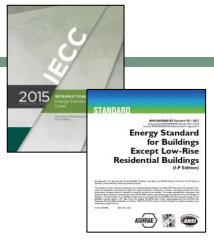
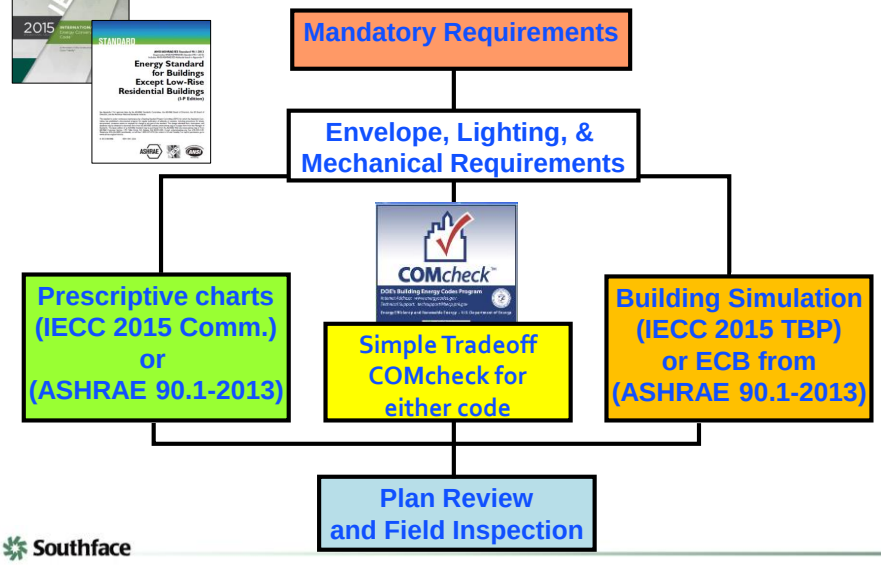
ROAD MAP OF COMPLIANCE PATHWAYS





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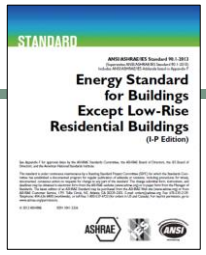
APPLYING THE CODE – 90.1



Conditioned space

- Cooled (>5 Btu/hr-ft2)
- Heated (>10 Btu/hr-ft2 for CZ3)
- Indirectly Conditioned (essentially, reasonably connected to a conditioned space)

Semi-heated space

- for CZ3, heated by system supplying between 3.4 and 10 Btu/h-ft2 (e.g., warehouse with freeze protection)

Unconditioned space

- neither of the above (e.g., crawlspaces, attics, parking garages)

- **ASHRAE space categories** (3 columns in tables)
  - ***Nonresidential*** – most commercial buildings
  - ***Residential*** – hotels, dorms, multifamily buildings over 3 stories
  - ***Semiheated*** – minimal space heating (e.g., freeze protection)

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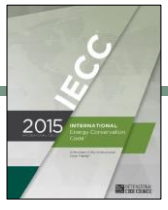
APPLYING THE CODE - IECC



Conditioned space

- An area or room within a building being heated or cooled, containing uninsulated ducts, or with a fixed opening directly into an adjacent conditioned space.

Low energy buildings (exempt from code)

- Design rate energy use less than 3.4 btu/h per ft² or 1.0 watt/ft²
- Buildings that do not contain conditioned space
- Greenhouses

- **IECC Building categories** (2 columns in tables)
  - ***Nonresidential "All Other"*** – most commercial buildings
  - ***Residential "Group R"***– hotels, dorms, multifamily buildings over 3 stories

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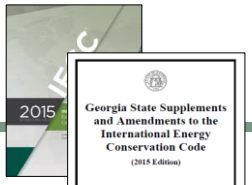
GA AMENDMENT TO IECC



SECTION C202
GENERAL DEFINITIONS

*Delete definition of 'CONDITIONED SPACE' and substitute the following:

SPACE. An enclosed space within a building. The classifications of spaces are as follows for the purpose of determining building envelope requirements:

(a) Conditioned space: a cooled space, heated space, or indirectly conditioned space is defined as follows:

(1) Cooled space: an enclosed space within a building that is cooled by a cooling system whose sensible output capacity exceeds 5 Btu/h·ft^2 of floor area.

(2) Heated space: an enclosed space within a building that is heated by a heating system whose output capacity relative to the floor area is greater than or equal to 5 Btu/h·ft^2.

(3) Indirectly conditioned space: an enclosed space within a building that is not a heated space or a cooled space, containing un-insulated ducts, or containing the heating equipment or which is heated or cooled indirectly by being connected to adjacent space(s), provided that air from heated or cooled spaces is transferred (naturally or mechanically) into the space. Unvented Attic Assemblies meeting the requirements of the IRC are an approved indirectly conditioned space.

(b) Semi-heated space: an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft^2 of floor area but is not a conditioned space.

(c) Unconditioned space: an enclosed space within a building that is not a conditioned space or a semi-heated space. Crawl spaces, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

(Effective January 1, 2020)

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90.1 SECTION 2: SCOPE

Scope

New buildings and their systems

New portions of buildings and their systems

New systems and equipment in existing buildings



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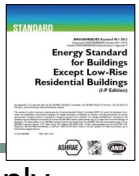
Building Envelope

Photo: Jonathan Hillyer, 2009

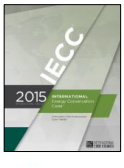
ALTERATIONS



- **Alterations** shall comply with 90.1 (eight exceptions)

alteration: a replacement or addition to a building or its systems and equipment; routine maintenance, repair, and service or a change in the building's use classification or category shall not constitute an alteration.

C401.2.1 Application to replacement fenestration products. Where some or all of an existing *fenestration* unit is replaced with a new *fenestration* product, including sash and glazing, the replacement *fenestration* unit shall meet the applicable requirements for *U-factor* and *SHGC* in Table C402.3.



Exception: An area-weighted average of the *U-factor* of replacement fenestration products being installed in the building for each fenestration product category listed in Table C402.3 shall be permitted to satisfy the *U-factor* requirements for each fenestration product category listed in Table C402.3. Individual fenestration products from different product categories listed in Table C402.3 shall not be combined in calculating the area-weighted average *U-factor*.

Exceptions: The following alterations need not comply with these requirements, provided such alterations will not increase the energy usage of the building:

1. Installation of storm windows or glazing panels over existing glazing, provided the storm window or glazing panel contains a low-emissivity coating. However, a low-emissivity coating is not required where the existing glazing already has a low-emissivity coating. Installation is permitted to be either on the inside or outside of the existing glazing.
2. Replacement of glazing in existing sash and frame, provided the U-factor and SHGC will be equal to or lower than before the glass replacement.
3. Alterations to roof/ceiling, wall, or floor cavities that are insulated to full depth with insulation having a minimum nominal value of R-3.0/in.
4. Alterations to walls and floors, where the existing structure is without framing cavities and no new framing cavities are created.
5. Roof recovering.
6. Removal and replacement of a roof membrane where there is existing roof insulation integral to or below the roof deck
7. Replacement of existing doors that separate a conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided that an existing vestibule that separates a conditioned space from the exterior shall not be removed.
8. Replacement of existing fenestration, provided that the area of the replacement fenestration does not exceed 25% of the total fenestration area of an existing building and that the U-factor and SHGC will be equal to or lower than before the fenestration replacement.

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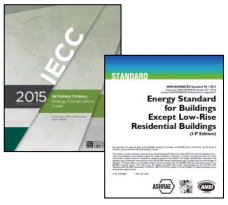
BUILDING ENVELOPE REQUIREMENTS

Compliance Paths – (choose one)

IECC 2015 – Commercial Section 402

ASHRAE 90.1-2013 – Section 5



Main Elements

Insulation

Fenestration

Air Leakage

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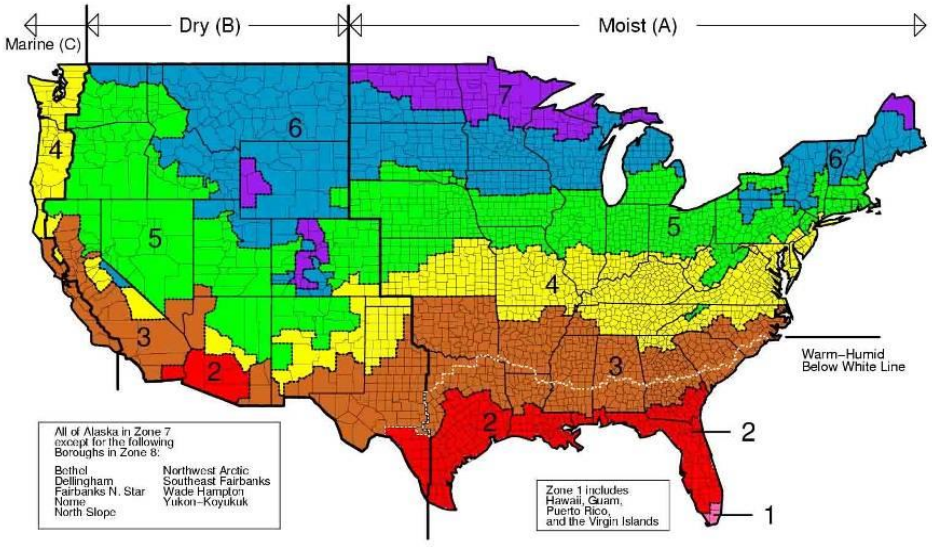
IECC / ASHRAE 90.1 CLIMATE ZONES



Note: GA is Climate Zone (CZ) 2A, 3A and 4A

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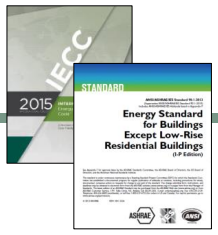
ENVELOPE KEY CONCEPTS

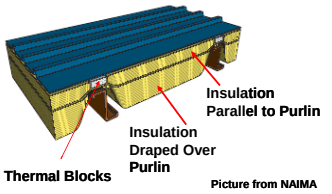


- R-values are for components, U-factors for assemblies
  - Buildings limited to 30%/40% Glass to Wall area (prescriptive)
  - Daylighting "required" for some spaces

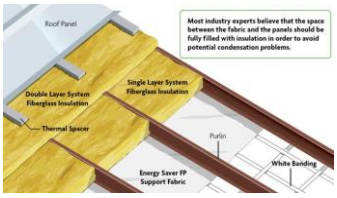
R = 1/U
U = 1/R

Metal Buildings

- Walls: R-9.8 c.i. (ASHRAE)
  Or, R-13+R-6.5 c.i. (IECC)
- Roof: R-10+R-19 FC;
  Min. R-3.5 thermal spacer block (ASHRAE)
  Or, R-19+R-11 LS (IECC)



Picture from NAIMA



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METAL BUILDING ROOFS

ENERGY SAVER FP R-VALUES

ROOF SYSTEM R-VALUES (Pre-installed)

Single Layer Systems		
R-19	6" Single Layer	
R-25	8" Single Layer	
R-30	9 ½" Single Layer	
Double Layer Systems		
R-20	6" Double Layer	(R-10 + R-10)
R-26	8" Double Layer	(R-13 + R-13)
R-30	9 ½" Double Layer	(R-19 + R-11)
R-32	10" Double Layer	(R-19 + R-13)
R-35	11" Double Layer	(R-25 + R-10)
R-36	11 ½" Double Layer	(R-25 + R-11)
R-38	12" Double Layer	(R-25 + R-13)
R-40	12" Double Layer	(R-30 + R-10)

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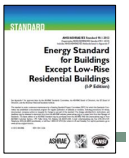
BUILDING ENVELOPE



Important Appendices

Appendix A: Rated R-value of Insulation and Assembly U-, C-, and F-factor Determinations

A2.3 Metal Building Roofs

A2.3.1 General. For the purpose of Section A1.2, the base assembly is a roof with thermal spacer blocks where the insulation is draped over the steel structure (purlins), spaced nominally 5 ft on center and compressed when the metal roof panels are attached to the steel structure (purlins).

A2.3.2 Rated R-Value of Insulation

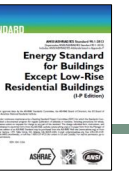
A2.3.2.1 Single Layer. The rated R-value of insulation is for insulation installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.

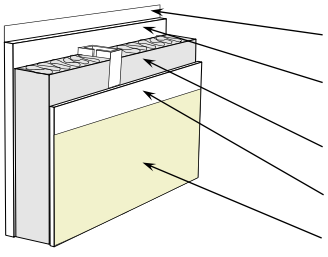
TABLE A2.3.3 Assembly U-Factors for Metal Building Roofs

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (Uninterrupted by Framing)								
			Rated R-Value of Continuous Insulation								
			R-6.5	R-9.8	R-13	R-15.8	R-19	R-22.1	R-25	R-32	R-38
Standing Seam Roofs with Thermal Spacer Blocks[a, b]											
Single Layer	None	1.280	0.137	0.095	0.073	0.060	0.051	0.044	0.039	0.031	0.026
	R-10	0.115	0.066	0.054	0.046	0.041	0.036	0.032	0.030	0.025	0.021
	R-11	0.107	0.063	0.052	0.045	0.040	0.035	0.032	0.029	0.024	0.021
	R-13	0.101	0.061	0.051	0.044	0.039	0.035	0.031	0.029	0.024	0.021
	R-16	0.096	0.059	0.049	0.043	0.038	0.034	0.031	0.028	0.024	0.021
	R-19	0.082	0.053	0.045	0.040	0.036	0.032	0.029	0.027	0.023	0.020
	R-10 + R-10	0.088	0.056	0.047	0.041	0.037	0.033	0.030	0.028	0.023	0.020
	R-10 + R-11	0.086	0.055	0.047	0.041	0.036	0.033	0.030	0.027	0.023	0.020
	R-11 + R-11	0.085	0.055	0.046	0.040	0.036	0.033	0.030	0.027	0.023	0.020

BUILDING ENVELOPE

Metal Framing (Thermal Bridging) Effects





Outside Air Film

1- inch Exterior foam sheathing (R-3.8) with Stucco

2 x 4 Metal Studs with R-13 in the Cavity

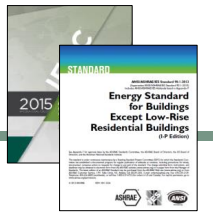
1/2 in. Gypsum Board

Inside Air Film

TABLE A9.2B Effective Insulation/Framing Layer R-Values for Wall Insulation Installed Between Steel Framing

Nominal Depth of Cavity, in.	Actual Depth of Cavity, in.	Rated R-Value of Airspace or Insulation	Effective Framing/Cavity R-Value at 16 in. on Center	Effective Framing/Cavity R-Value at 24 in. on Center
Empty Cavity, No Insulation				
4	3.5	R-0.91	0.79	0.91
Insulated Cavity				
4	3.5	R-11	5.5	6.6
4	3.5	R-13	6.0	7.2
4	3.5	R-15	6.4	7.8

BUILDING ENVELOPE



General

Space-Conditioning Categories:

- **Nonresidential** conditioned space (90.1)
- **Commercial** conditioned space (IECC)

"All occupancies other than residential"

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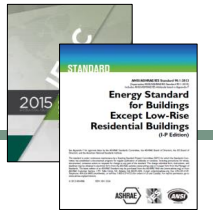
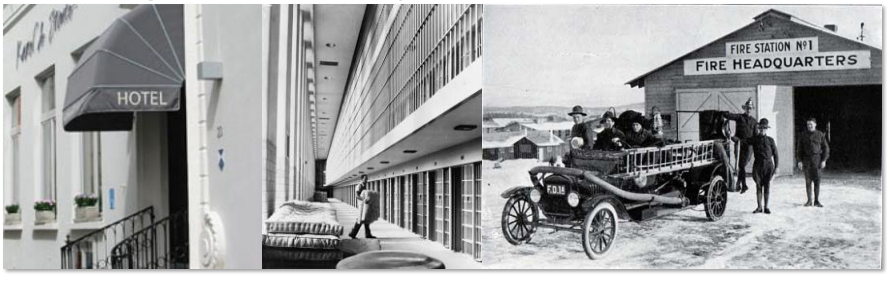
BUILDING ENVELOPE



General

Space-Conditioning Categories

- **Residential** conditioned space (90.1)
- **Group R** conditioned space (IECC)



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

IECC Residential (Group R) - places providing accommodations for overnight stay (excluding Institutional). Examples: houses, apartment buildings, hotels, and motels.

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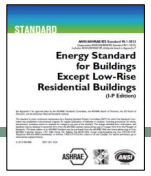
SECTION 5: BUILDING ENVELOPE
(ASHRAE 90.1 ONLY)



5.1 - General
Space-Conditioning Categories

- **Semiheated space** *(ASHRAE Only)*

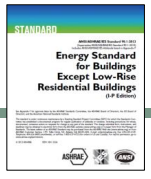
  "an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft² of floor area but is not a conditioned space."

"In climate zones 3 through 8, a space may be designated as either semiheated or unconditioned only if approved by the building official."

TABLE 3.1 Heated Space Criteria

Heating Output (Btu/h·ft²)	Climate Zone
5	1 and 2
10	3
15	4 and 5
20	6 and 7
25	8

SECTION 5.4: MANDATORY ENVELOPE

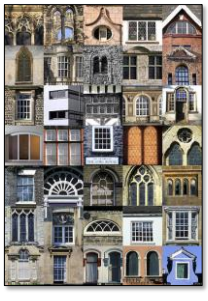


5.4 - Mandatory Provisions

Insulation

Glazed Fenestration and Doors

Air Leakage



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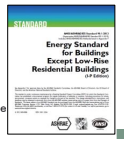
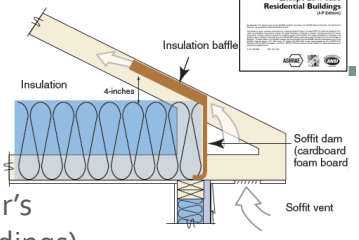
SECTION 5.4: BUILDING ENVELOPE



5.4.1 Mandatory Provisions



Insulation (details 5.8.1)

- Labeling of envelope insulation
- Install in compliance with manufacturer's requirements (exception for metal buildings)
- Insulation in substantial contact with air barrier
- Extent of insulation – full component area
- No loose-fill insulation in attic when ceiling is more than 3:12 slope (baffles at eave vents)
- Recessed equipment – effect on insulation
- Insulation protected from sun, moisture, landscapers, access & maintenance, and wind
- Stagger joints of multilayered rigid insulation

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90.1-2013: PRESCRIPTIVE CHART – CZ3

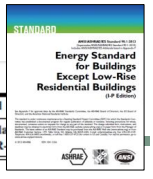

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

	Nonresidential		Residential		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insula Min. R-**
Roofs						
Insulation Entirely above Deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.119	R-7.6 c.i.
Metal Building[a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16
Attic and Other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19
Walls, above Grade						
Mass	U-0.123	R-7.6 c.i.	U-0.104	R-9.5 c.i.	U-0.580	NR
Metal Building	U-0.094	R-0 + R-9.8 c.i.	U-0.072	R-0 + R-13 c.i.	U-0.162	R-13
Steel Framed	U-0.077	R-13 + R-5 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
Wood Framed and Other	U-0.089	R-13	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13
Wall, below Grade						
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.074	R-10 c.i.	U-0.074	R-10 c.i.	U-0.137	R-4.2 c.i.
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
Slab-on-Grade Floors						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

90.1-2013: PRESCRIPTIVE CHART – CZ2

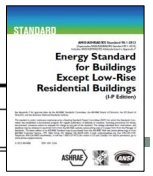

Table 5.5-2 Building Envelope Requirements for Climate Zone 2 (A,B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.173	R-5 c.i.
Metal Building[a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16
Attic and Other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19
Walls, above Grade						
Mass	U-0.151[b]	R-5.7 c.i.[b]	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	U-0.094	R-0 + R-9.8 c.i.	U-0.094	R-0 + R-9.8. c.i.	U-0.162	R-13
Steel Framed	U-0.084	R-13 + R-3.8 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
Wood Framed and Other	U-0.089	R-13	U-0.089	R-13	U-0.089	R-13
Wall, below Grade						
Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.069	R-13
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.066	R-13
Slab-on-Grade Floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.900	R-10 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

90.1-2013: PRESCRIPTIVE CHART – CZ4

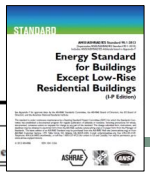

Table 5.5-4 Building Envelope Requirements for Climate Zone 4 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.093	R-10 c.i.
Metal Building[a]	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
Attic and Other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above Grade						
Mass	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
Metal Building	U-0.060	R-0 + R-15.8 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.162	R-13
Steel Framed	U-0.064	R-13 + R-7.5 c.i.	U-0.064	R-13 + R-7.5 c.i	U-0.124	R-13
Wood Framed and Other	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13
Wall, below Grade						
Below Grade Wall	C-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
Floors						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
Slab-on-Grade Floors						
Unheated	F-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.843	R-20 for 24 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

IECC TABLE C402.1.3

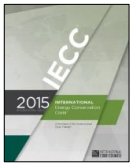

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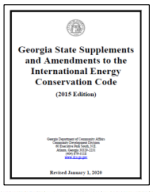
TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]

CLIMATE ZONE	2		3		4 EXCEPT MARINE	
	All other	Group R	All other	Group R	All other	Group R
					Roofs	
Insulation entirely above roof deck	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci
Metal buildings[a, b]	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38
					Walls, above grade	
Mass	R-5.7ci[c]	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci
Metal building	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci
Metal framed	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20
					Walls, below grade	
Below-grade wall[d]	NR	NR	NR	NR	R-7.5ci	R-7.5ci
					Floors	
Mass[e]	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci
Joist/framing	R-30	R-30	R-30	R-30	R-30	R-30
					Slab-on-grade floors	
Unheated slabs	NR	NR	NR	NR	~~R-10 for 24" below~~	~~R-10 for 24" below~~
Heated slabs[f]	R-7.5 for 12" below	R-7.5 for 12" below	R-10 for 24" below	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below
					Opaque doors	
Nonswinging	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75



*Revise Table C402.1.3 'Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-Value Method[b]' *Climate Zone* 4 except Marine, for unheated slabs to read as follows:

TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]

Climate Zone	4 EXCEPT MARINE	
	All other	Group R
	Slab-on-grade floors	
Unheated slabs	NR	NR

(remainder of table left unchanged)

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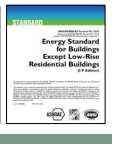
BUILDING ENVELOPE: ROOFS

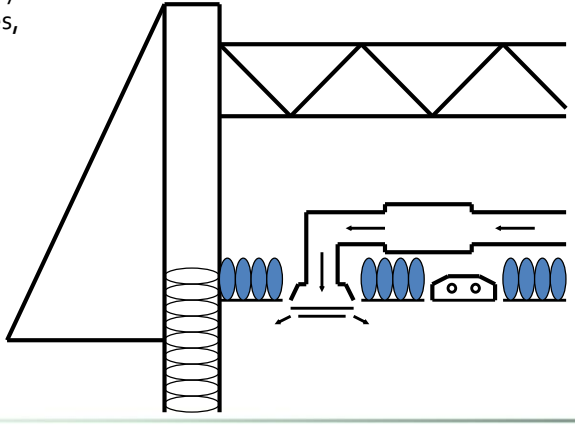
Note: Both codes ban insulation on top of suspended ceiling (90.1 section 5.8.1.8 ; IECC section C402.2.2)



- Unacceptable Design:

  Batts over suspended ceiling tiles

  - Poor pressure boundary caused by tile grid, porous tiles, lighting vent holes
  - Poor durability - maintenance disrupts batts, exposure to fiberglass dust
  - Many thermal breaks due to ductwork, light fixtures, grid, and support wires



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BUILDING ENVELOPE EXAMPLE: ROOFS

- **Unacceptable Design:** Batts over suspended ceiling tiles

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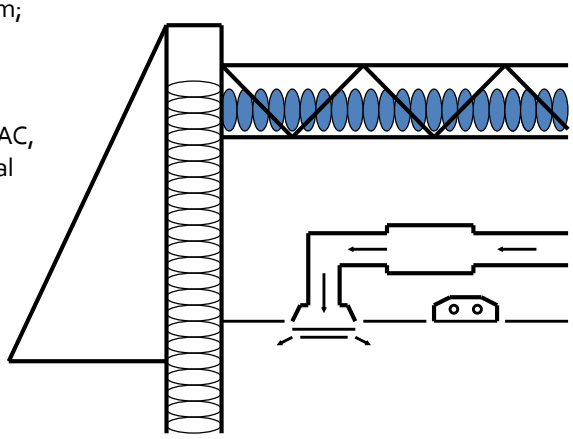
BUILDING ENVELOPE EXAMPLE: ROOFS

- **Okay Design:**

Insulation above hard ceiling

- Example: taped gypsum; similar to residential construction
- Ductwork is inside but must limit and seal HVAC, plumbing, and electrical penetrations through pressure boundary
- Thermal bridging from metal roof trusses



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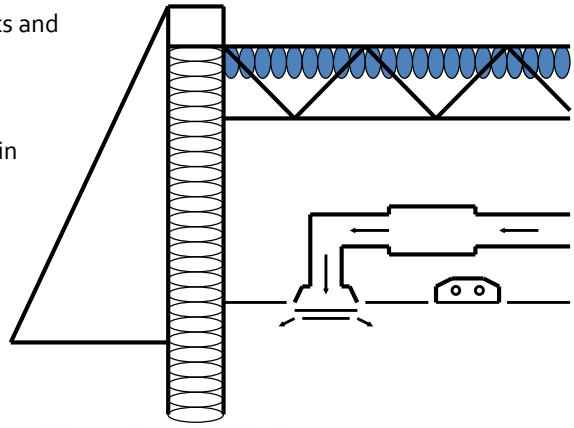
BUILDING ENVELOPE EXAMPLE: ROOFS

- **Very Good Design:**
  Spray foam insulation against underside of roof deck
  - Minimal thermal breaks and continuous pressure boundary
  - HVAC equipment and ductwork located within conditioned space
  - Good durability
  - Retrofit option



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BUILDING ENVELOPE EXAM[LE: ROOFS

Retrofit Option:
Sprayed foam against underside of roof deck

- *Preschool installed new lighting and R-20 foam along roofline*
- *Load reduced from 12 tons to 8*

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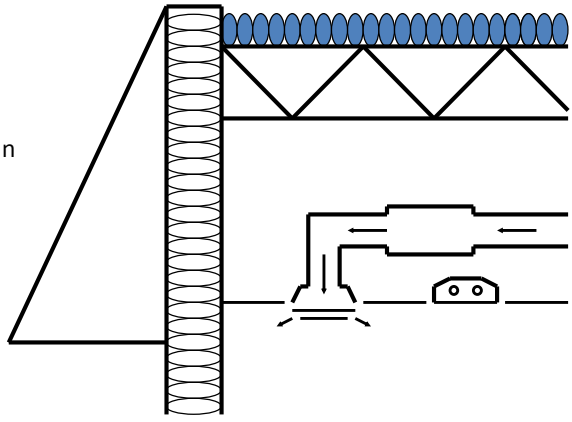
BUILDING ENVELOPE EXAMPLE: ROOFS

- **Best Design:**
  Rigid insulation above roof deck
  - No thermal breaks and continuous pressure boundary
  - HVAC equipment and ductwork located within conditioned space
  - Good durability



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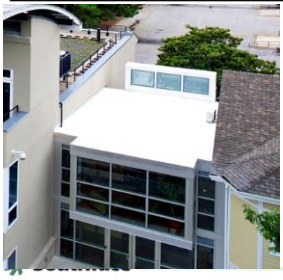
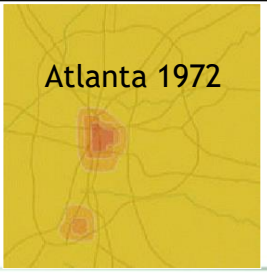
REFLECTIVE ROOF REQUIREMENT

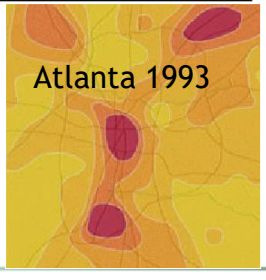
Reflective roofs are now required in CZ 1-3 or else R-value must be increased from R-25 to R-33

Table 5.5.3.1.1 Increased Roof Insulation Levels

Roofs	Nonresidential		Residential	
Opaque Elements	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Insulation entirely above deck	U-0.030	R-33	U-0.029	R-34
Metal buildings	U-0.028	R-35		

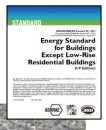






SECTION 5.5.3.1.1: REFLECTIVE ROOF EXCEPTIONS

Cool Roofs required in CZ 1-3



5.5.3.1.1 Roof Solar Reflectance and Thermal Emittance. Roofs in Climate Zones 1 through 3 shall have one of the following:

a. A minimum three-year-aged solar reflectance of 0.55 and a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with CRRC-1 Standard

b. A minimum Solar Reflectance Index of 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 Btu/h·ft^{2}·°F, based on three-year-aged solar reflectance and three-year-aged thermal emittance tested in accordance with CRRC-1 Standard

c. Increased roof insulation levels found in Table 5.5.3.1.1

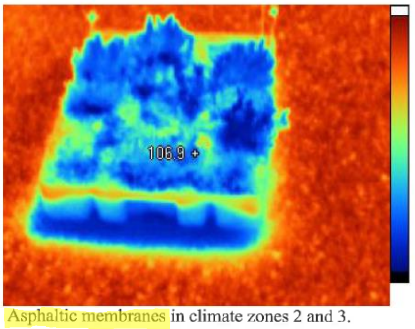
- 3 yr reflectance of ≥ 0.55 and 3 yr thermal emittance ≥ 0.75
- SRI ≥ 64
- R-33-35

Except

a.

b.

c.



d.

e.

f.

g. Asphaltic membranes in climate zones 2 and 3.

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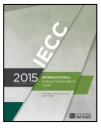
IECC 402.3 REFLECTIVE ROOFS

Cool Roofs required in CZ 1-3



C402.3 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above cooled conditioned spaces in *Climate Zones* 1, 2 and 3 shall comply with one or more of the options in Table C402.3.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.3:

1. Portions of the roof that include or are covered by the following:
   - 1.1. Photovoltaic systems or components.
   - 1.2. Solar air or water-heating systems or components.
   - 1.3. Roof gardens or landscaped roofs.
   - 1.4. Above-roof decks or walkways.
   - 1.5. Skylights.
   - 1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot [74 kg/m^2] or 23 psf [117 kg/m^2] pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

C402.3.1 Aged roof solar reflectance. Where an aged solar reflectance required by Section C402.3 is not available, it shall be determined in accordance with Equation 4-3.

$$R_{aged} = [0.2+0.7(R_{initial}-0.2)] \quad \textbf{(Equation 4-3)}$$

where:

R_{aged} = The aged solar reflectance.

$R_{initial}$ = The initial solar reflectance determined in accordance with CRRC-1.

- 3 yr reflectance of ≥ 0.55 and 3 yr thermal emittance ≥ 0.75
- SRI ≥ 64

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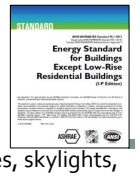
SECTION 5.5: BUILDING FENESTRATION

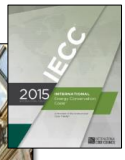


5.5.4 - Prescriptive

- Fenestration
  - Vertical Glazing ≤ 40 (< 30% for IECC)
  - Skylights ≤ 3-6% of roof
  - Daylighting is "required"

Fenestration: All areas (including frames) that let in light, including windows, plastic panels, clerestories, skylights, glass doors that are more than half glass, and glass block walls

Fenestration: Skylights, roof windows, vertical windows (fixed or moveable), "*opaque doors*", glazed doors, glazed block, and combination opaque/glazed doors…



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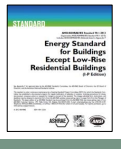
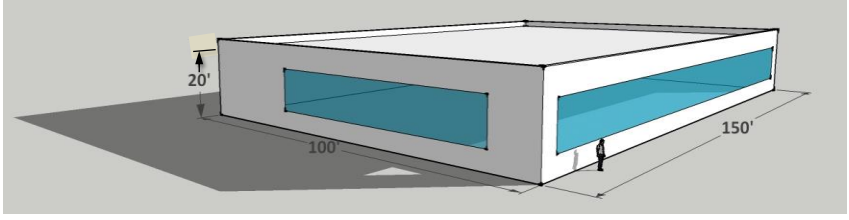
SECTION 5.5.4: FENESTRATION



% Glazing Example

% Glazing = Fenestration Area / Gross Wall Area

What is the % Glazing for a 100'x150' building with 20' high walls and 3,000 sq ft of windows and glass doors?



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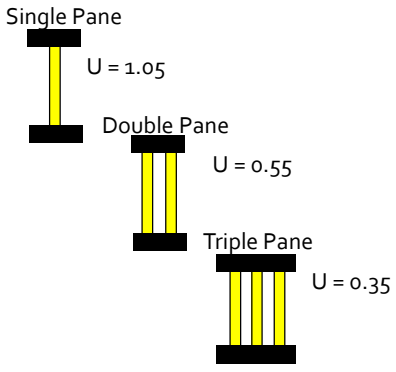
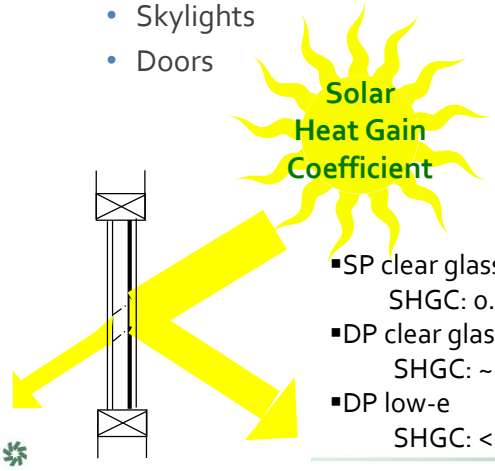
FENESTRATION U-FACTOR & SHGC

Lower **U-factor** = Better insulated (U = 1/R)

U-factor applies to:

- Windows
- Skylights
- Doors



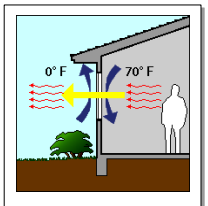


- SP clear glass
  SHGC: 0.8
- DP clear glass
  SHGC: ~ 0.6-0.7
- DP low-e
  SHGC: < 0.2-0.4

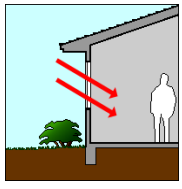
FENESTRATION & DOORS

Energy Performance of Glazing

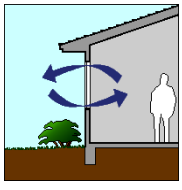
Fenestration Terminology



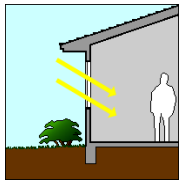
U-Factor



Solar Heat Gain Coefficient (SHGC)



Air Leakage



Visible Light Trasmittance (VLT)

- Okay to use weighted average for U-factor and SHGC as long as for a common class of construction or space-conditioning category

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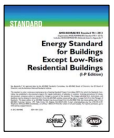
SECTION 5.4.2: FENESTRATION & DOORS



5.8.2 - Mandatory Provisions

Fenestrations and Doors

- Rating, Labeling, & Determination of Fenestration Products: U-factor, SHGC, air leakage, VLT

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

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

Southface

90.1-2013: FENESTRATION – CZ3

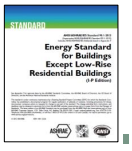


TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A, B, C)*

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

Southface

90.1-2013: FENESTRATION – CZ2 & 4

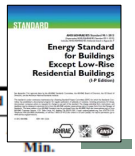


Table 5.5-2 Building Envelope Requirements for Climate Zone 2 (A,B)*

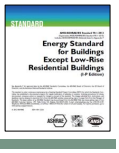
Fenestration	Nonresidential			Residential			Semiheated	
	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Min. VT/SHGC	Assembly Max. U	Assembly Min. VT/SHGC
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for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

Table 5.5-4 Building Envelope Requirements for Climate Zone 4 (A,B,C)*

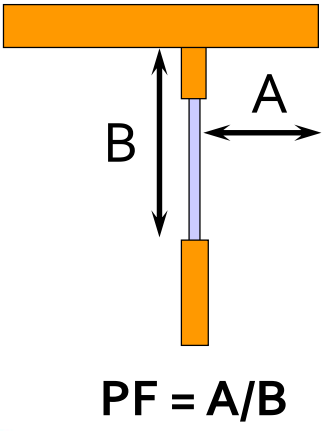
Vertical Fenestration, 0%–40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)
Nonmetal framing, all	U-0.35			U-0.35			U-0.51	
Metal framing, fixed	U-0.42			U-0.42			U-0.73	
Metal framing, operable	U-0.50	SHGC-0.40	1.10	U-0.50	SHGC-0.40	1.10	U-0.81	NR NR
Metal framing, entrance door	U-0.77			U-0.68			U-0.77	
Skylight, 0%–3% of Roof								
All types	U-0.50	SHGC-0.40	NR	U-0.50	SHGC-0.40	NR	U-1.15	NR NR

SECTION 5.5.4.4.1: OVERHANGS

Projection Factor (PF) and SHGC



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



PF = A/B

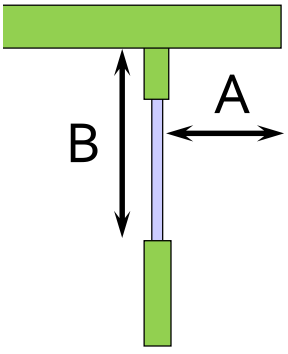
TABLE 5.5.4.4.1 SHGC Multipliers for Permanent Projections

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

IECC 402.4 – U_{FACTOR} & SHGC

Projection Factor (PF) and SHGC

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



PF = A/B

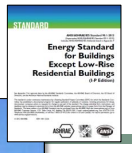
TABLE C402.4
BUILDING ENVELOPE FENESTRATION MAXIMUM *U*-FACTOR AND SHGC REQUIREMENTS

CLIMATE ZONE	2		3		4 EXCEPT MARINE	
Vertical fenestration						
***U*-factor**						
Fixed fenestration	0.50		0.46		0.38	
Operable fenestration	0.65		0.60		0.45	
Entrance doors	0.83		0.77		0.77	
SHGC						
Orientation[a]	SEW	N	SEW	N	SEW	N
PF < 0.2	0.25	0.33	0.25	0.33	0.40	0.53
0.2 ≤ PF < 0.5	0.30	0.37	0.30	0.37	0.48	0.58
PF ≥ 0.5	0.40	0.40	0.40	0.40	0.64	0.64
Skylights						
U-factor	0.65		0.55		0.50	
SHGC	0.35		0.35		0.40	

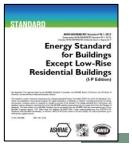
NR = No requirement, PF = Projection factor.
a. "N" indicates vertical fenestration oriented within 45 degrees of true north. "SEW" indicates orientations other than "N." For buildings in the southern hemisphere, reverse south and north. Buildings located at less than 23.5 degrees latitude shall use SEW for all orientations.

Southface

SECTION 5.5.4.4.1: OVERHANGS



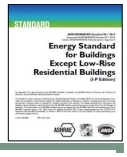
90.1 DAYLIGHTING DETAILS



- 5.5.4.2.2 Max. Skylight Fenestration Area
  - Total skylight area shall not exceed 3% of gross roof area
  - May go to 6% of gross roof area provided design meets all criteria
- 5.5.4.2.3 Minimum Skylight Fenestration Area
  - for any enclosed space in a building (all of the following):
    - ≥2,500 sq. ft.
    - Directly under a roof with ceiling heights greater than 15 feet
    - One of the following space types: office, lobby, atrium, concourse, corridor, warehouse, gym, convention center, courtroom automotive service, fire station engine room, manufacturing, retail, library, distribution/sorting, transportation baggage and seating, or workshop
  - Minimum 50% of floor area is daylit area and either:
    - Provide skylight to daylight area of 3% and VT of 0.4
    - Minimum skylight effective aperture of 1%
  - Many exceptions based on LPD, space type, and side daylighting

Southface

90.1 DAYLIGHTING EXCEPTIONS



5.5.4.2.3 Minimum Skylight Fenestration Area. In any enclosed space in a building that is

a. 2500 ft^2 and greater;
b. directly under a roof with ceiling heights greater than 15 ft; and
c. one of the following space types: office, lobby, atrium, concourse, corridor, storage (including nonrefrigerated warehouse), gymnasium, fitness/exercise area, playing area, gymnasium seating area, convention exhibit/event space, courtroom, automotive service, fire station engine room, manufacturing corridor/transition and bay areas, retail, library reading and stack areas, distribution/sorting area, transportation baggage and seating areas, or workshop,

the total daylight area under skylights shall be a minimum of half the floor area and either

a. provide a minimum skylight area to daylight area under skylights of 3% with a skylight VT of at least 0.40 or
b. provide a minimum skylight effective aperture of at least 1%.

These skylights shall have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003. General lighting in the daylight area shall be controlled as described in Section 9.4.1.1(f).

Exceptions:

1. Enclosed spaces in Climate Zones 6 through 8
2. Enclosed spaces where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.
3. Enclosed spaces where the daylight area under roof monitors is greater than 50% of the enclosed space floor area
4. Enclosed spaces where it is documented that 90% of the skylight area is shaded on June 21 in the Northern Hemisphere (December 21 in the Southern Hemisphere) at noon by permanent architectural features of the building
5. Enclosed spaces where the total area minus the primary and secondary sidelighted area(s) is less than 2500 ft^2 and where the lighting is controlled according to sidelighting requirements described in Section 9.4.1.1(e)

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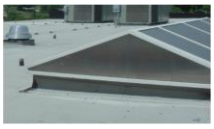
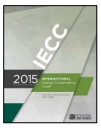
IECC DAYLIGHTING

Near Identical Requirements





C402.4.2 Minimum skylight fenestration area. In an enclosed space greater than 2,500 square feet (232 m^2) in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation depot or workshop, the total *daylight zone* under skylights shall be not less than half the floor area and shall provide one of the following:

1. A minimum skylight area to *daylight zone* under skylights of not less than 3 percent where all skylights have a VT of at least 0.40 as determined in accordance with Section C303.1.3.
2. A minimum skylight effective aperture of at least 1 percent, determined in accordance with Equation 4-4.

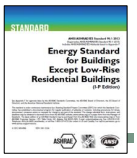
Exception: Skylights above *daylight zones* of enclosed spaces are not required in:

1. Buildings in *Climate Zones* 6 through 8.
2. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft^2 (5.4 W/m^2).
3. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.
4. Spaces where the *daylight zone* under rooftop monitors is greater than 50 percent of the enclosed space floor area.
5. Spaces where the total area minus the area of *daylight zones* adjacent to vertical fenestration is less than 2,500 square feet (232 m^2), and where the lighting is controlled according to Section C405.2.5.

C402.4.2.1 Lighting controls in daylight zones under skylights. *Daylight responsive controls* complying with Section C405.2.3.1 shall be provided to control all electric lights with *daylight zones* under skylights.

Southface

SECTION 5.5.4.4: FENESTRATION SHGC



- Vertical Glazing SHGC shall be ≤ 0.25
  - Exceptions
    - Opaque and partially opaque permanent projections are credited (calculations)
    - Glazing using the street-level exception for SHGC
      - Street level story ≤ 20'
      - Overhang > 0.5 PF
      - Fenestration area of street level is < 75% of the gross wall area of the street side
      - Separate calculations required

    - Dynamic glazing calculated separately
    - North oriented glazing allowed 0.05 higher SHGC (0.30)
    - Separate details for skylight SHGC (with exceptions)

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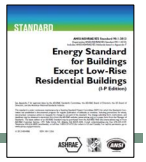
SECTION 5.5.4.5: OPTIMAL FENESTRATION ORIENTATION



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- Area of vertical fenestration on east and west facades may not exceed 25% of total area of vertical glazing

5.5.4.5 Fenestration Orientation. The vertical fenestration shall comply with either (a) or (b):

a. $A_W \le (A_T)/4$ and $A_E \le (A_T)/4$

b. $A_W \times \text{SHGC}_W \le (A_T \times \text{SHGC}_C)/4$ and $A_E \times \text{SHGC}_E \le (A_T \times \text{SHGC}_C)/4$

Exceptions:

1. Vertical fenestration that complies with Exception (3) Section 5.5.4.4.1.
2. Buildings that have an existing building or existing permanent infrastructure within 20 ft to the south (north in the southern hemisphere) that is at least half as tall as the proposed building
3. Buildings with shade on 75% of the west- and east-oriented vertical fenestration areas from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere)
4. Alterations and additions with no increase in vertical fenestration area
5. Buildings where the west-oriented and east-oriented vertical fenestration area (as defined in Section 5.5.4.5) does not exceed 20% of the gross wall area for each of those façades, and SHGC on those facades is no greater than 90% of the criteria in Tables 5.5-1 through 5.5-8

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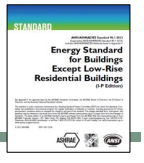
SECTION 5.5.4.6: VT/SHGC RATIO



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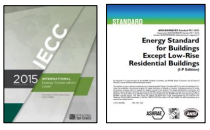
- Where automatic daylighting controls are required, the Visible Transmittance / SHGC ratio shall be $\geq$ 1.1

Exceptions:

1. A light-to-solar-gain ratio (LSG) of not less than 1.25 is allowed to be used as an alternative to VT/SHGC. When using this option, the center-of-glass VT and the center-of-glass SHGC shall be determined in accordance with NFRC 300 and NFRC 301, determined by an independent laboratory or included in a database published by a government agency, and certified by the manufacturer.
2. Fenestration not covered in the scope of the NFRC 200
3. Enclosed spaces where the daylight area under rooftop monitors is greater than 50% of the enclosed space floor area
4. Enclosed spaces with skylight(s) that comply with Section 5.5.4.2.3
5. Enclosed spaces where the sidelighting effective aperture is greater than or equal to 0.15
6. For dynamic glazing, the VT/SHGC ratio and the LSG shall be determined using the maximum VT and maximum SHGC. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.

COMCHECK™ SOFTWARE



Software evaluates specific designs quickly

Allows trade-offs (web-based or downloadable)

- Building Envelope components
- Lighting and Power components
- Mechanical components

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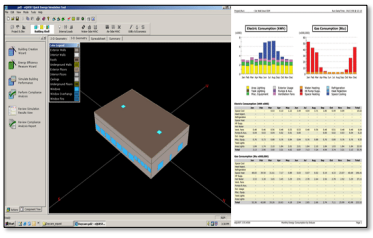
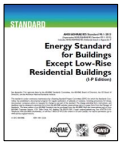
ENVELOPE TRADE-OFFS

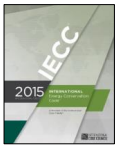
90.1 Section 11 - Energy Cost Budget Method

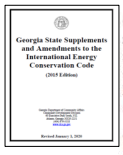
- Must comply with mandatory provisions





the design energy cost, as calculated in Section 11.5, does not exceed the energy cost budget as calculate ' ' y the simulation program described in Section 11.4; and





3. The requirements of Sections C402.5, C403.2, C404, C405.2, C405.3, C405.4, C405.6 and C407. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

C407.3 Performance-based compliance. Compliance based on total building performance requires that a proposed building (*proposed design*) be shown to have an annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Price and Expenditure Report*. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations.

The reduction in annual energy cost of the *proposed design* associated with *on-site renewable energy* shall be not more than 5% of the total annual energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

(Effective January 1, 2020)

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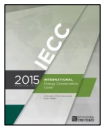
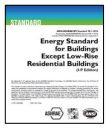
SECTION 5.4: BUILDING ENVELOPE





5.4.3.1.3 Continuous Air Barrier

The air barrier shall be designed and noted:

- Air barrier components shall be identified on construction documents
- Joints, interconnections, and penetrations of air barrier including lighting fixtures shall be detailed or otherwise noted
- Continuous air barrier shall extend over all surfaces of the envelope
- Air barrier shall be designed to resist positive and negative pressures from wind, stack effect, and vent fans

Acceptable air barrier materials/assemblies

- 3/8" plywood & OSB
- ½" XPS & poly-iso
- ½" Gyp board
- ½" Cement board
- Built up, modified bit, & adhered single-ply roof membranes
- ½" cement parge, stucco or gyp board
- Concrete
- Sheet metal
- 1" (1.5") Closed cell foam
- 4.5" Open cell foam
- CMU walls – painted/grouted
- Sheet steel/aluminum

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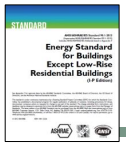
SECTION 5: ENVELOPE AIR SEALING



5.4 - Mandatory Provisions

Air Leakage - Fenestration and Doors (5.4.3.2)

Air leakage ≤ 1.0 cfm/ft² for glazed swinging & revolving doors
Air leakage ≤ 0.06 cfm/ft² for curtainwall & storefront glazing
Air leakage ≤ 0.3 cfm/ft² for skylights
Air leakage ≤ 1.3 cfm/ft² for nonswinging doors for vehicles & materials
Air leakage ≤ 0.2-0.4 cfm/ft² for others

*Exception: Field-fabricated fenestration and doors, semi-heated space metal coiling doors and buildings that pass blower door test of 0.40 ELR75

Also, (**5.4.3.3**) - Loading dock weatherseals in CZ4-8



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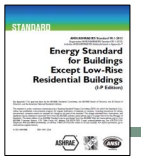
SECTION 5: ENVELOPE AIR SEALING



5.4 - Mandatory Provision

- Air Leakage – Vestibules (5.4.3.4)

Vestibules are required in CZ 3-8 for entrances in buildings

- All doors must be equipped with self-closing devices
- Interior and exterior doors at least 7 ft* apart
- Floor area of vestibule ≤ 50 s.f. or 2% of gross area of floor
- Envelope of unconditioned vestibule (interior/exterior) meets semi-heated

*16' if building > 40k s.f.

Exceptions:

- revolving doors, non-entrance doors, and dwelling unit doors
- not required in CZ 1-2
- Entrances in CZ3 for buildings < 4 stories and < 10,000 s.f.
- Entrances in CZ4-8 for buildings < 1,000 s.f.
- Doors from a space < 3,000 s.f. and separate from the entrance

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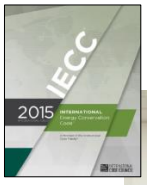
IECC - VESTIBULES



C402.5.7 Vestibules. Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 1 and 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C408.2.3.

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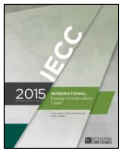
CONDITIONING VESTIBULES?

C402.4.8: RECESSED LIGHTING



- Air Leakage – Recessed Luminaires

Recessed lights must be air sealed to limit air leakage between conditioned and unconditioned space

- Insulation may cover over (IC-rated)
- Air tight (not more than 2.0 cfm leakage at 75 Pa

MAJOR AIR LEAKAGE SITES

- Cavities above suspended ceilings
- Plenum return spaces (Highly depressurized)
- Ventilated walls
- Equipment tunnels and chases
- Mechanical rooms and mezzanines
- Unconditioned adjacent space (storage, plant, warehouse, etc.)

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ENVELOPE – AIR SEALING

Air sealing – mandatory requirement and cannot be traded off

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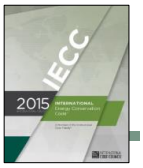
ENERGY EFFICIENT BUILDING ENVELOPE



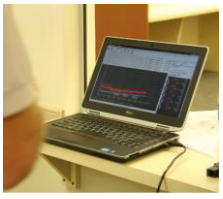
Blower Door Testing – Recognized by IECC

- Prove Air Sealing
- Envelope Integrity

C402.5 Air leakage—thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Sections C402.5.1 through C402.5.8, or the building *thermal envelope* shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft^2 (0.2 L/s · m^2). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

$$ELR_{75} = \frac{CFM_{75}}{\text{shell area}}$$

$$ELR_{75} \leq 0.40$$



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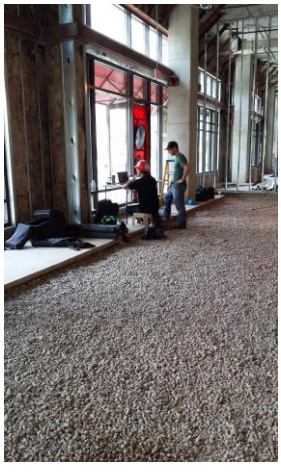
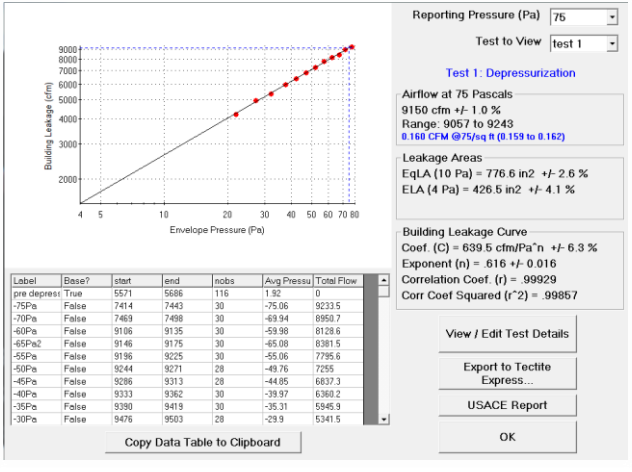
MULTI-BLOWER DOOR – ENVELOPE LEAKAGE TEST





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INTERIOR & EXTERIOR LIGHTING CONTROLS

Fostering human habits proves to save energy

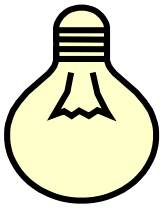
- Vacancy sensors preferred
- Occupancy sensors (no daylight)
- Multi-level controls
- Photosensors for daylit areas
- Automatic shut-offs
- Building automation systems or scheduled auto off
- Controls: KISS principle and verify/Cx

SECTION 9: LIGHTING

Key Section Changes 90.1-2007 vs. 2013

Lighting Alterations must meet Lighting Power Density (LPD)

- Now take effect at ≥ 10% replacement
- Include exterior areas
- Include renovations where just the lamp / ballast is replaced
- Require compliance with auto shut off controls



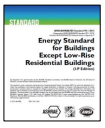
Lighting Power

- LPD tables changes (~ 15% reduction overall)
- Bonus LPD now available for advanced control spaces
- Retail allowances have been reduced
- Exterior LPD now based on 5 lighting zones

Lighting Controls

- Bi-level control requirement added
- Auto shut off now required in all buildings
- Auto shut off required for more spaces
- Functional testing now required
- Daylight harvesting required in certain situations

SECTION 9: LIGHTING



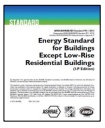
9.1.1 Scope:

- Interior spaces of buildings
- Exterior building features
- Exterior lighting powered through building

Exceptions:

- Emergency lighting that is normally off
- Lighting required by life safety statute
- Lighting within dwelling units of buildings
- Decorative gas lighting

SECTION 9: LIGHTING



How this presentation considers lighting

Interior	Exterior
Budget	Budget
Installed Design (exemptions)	Installed Design (exemptions)
Controls	Controls

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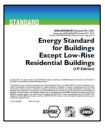
SECTION 9.5&6: INTERIOR LIGHTING BUDGET

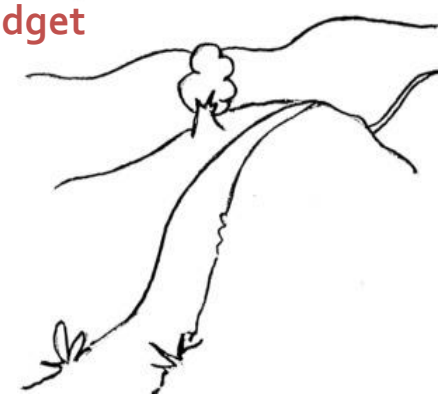


Interior Lighting Power Budget

9.5 Building Area Method

or

9.6 Space by Space Method



- Trade-offs not allowed between different methods
- Actual installed interior lighting fixtures ≤ allowance

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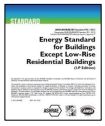
SECTION 9.5: INTERIOR LIGHTING BUDGET



9.5.1 - Building Area Method

Used for projects involving

- An entire building
- A single, independent, and separate occupancy in a multi-occupancy building

Most Building Types listed

- "Selection of a reasonably equivalent type" is permitted

Multiply Gross Lighted Floor Area (measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings) by allowance from Table 9.5.1

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SECTION 9.5: INTERIOR LIGHTING BUDGET

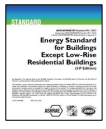

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	LPD, W/ft^2
Automotive facility	0.80
Convention center	1.01
Courthouse	1.01
Dining: Bar lounge/leisure	101
Dining: Cafeteria/fast food	0.90
Dining: Family	0.95
Dormitory	0.57
Exercise center	0.84
Fire station	0.671
Gymnasium	0.94
Health-care clinic	0.90
Hospital	1.05
Hotel/Motel	0.87
Library	1.19

Building Area Type[a]	*LPD* (W/ft^2)
Manufacturing facility	1.17
Motion picture theater	0.76
Multifamily	0.51
Museum	1.02
Office	0.82
Parking garage	0.21
Penitentiary	0.81
Performing arts theater	1.39
Police station	0.87
Post office	0.87
Religious building	1.00
Retail	1.26
School/university	0.87
Sports arena	0.91
Town hall	0.89
Transportation	0.70
Warehouse	0.66
Workshop	1.19

What is "budget" for a 10k office building?

Answer: 8,200 W

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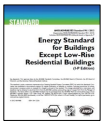
SECTION 9.6: INTERIOR LIGHTING BUDGET



9.6.1 – Space-by-Space Method

Identify different space types in your project

Determine gross lighted area of all space types

Calculate lighting power allowance per LPD table

Sum all the allowances for each space type

Trade-offs between subspaces are permitted

Advantages

- More flexible
- Applicable to more building types
- Opportunity for additional allowances

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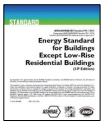
SECTION 9.6.1: SPACE BY SPACE SAMPLE TABLE



Common Space Types[1]	LPD, W/ft²	RCR Threshold
Office		
… enclosed and ≤250 ft²	1.11	8
… enclosed and >250 ft²	1.11	8
… open plan	0.98	4
Parking Area, Interior	0.19	4
Pharmacy Area	1.68	6
Restroom		
… in a facility for the visually impaired (and not used primarily by the staff)[3]	1.21	8
… all other restrooms	0.98	8
Sales Area[4]	1.44	6
Seating Area, General	0.54	4
Stairway		
Stairwell	0.69	10
Storage Room		
… <50 ft²	1.24	6
… ≥50 ft² and ≤ 1000 ft²	0.63	6
… all other storage rooms	0.63	6
Vehicular Maintenance Area	0.67	4
Workshop	1.59	6

Informative Note: **This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.**

Building Type Specific/Space Types[1]	LPD W/ft²	RCR Threshold
… in a nurse's station	0.71	6
… in an operating room	2.48	6
… in a patient room	0.62	6
… in a physical therapy room	0.91	6
… in a recovery room	1.15	6
Library		
… in a reading area	1.06	4
… in the stacks	1.71	4
Manufacturing Facility		
… in a detailed manufacturing area	1.29	4
… in an equipment room	0.74	6
… in an extra high bay area (>50 ft floor-to-ceiling height)	1.05	4
… in a high bay area (25–50 ft floor-to-ceiling height)	1.23	4
… in a low bay area (<25 ft floor-to-ceiling height)	1.19	4
Museum		
… in a general exhibition area	1.05	6
… in a restoration room	1.02	6

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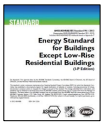
SECTION 9.6: INTERIOR LIGHTING BUDGET



9.6.2 - Space-by-Space Method

Additional Interior Lighting Power

Decorative / highlighting luminaires

- 1.0 W/ft² in space where used

Retail Sales Area (Base 1.68 W/ft²)

Additional Allowance = 1000 watts

+ (Retail Area 1 x .6 W/ft2)

+ (Retail Area 2 x .6 W/ft²)

+ (Retail Area 3 x 1.4 W/ft²)

+ (Retail Area 4 x 2.5 W/ft²)

Retail 1 – All goods not covered in 2, 3, 4
Retail 2 – vehicles, sporting goods, small electronics
Retail 3 – furniture, clothing, cosmetics, artwork
Retail 4 – jewelry, crystal, china

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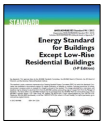
SECTION 9: INTERIOR LIGHTING BUDGET



9.6.3 – Space-by-Space Method

Additional Interior Lighting Power Using Better Controls (5% to 30% bonus)*

*Additional interior lighting control = lighting power under control **X** control factor (per table 9.6.3)

TABLE 9.6.3 Control Factors Used In Calculating Additional Interior Lighting Power Allowance

Additional Control Method (in Addition to Mandatory Requirements)	Space Type				
	Open Office	Private Office	Conference Room, Meeting Room, Classroom (Lecture/ Training)	Retail Sales Area	Lobby, Atrium, Dining Area, Corridors/ Stairways, Gym/ Pool, Mall Concourse, Parking Garage
Manual, continuous dimming control or programmable multilevel dimming control	0.05	0.05	0.10	0.10	0
Programmable multilevel dimming control using programmable time scheduling	0.05	0.05	0.10	0.10	0.10
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off capabilities	0.25[a]	0	0	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off operation, in combination with personal continuous dimming control of downlight illumination by workstation occupant	0.30[a,b]	0	0	0	0
Automatic continuous daylight dimming in secondary sidelighted areas	0.10[c]	0.10[c]	0.10[c]	0.10[c]	0.10[c]

a. Control factor is limited to workstation-specific luminaires in partitioned single occupant work spaces contained within an open office environment (i.e. direct-indirect luminaires with separately controlled downlight and uplight components, with the downward component providing illumination to a single occupant in an open plan workstation). Within 30 minutes of the occupant leaving the space, the downward component shall continuously dim to off over a minimum of two minutes. Upon the occupant entering the space, the downward component shall turn on at the minimum level and continuously raise the illumination to a preset level over a minimum of 30 seconds. The uplight component of workstation specific luminaire shall comply with Section 9.4.1.1(h) (automatic full off).
b. In addition to the requirements described in footnote (b), the control shall allow the occupant to select their preferred light level via a personal computer, handheld device, or similarly accessible device located within the workstation.
c. Control factors may not be used if controls are used to satisfy exceptions to Section 5.5.4.2.3

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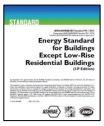
SECTION 9: INTERIOR LIGHTING BUDGET



9.6.4 – Space-by-Space Method

Room Geometry Adjustment

(20% LPD bonus if calculated RCR is greater than RCR threshold)

RCR = 2.5 **X** room cavity height* **X** room perimeter length**/** room area

*Room cavity height = luminaire mounting height - workplane

Example: 30'x40' open office with 16.5' fixture height: RCR = 2.5 x 14 x (140/1200) = **4.1**

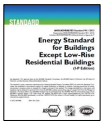
TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types[a]	LPD, W/ft²	RCR Threshold
Audience Seating Area		
... in an auditorium	0.63	6
... in a convention center	0.82	4
... in a gymnasium	0.65	6
... in a motion picture theater	1.14	4
... in a penitentiary	0.28	4
... in a performing arts theater	2.43	8
... in a religious building	1.53	4
... in a sports arena	0.43	4
... all other audience seating areas	0.43	4
Banking Activity Area	1.01	6

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method *(continued)*

Building-Specific Space Types	*LPD*, W/ft²	RCR Threshold
Office		
... enclosed and ≤250 ft²	1.11	8
... enclosed and >250 ft²	1.11	8
... open plan	0.98	4
Parking Area, Interior	0.19	4
Pharmacy Area	1.68	6
Restroom		
... in a facility for the visually impaired (and not used primarily by the staff)[3]	1.21	8
... all other restrooms	0.98	8
Sales Area[4]	1.44	6
Seating Area, General	0.54	4

SECTION 9.2.2.3: LIGHTING DESIGN



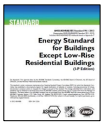
Interior Lighting Power Allowance Exemptions

(often require separate control)

- Display or accent lighting for galleries, museums, and monuments
- Lighting integral to equipment or instrumentation
- Medical and dental procedures
- Refrigerator and freezer cases
- Lighting for food warming
- Life support for non-humans
- Retail display windows (enclosed by ceiling height partitions)
- Registered historic landmarks
- Advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Theatrical, stage, film, and video production
- TV broadcasting in sporting activity areas
- Casino gaming areas
- Furniture mounted task lighting
- Mirror lighting in dressing rooms + religious pulpit & choir accent lighting
- Parking garage transition lighting

Lighting exempt from code still offer lots of opportunities for saving energy – make sure it's LED!!!

SECTION 9.1.4: LIGHTING DESIGN WATTAGE



Luminaire Wattage – *"the rules"*

Luminaires not containing permanently installed ballasts, transformers, etc. = **max. labeled wattage of the luminaire**

Luminaires with permanently installed or remote ballasts, transformers, etc. = **operating input wattage of the lamp/auxiliary combination***

Line-voltage track =

- **Minimum 30 W per foot**
- **Or limit of system's circuit breaker**
- **Or wattage of other current-limiting device**

Low-voltage track = **transformer wattage**

All others as specified

*based on manufacturer's data, lab results, or max labeled wattage of luminaire (exception for adjustable ballast factors)

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SECTION 9.1.4: LIGHTING DESIGN WATTAGE

Example: Installed Interior Lighting Design

Calculate the total lighting wattage of a room containing the following fixtures:

+ Eight 4' Fluorescent Fixtures
  - Three 4' fluorescent T8 lamps per fixture, 32 Watts
  - One three-lamp electronic ballast, Input Wattage – 90 Watts
+ Six Incandescent Downlights
  - Specified Lamps – 60 Watt, A-line, Medium Screw Base
  - Maximum labeled wattage of fixture – 75 Watts
+ 16 Feet of Line Voltage Track
  - Specified – 5 Track Heads
  - 90 Watts Halogen PAR38 Lamps

Interior Lighting Wattage Calculation

8 Fixtures x 90 Ballast Input Watts	= 720 Watts
6 Downlights x 75 Watt Labeled A-line	= 450 Watts
16' Track x 30 Watts/Foot	= 480 Watts
Total Wattage	**= 1,650 Watts**

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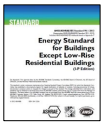
SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Interior Lighting Controls

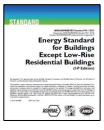
Minimum Control Requirements (a-i) from Table 9.6.1

Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft²	RCR Threshold	a Local Control (See Section 9.4.1.1[a])	b Restricted to Manual ON (See Section 9.4.1.1[b])	c Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	d Bilevel Lighting Control (See Section 9.4.1.1[d])	e Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][4])	f Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][4])	g Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	h Automatic Full OFF (See Section 9.4.1.1[h])	i Scheduled Shutoff (See Section 9.4.1.1[i])
Conference/Meeting/Multipurpose Room	1.23	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	REQ	—
Confinement Cells	0.81	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Copy/Print Room	0.72	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	REQ	—
Corridor[2]											
… in a facility for the visually impaired (and not used primarily by the staff)[3]	0.92	width <8 ft	REQ	—	—	—	REQ	REQ	REQ	ADD2	ADD2
… in a hospital	0.99	width <8 ft	REQ	—	—	—	REQ	REQ	ADD2	ADD2	ADD2
… in a manufacturing facility	0.41	width <8 ft	REQ	—	—	—	REQ	REQ	—	ADD2	ADD2
… all other corridors	0.66	width <8 ft	REQ	—	—	—	REQ	REQ	REQ	ADD2	ADD2
Courtroom	1.72	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Computer Room	1.71	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Dining Area											
… in a penitentiary	0.96	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
… in a facility for the visually impaired (and not used primarily by staff)[3]	2.65	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
… in bar/lounge or leisure dining	1.07	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
… in cafeteria or fast food dining	0.65	4	REQ	ADD1 OR	ADD1	REQ	REQ	REQ	—	ADD2 OR	ADD2
… in family dining	0.89	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
… all other dining areas	0.65	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2

SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Interior Lighting Controls

a. Local Controls (for small/big spaces)

Local control – Requires one or more manual control in the space that controls all the lighting in that space.

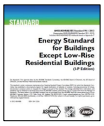
Each control device will control a maximum of:

- 2,500 ft² in spaces ≤ 10,000 ft²
- 10,000 ft² in spaces > 10,000 ft²
- Readily accessible so occupants can see the controlled lighting when using the control device

Exceptions:

- Remote location for safety & security (requires pilot indicator and lighting clearly labeled)

SECTION 9.4: MANDATORY PROVISIONS



9.4.1.1– Lighting Control

b. Restricted to Manual ON

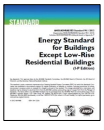
None of the lighting shall be automatically turned ON

Exceptions: (spaces where full automatic-on is allowed)

Areas where manual-on would endanger safety or security of the room or building occupants

Southface

SECTION 9.4: MANDATORY PROVISIONS



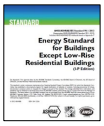
9.4.1.1– Lighting Control

c. Restricted to Partial Automatic ON

Maximum of 50% of the lighting power for general lighting is allowed to be automatically turned on and none of the remaining shall be auto ON

Southface

SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Lighting Control

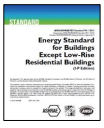
d. Bilevel Lighting Controls

The general lighting shall be controlled to have at least one step between 30% and 70% power (in addition to full on / off)

Inboard Only **Outboard Lamps** **Full On**

Southface

SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Lighting Control

e. Auto Daylight Controls - Sidelighting

- Photocontrols required for any space with primary sidelighting ≥ 150 W
- Photocontrols required for any space with combined primary and secondary sidelighting ≥ 300 W

Photocontrols shall:

- Have readily accessible calibration adjustments
- Have secondary sidelighting controls separate from primary sidelighting
- Reduce electric lighting based on available daylight using continuous or 4-step staged dimming

Exceptions for sidelights with tall adjacent structures, < 20 s.f. of glazing, retail spaces

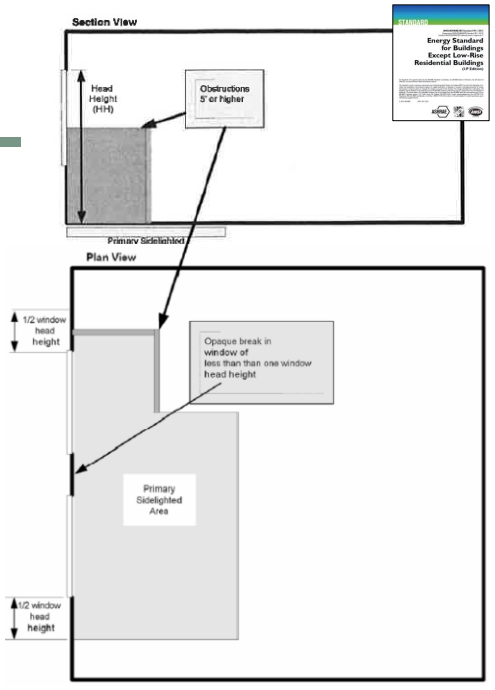
Southface

SIDELIGHTED AREA - PRIMARY

primary sidelighted area: the total primary sidelighted area is the combined primary sidelighted area within each space. Each primary sidelighted area is directly adjacent to vertical fenestration below the ceiling (see Figure 3.2-3).

a. The primary sidelighted area width is the width of the vertical fenestration plus, on each side, the smaller of
   1. one half of the vertical fenestration head height (where head height is the distance from the floor to the top of the glazing) or
   2. the distance to any 5 ft or higher opaque vertical obstruction.

b. The primary sidelighted area depth is the horizontal distance perpendicular to the vertical fenestration which is the smaller of
   1. one vertical fenestration head height or
   2. the distance to any 5 ft or higher opaque vertical obstruction.



Southface

SECTION 9.4.1: LIGHTING CONTROL

9.4.1.1 Lighting Control

f. Auto Daylight Controls - Toplighting

- Photocontrols required for general lighting in any space top-lit by ≥ 150 W

  Photocontrols shall:
  - Have readily accessible calibration adjustments
  - Reduce electric lighting based on available daylight using continuous or 4-step staged dimming
  - Combine controls for overlapping top- and sidelighted areas and lighting shall be controlled by toplighting

Exceptions for Toplighting with tall adjacent shading, skylight VT < 0.4, spaces in CZ 8 < 200 W

Southface

DAYLIGHTED AREA – ROOF MONITORS

daylighted area: the floor area substantially illuminated by daylight.

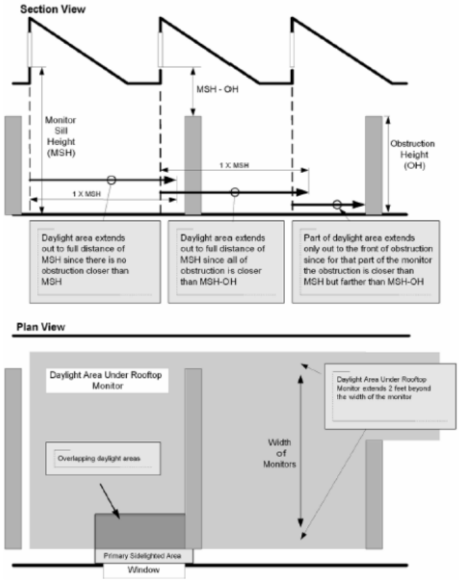
daylight area:

daylight area under roof monitors: the daylight area under roof monitors is the combined daylight area under each roof monitor within each space. The daylight area under each roof monitor is the product of

a. the width of the vertical fenestration above the ceiling level plus, on each side, the smallest of
   1. 2 ft,
   2. the distance to any 5 ft or higher vertical obstruction, or
   3. the distance to the edge of any primary sidelighted area

and

b. the smaller of the following horizontal distances inward from the bottom edge of the vertical fenestration (see Figure 3.2-1):
   1. The monitor sill height (MSH) (the vertical distance from the floor to the bottom edge of the monitor glazing)
   2. The distance to the nearest face of any opaque vertical obstruction, where any part of the obstruction is farther away than the difference between the height of the obstruction and the monitor sill height (MSH – OH).



Rooftop Monitor Daylit Area

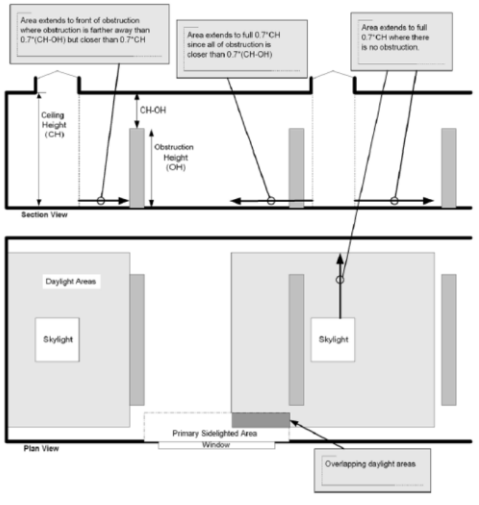
DAYLIGHTED AREA - SKYLIGHTS

daylighted area: the floor area substantially illuminated by daylight.

daylight area under skylights: the daylight area under skylights is the combined daylight area under each skylight within a space. The daylight area under each skylight is bounded by the opening beneath the skylight and horizontally in each direction (see Figure 3.2-2), the smaller of

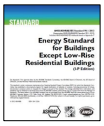
a. 70% of the ceiling height (0.7 × CH), or
b. the distance to the nearest face of any opaque vertical obstruction, where any part of the obstruction is farther away than 70% of the distance between the top of the obstruction and the ceiling (0.7 × [CH – OH],

where CH = the height of the ceiling at the lowest edge of the skylight and OH = the height to the top of the obstruction).



Skylight Daylit Area

SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Lighting Control

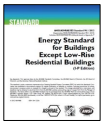
g. Auto Partial OFF- (full OFF complies)

- General lighting shall be auto reduced by at least half within 20 minutes of being unoccupied

HID exception if meet all:
Space LPD is ≤ 0.8 W/s.f., only HID fixtures are used in the space, and general lighting is reduced at least 30% within 20 minutes of unoccupied

Southface

SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Lighting Control

h. Auto Full OFF

- All lighting shall be auto shut off within 20 minutes of being unoccupied
  - Maximum control device area served is 5000 s.f.

Exceptions:

- General and task lighting in shop and lab classrooms
- General and task lighting where it would endanger safety or security of the room or building occupants
- Lighting for 24/7 operation

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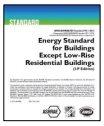
SECTION 9.4.1: LIGHTING CONTROL



9.4.1.1 Lighting Control

i. Scheduled Shutoff

- All non-exempt lighting shall be auto shut off during periods when space is scheduled to be unoccupied
- Options include:
  - Time of day controller
  - Signal from other such as alarm/security
  - Max area of 25,000 s.f. on one floor, account for weekends and holidays, max. 2 hour override

Exceptions:

- Lighting for 24/7 operation
- Patient care spaces
- General and task lighting where it would endanger safety or security of the room or building occupants

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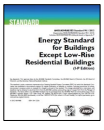
SPECIAL APPLICATIONS



9.4.1.3 Special Applications

a. The following lighting shall be separately controlled from the general lighting in all spaces:
   1. Display or accent lighting
   2. Lighting in display cases
   3. Nonvisual lighting, such as for plant growth or food warming
   4. Lighting equipment that is for sale or used for demonstrations in lighting education

b. Guestrooms
   1. All lighting and all switched receptacles in guestrooms and suites in hotels, motels, boarding houses, or similar buildings shall be automatically controlled such that the power to the lighting and switched receptacles in each enclosed space will be turned off within 20 minutes after all occupants leave that space.

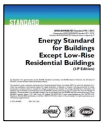
   Exception: Enclosed spaces where the lighting and switched receptacles are controlled by captive key systems and bathrooms are exempt.

   2. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting within 30 minutes after all occupants have left the bathroom.

   Exception: Night lighting of up to 5 W per bathroom is exempt.

c. All supplemental task lighting, including permanently installed undershelf or undercabinet lighting, shall be controlled from either (1) a control device integral to the luminaires or (2) by a wall-mounted control device that is readily accessible and located so that the occupant can see the controlled lighting.

9.4.2: EXTERIOR LIGHTING POWER



9.4.2 Exterior Building Lighting Power

Exterior Building Lighting Power Budget:

Sum of the base site allowance

+

Individual allowances from the exterior LPD table (9.4.2.2)
based on lighting zone

TABLE 9.4.2-1 Exterior Lighting Zones

Lighting Zone	Description
0	Undeveloped areas within national parks, state parks, forest land, rural areas, and other undeveloped areas as defined by the authority having jurisdiction
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 jurisdiction

Installed power shall not exceed budget
Trade-offs are allowed only among "tradable surfaces"
Lighting zone is determined per table 9.4.2.1

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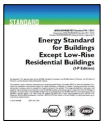
9.4.2: EXTERIOR LIGHTING POWER



9.4.2 Exterior Building Lighting Power

Exterior lighting used for the following applications equipped with a dedicated control device is exempt:

Exceptions:

1. Lighting used for the following exterior applications is exempt when equipped with a control device that complies with the requirements of Section 9.4.1.4 and is independent of the control of the nonexempt lighting:
   a. Lighting that is integral to signage and installed in the signage by the manufacturer
   b. Lighting for athletic playing areas
   c. Lighting for industrial production, material handling, transportation sites, and associated storage areas
   d. Theme elements in theme/amusement parks
   e. Lighting used to highlight features of public monuments and registered historic landmark structures or buildings.
   f. Lighting for water features
2. Lighting used for the following exterior applications is exempt when controlled separately:
   a. Specialized signal, directional, and marker lighting associated with transportation
   b. Lighting integral to equipment or instrumentation and installed by its manufacturer
   c. Lighting for theatrical purposes, including performance, stage, film production, and video production
   d. Temporary lighting
   e. Lighting for hazardous locations
   f. Lighting for swimming pools
   g. Searchlights

9.4.2: EXTERIOR LIGHTING POWER

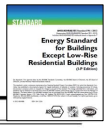
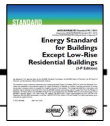


TABLE 9.4.2-2 Individual Lighting Power Allowances for Building Exteriors

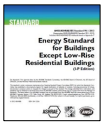
	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (base allowance may be used in tradable or non-tradable surfaces)					
	No base site in Zone 0	500 W	600 W	750 W	1300 W
Tradable Surfaces (LPDs for uncovered parking areas, building grounds, building entrances, exits and loading docks, canopies and overhangs, and outdoor sales areas may be traded.)					
Uncovered Parking Areas					
Parking areas and drives	No allowance	0.04 W/ft^2	0.06 W/ft^2	0.10 W/ft^2	0.13 W/ft^2
Building Grounds					
Walkways less than 10 ft wide	No allowance	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
Walkways 10 ft wide or greater Plaza areas Special feature areas	No allowance	0.14 W/ft^2	0.14 W/ft^2	0.16 W/ft^2	0.2 W/ft^2
Stairways	No allowance	0.75 W/ft^2	1.0 W/ft^2	1.0 W/ft^2	1.0 W/ft^2
Pedestrian tunnels	No allowance	0.15 W/ft^2	0.15 W/ft^2	0.2 W/ft^2	0.3 W/ft^2
Landscaping	No allowance	0.04 W/ft^2	0.05 W/ft^2	0.05 W/ft^2	0.05 W/ft^2
Building Entrances, Exits, and Loading Docks					
Main entries	No allowance	20 W/lin ft of door width	20 W/lin ft of door width	30 W/lin ft of door width	30 W/lin ft of door width
Other doors	No allowance	20 W/lin ft of door width	20 W/lin ft of door width	20 W/lin ft of door width	20 W/lin ft of door width
Entry canopies	No allowance	0.25 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
Loading docks	No allowance	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2
Sales Canopies					
Free standing and attached	No allowance	0.6 W/ft^2	0.6 W/ft^2	0.8 W/ft^2	1.0 W/ft^2
Outdoor Sales					
Open areas (including vehicle sales lots)	No allowance	0.25 W/ft^2	0.25 W/ft^2	0.5 W/ft^2	0.7 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot

9.4.2: EXTERIOR LIGHTING BUDGET



	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
Nontradable Surfaces (LPD calculations for the following applications can be used only for the specific application and cannot be traded between 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	No allowance	0.1 W/ft^2 for each illuminated wall or surface or 2.5 W/ linear foot for each illuminated wall or surface length	0.15 W/ft^2 for each illuminated wall or surface or 3.75 W/ linear foot for each illuminated wall or surface length	0.2 W/ft^2 for each illuminated wall or surface or 5.0 W/ linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	No allowance	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 gatehouse inspection stations at guarded facilities	No allowance	0.75 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.75 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.75 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.75 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")
Loading areas for law enforcement, fire, ambulance, and other emergency service vehicles	No allowance	0.5 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.5 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.5 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")	0.5 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")
Drive-through windows/ doors	No allowance	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	No allowance	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

SECTION 9.4.1.4: LIGHTING CONTROLS



9.4.1.4 – Exterior Lighting Control

Three requirements:

a. Automatic off control when daylight is available

b. Curfew hours for façade and landscape lighting (midnight – 6am or close to open)

c. Other exterior lighting (including advertising) must automatically reduce power by a minimum of 30% either:

1. Midnight – 6am (or 1 hour after business close until open)
2. Motion sensor control (any period of inactivity greater than 15 min)

Note: controls must retain settings during power outage

Exceptions:

- Lighting for covered vehicle entrances or exits where required for safety, security or eye adaptation
- Lighting integral to signage

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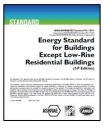
SECTION 9.4.1: LIGHTING CONTROLS



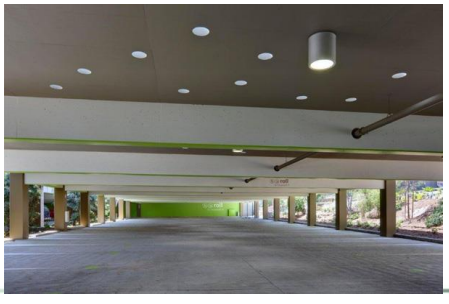
9.4.1.2 – Parking Garage Control

a) Automatic shut off is required per 9.4.1 (i)

b) Lighting must auto step-back to a minimum 30% power after 20 minutes (max zone 3,600 ft²)
Daylight "transition zones" and ramps without parking exempt

c) Covered vehicle entrance and exit lighting must have separate auto-control to reduce lighting by ≥ 50% from sunset to sunrise

d) Daylight sensor control required to auto reduce power for luminaires within 20 ft of any perimeter wall with net opening to wall ratio ≥ 40% or more and no exterior obstructions within 20 ft



Exceptions:

- Daylight transition zones and ramps without parking

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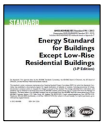
SECTION 9.4.3: FUNCTIONAL TESTING



Control devices and systems must be tested to ensure hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with CD's and manufacturer's instructions

- Must be independent from design & construction team
- Must provide documentation that the controls meet performance requirements
- The following controls require detailed functional testing as per 9.4.3 and proper operation must be confirmed and documented:
  - Occupant sensors
  - Auto Time switches and programmable schedule devices
  - Photo-sensor controls

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SECTION 9: LIGHTING

- COMcheck is the easiest way to show lighting compliance – it is 100% identical to 90.1
  - Determines budget – Interior & Exterior
  - Creates lighting fixture schedule
  - Provides checklist of mandatory items

COMcheck™

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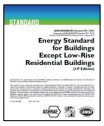
SECTION 8: POWER

Conductor sizes and Switched Receptacles:



8.4 Mandatory Provisions

8.4.1 Voltage Drop

Exception: Feeder conductors and branch circuits that are dedicated to emergency services

8.4.1.1 Feeders. Feeder conductors shall be sized for a maximum voltage drop of 2% at design load.

8.4.1.2 Branch Circuits. Branch circuit conductors shall be sized for a maximum voltage drop of 3% at design load.

8.4.2 Automatic Receptacle Control. The following shall be automatically controlled:

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

This control shall function on

a. a scheduled basis using a time-of-day operated control device that turns receptacles off at specific programmed times—an independent program schedule shall be provided for controlled areas of no more than 5000 ft^2 and not more than one floor (the occupant shall be able to manually override the control device for up to two hours),
b. an occupant sensor that shall turn receptacles off within 20 minutes of all occupants leaving a space, or
c. an automated signal from another control or alarm system that shall turn receptacles off within 20 minutes after determining that the area is unoccupied.

All controlled receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles and are to be uniformly distributed throughout the space.

Plug-in devices shall not be used to comply with Section 8.4.2.

Exceptions: Receptacles for the following shall not require an automatic control device:

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

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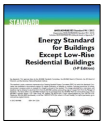
SECTION 8: POWER

Energy Monitoring and Recording:



8.4.3 Electrical Energy Monitoring

8.4.3.1 Monitoring. Measurement devices shall be installed in new buildings to monitor the electrical energy use for each of the following separately:

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

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

Exception: Up to 10% of the load for each of the categories (b) through (e) shall be allowed to be from other electrical loads.

8.4.3.2 Recording and Reporting. The electrical energy usage for all loads specified in Section 8.4.3.1 shall be recorded a minimum of every 15 minutes and reported at least hourly, daily, monthly, and annually. The data for each tenant space shall be made available to that tenant. The system shall be capable of maintaining all data collected for a minimum of 36 months.

Exceptions to 8.4.3.1 and 8.4.3.2:

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

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C405: LIGHTING SYSTEMS

Major Items of Note

- Dwelling units shall comply by having 75% of installed fixtures be high efficacy (R404.1) C405.1
- Lighting control requirements are similar to 90.1 but worded very differently C405.2
- Occupancy sensor controls required in 12 spaces C405.2.1

C405.2.1 Occupant sensor controls. Occupant *sensor controls* shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms
3. Copy/print rooms.
4. Lounges.
5. Employee lunch and break rooms.
6. Private offices.
7. Restrooms.
8. Storage rooms.
9. Janitorial closets.
10. Locker rooms.
11. Other spaces 300 square feet (28 m^2) or less that are enclosed by floor-to-ceiling height partitions.
12. Warehouses.

C405.2.1.1

- Auto shut-off within 30 minutes
- Limits to all on %
- Manual override
- Warehouse aisles

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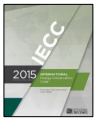
C405: LIGHTING SYSTEMS



Major Items of Note (cont.)

Time-switch controls required: C405.2.2.1
- 7-day clock with seven different daily programs
- automatic holiday "shutoff"
- 10 hour power backup for settings
- 2-hour manual override for up to 5,000 s.f. area

Exceptions for: C405.5.2
- sleeping units,
- patient care,
- safety or security,
- continuous operation lighting,
- shop and laboratory classrooms

Light-reduction controls required C405.2.2.2

Exception for daylit zones (with compliant daylight responsive controls):
- 50% power reduction
- dimming or alternate lamp switching

Manual Controls: C405.2.2.3
- Readily accessible,
- Located in space with fixture or status indicator required,

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C405: LIGHTING SYSTEMS

Major Items of Note (cont.)

Daylight responsive controls required: C405.2.3

- Electric general lighting > 150 Watts in daylit zones
- Sidelight daylit zones separate from Toplight zones

Exceptions for:

- Sleeping units,
- Patient care,
- Exempted lighting

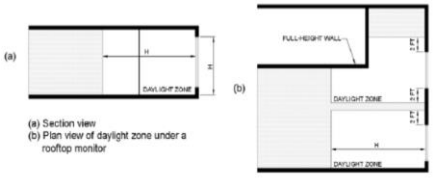

FIGURE C405.2.3.2(1)
DAYLIGHT ZONE ADJACENT TO FENESTRATION IN A WALL

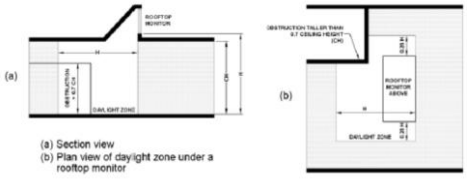

FIGURE C405.2.3.2(3)
DAYLIGHT ZONE UNDER A SLOPED ROOFTOP MONITOR

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C405: LIGHTING SYSTEMS

Major Items of Note (cont.)

Specific applications (Separate controls) required for: C405.2.4

- Display & Accent Lighting
- Case lighting
- Hotel/motel sleeping unit – master control for luminaires and switched receptacles (auto-off within 20 minutes)
  - Exceptions for captive key system
- Supplemental task lighting
- Non-visual lighting (plant growth and food warming)
- Lighting sales demonstration

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C405: LIGHTING SYSTEMS

Major Items of Note (cont.)

Exterior Lighting controls (keep settings for 10 hour backup) C405.2.5

- Auto-off when available daylight
- Façade or landscape light controls dawn/dusk and opening/closing time
- Curfew lighting for other exterior fixtures (minimum 30% reduction)

Exit signs – max 5 W per side (no longer in 90.1) C405.3

Connected lighting may not exceed budget C405.4

- List of exempt lighting

Lighting power budget C405.4.2
(Building Area vs. Space-by-Space)

Additional lighting power for retail & decorative lighting C405.4.2.2.1

- No RCR or Additional Control wattage allowance

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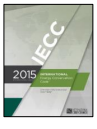
C405: LIGHTING SYSTEMS



Major Items of Note (cont.)

Exterior Lighting budget C405.5.1

- Exempt outdoor lighting (providing separately controlled)
  - Special signal and transportation directional light
  - Advertising or directional signage
  - Integral to equipment
  - Theatrical lighting
  - Athletic playing areas
  - Temporary lighting
  - Industrial production lighting
  - Theme lighting in amusement parks
  - Public monument lighting

TABLE C405.5.2(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 not classified as lighting zone 1, 2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

- No zone 0 for Exterior Lighting Zone C405.5.2(1)

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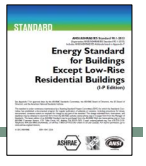
THE BIG CHANGES TO 90.1-2013



The most significant changes included are as follows:

*a. **Building Envelope.** Opaque elements and fenestration requirements have been revised to increase stringency while maintaining a reasonable level of cost-effectiveness. Opaque and fenestration assemblies in Tables 5.5-1 through 5.5-8 are revised in most climates. These changes include*
1. criteria requiring double-glazed fenestration in many climates;
2. minimum VT/SHGC ratio to enable good daylighting with minimum solar gain, while not restricting triple and quadruple glazing; and
3. simplification of the skylighting criteria.

*b. **Lighting.** These changes include improvements to daylighting and daylighting controls, space-by-space lighting power density limits, thresholds for toplighting, and revised controls requirements and format. LPD's changed in the 2010 version*
.

*c. **Mechanical.** Equipment efficiencies were revised upward for heat pumps, packaged terminal air conditioners (PTAC), single-package vertical heat pumps and air conditioners (SPVHP and SPVAC), and evaporative condensers. Also, fan efficiency requirements were introduced for the first time. Additional provisions that have been included address commercial refrigeration equipment, improved controls on heat rejection and boiler equipment, requirements for expanded use of energy recovery, small motor efficiencies, and fan power control and credits. Control revision requirements were added to the standard, such as DDC controls in many applications. Finally, the 2013 edition completes the work that was begun on equipment efficiencies for chillers in the 2010 edition.*

*d. **Energy Cost Budget (ECB) and Modeling.** Improvements were made to the ECB and Appendix G provisions in the standard to clarify the use of the prescriptive provisions when performing building-energy-use modeling. In addition, these sections were revised to enhance capturing daylighting when performing the modeling calculations.*

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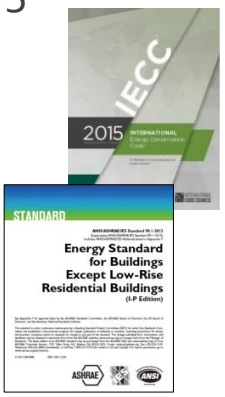
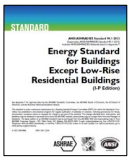
HVAC: 90.1 SECTION 6 / IECC C403



Key Code Concepts:

- Load calcs are required
- All equipment has a minimum efficiency
- Ductwork must be sealed and insulated and balanced
- Fan motor power must be under a certain limit
- All systems must be capable of automatic setback/up during unoccupied times
- Some degree of Commissioning (CX)

ONLY IN 90.1 SECTION 6.3: HVAC



6.3 - Simplified Approach

Applies to 80-85% of all commercial buildings

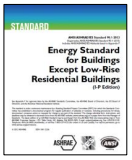
If the 18 requirements are met, the building complies

More restrictive,
but simpler

Limited to:

- 1 or 2 story buildings
- Buildings less than 25,000 sq. ft.
- Each HVAC system must comply

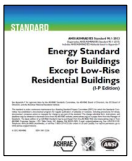
ONLY IN 90.1
SECTION 6.3: HVAC



6.3.2 - Simplified Approach

a. Each system must serve a single zone
b. Variable airflow requirements must be met (6.5.3.2.1)
c. Cooling shall be packaged or split system either air or evaporative cooled (and meet min. efficiencies, 6.8.1)
d. Economizers required in most circumstances (6.5.1)
e. Heating shall be packaged or split system heat pump, gas, electric, or hot water (and meet min. efficiencies, 6.8.1)
f. System shall meet exhaust air energy recovery requirements (6.5.6.1)

90.1 SECTION 6.3: HVAC



6.3.2 - Simplified Approach *(Economizer Details)*

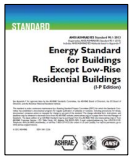
- For systems ≥ 5 tons, economizers required everywhere except CZ1 (Ten exceptions, 6.5.1-1)
- Computer room economizers never required in CZ 2a, 3a, and 4a (Table 6.5.1-2)
- Economizers may be traded off with more efficient equipment
- Not all control options allowed in all CZ's
- List of 10 exceptions (supermarkets, etc.)

Table 6.5.1-3 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling Efficiency

Climate Zone	Efficiency Improvement[a]
2a	17%
2b	21%
3a	27%
3b	32%
3c	65%
4a	42%

a. If a unit is rated with an IPLV, IEER, or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full-load metric like EER cooling then these must be increased by the percentage shown.

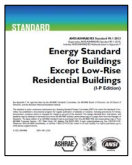
ONLY IN 90.1 SECTION 6.3: HVAC



6.3.2 - Simplified Approach

g. Requires manual changeover or dual set point thermostat
h. When possible, heat pump feature will always provide heating (minimal resistance backup, <40°F lockout)
i. No reheat or simultaneous heating and cooling
j. Control for systems larger than 15k Btu/h and ¾ HP fan motor requires a 7-day / week time clock with 10 hr power loss programming backup, 2-hr override plus temperature setback to 55°F and setup to 90°F (exception for guest rooms and continuously operating systems)
k. Piping insulation and weather protection (6.8.3)

ONLY IN 90.1 SECTION 6.3: HVAC



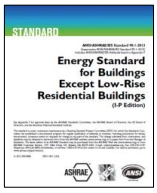
6.3.2 - Simplified Approach

l. Ductwork / plenums insulated (6.8.2) & sealed (6.4.4.2.1)
m. CD's show ducted systems must be air balanced to industry standards (~10% of design)
n. Outdoor air and exhausts shall comply with motorized dampers & controls (some exceptions, 6.4.3.4)
o. Separate thermostats interlocked to prevent simultaneous heating and cooling
p. System greater than 10,000 cfm shall have optimum start controls
q. Demand control ventilation required in high occupancy situations (6.4.3.8)
r. Door switch requirements complied with (6.5.10)

90.1 SECTION 6.4: HVAC – MANDATORY ITEMS

6.4 – Mandatory Provisions

(for non-simple HVAC systems)



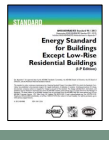
Overview

Must be met whether using prescriptive or performance (ECB method) path

Mandates include:

- 6.4.1 - Equipment efficiency
- 6.4.2 - Calculations (loads, pump sizing)
- 6.4.3 – Controls (zone T-stat, deadband, overlap, off-hour, automatic shutdown, setback, optimum start, zone isolation, ventilation, HP auxiliary heat, humidification & dehumidification, freeze protection & snow melt, demand control ventilation, vestibule heating, DDC)
- 6.4.4 - Construction and insulation (duct & plenum, piping, site built walk-in coolers, refrigerated display cases)
- Submittals and Completion documentation

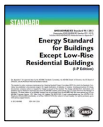
90.1 SECTION 6.5: HVAC – PRESCRIPTIVE



6.5 – Prescriptive Items

- Economizers – (6.5.1)
- Simultaneous heating & cooling – (6.5.2)
- Air system design and control – (6.5.3)
- Hydronic design & control – (6.5.4)
- Heat rejection equipment – (6.5.5)
- Energy recovery – (6.5.6)
- Exhaust systems – (6.5.7)
- Radiant heating – (6.5.8)
- Hot gas bypass limitation – (6.5.9)
- Door switches– (6.5.10)
- Refrigeration systems– (6.5.11)

90.1 SECTION 6.5: HVAC – PRESCRIPTIVE



6.5 – Prescriptive

Air system design and control – (6.5.3)

Must satisfy either

- Option 1 (Nameplate motor hp calculation), or
- Option 2 (Fan System bhp)

Strong incentive for variable speed systems

TABLE 6.5.3.1-1 Fan Power Limitation[a]

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	$hp \le cfm_S \cdot 0.0011$	$hp \le cfm_S \cdot 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \le cfm_S \cdot 0.00094 + A$	$bhp \le cfm_S \cdot 0.0013 + A$

a. where
cfm_S = maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute
hp = maximum combined motor nameplate horsepower
hp = maximum combined fanbrake horsepower
A = sum of $(PD \times cfm_D/4131)$
where
PD = each applicable pressure drop adjustment from Table 6.5.3.1-2 in in. wc
cfm_D = the design airflow through each applicable device from Table 6.5.3.1-2 in cubic feet per minute

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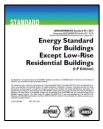
90.1 SECTION 6.5: HVAC – PRESCRIPTIVE



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Option 2: Fan system bhp	Allowable fan system bhp	$bhp \le cfm_S \cdot 0.00094 + A$	$bhp \le cfm_S \cdot 0.0013 + A$

Impact:

- To efficiently move air, ducts must be sufficiently large enough to provide required CFM
- Designers must provide adequate room for properly sized ducts to deliver needed airflow

TABLE 6.5.3.1-2 Fan Power Limitation Pressure Drop Adjustment

Device	Adjustment
Credits	
Fully ducted return and/or exhaust air systems	0.5 in. wc (2.15 in. wc for laboratory and vivarium systems)
Return and/or exhaust airflow control devices	0.5 in. wc
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate Filtration Credit: MERV 9 through 12	0.5 in. wc
Particulate Filtration Credit: MERV 13 through 15	0.9 in. wc
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2× clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Biosafety cabinet	Pressure drop of device at fan system design condition
Energy recovery device, other than coil runaround loop	(2.2 × Energy Recovery Effectiveness) – 0.5 in. wc for each airstream
Coil runaround loop	0.6 in. wc for each airstream
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design condition
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 in. wc
Exhaust system serving fume hoods	0.35 in. wc
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 in. wc/100 ft of vertical duct exceeding 75 ft
Deductions	
Systems without central cooling device	–0.6 in. wc
Systems without central heating device	–0.3 in. wc
Systems with central electric resistance heat	–0.2 in. wc

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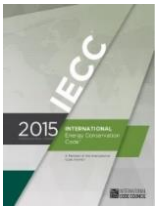
IECC C403 BUILDING MECHANICAL SYSTEMS



Mandatory Requirements

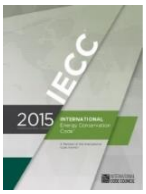
- Load calcs & equipment sizing
- HVAC equipment minimum efficiency
- Controls (Tstat, HP, Deadband, Overlap, Off-hour, Setback, Automatic shutdown & startup),
- Dampers, Zone isolation, Snow/ice melt & freeze protection,
- Economizer Fault Detection & Diagnostic (FDD), Boiler reset,
- Ventilation (DCV, Parking garage, ERV, kitchen exhaust),
- Duct/plenum insulation and sealing, Piping, CX (Functional Performance Testing),
- Fan motors over 5 hp must meet fan power limitations and minimum efficiency
- Outdoor heating must be radiant (controls)
- Refrigeration equipment, walk-in coolers, refrigerated warehouses, display cases

IECC C402 & C403 – GA AMENDMENTS

Commercial Amendments to IECC only!

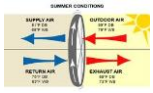
- 403.2.3 -Equipment efficiencies shall use 90.1-2013 tables
- 403.2.8 - Kitchen exhaust hood requirements deleted
- 403.2.9 - Duct and plenum insulation and sealing (revised to allow spray foam as sealant) (Joints, seams and connections shall be sealed with mastic and spray foam is allowed option)
- 403.3 - Economizer exception added for computer rooms (aligns with 90.1 exception)
- 403.4.2.6 - Revised Pump isolation details
- 407.3 - Energy simulation compliance –limits renewables to maximum of 5% credit in model
- 408 - Substitute word "Commissioning" with "Functional Performance Testing"

IECC C406 – CHOOSE YOUR "BONUS"



Additional Efficiency

- Projects must comply with at least one option
- Two are HVAC related
  - More efficient equipment (10%)
  - DOAS



C406.6 Dedicated outdoor air system. Buildings covered by Section C403.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by the *International Mechanical Code*. The ventilation system shall be capable of total energy recovery. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature at least 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

SECTION C406
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

C406.1 Requirements. Buildings shall comply with at least one of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power density system in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.

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RESOURCES

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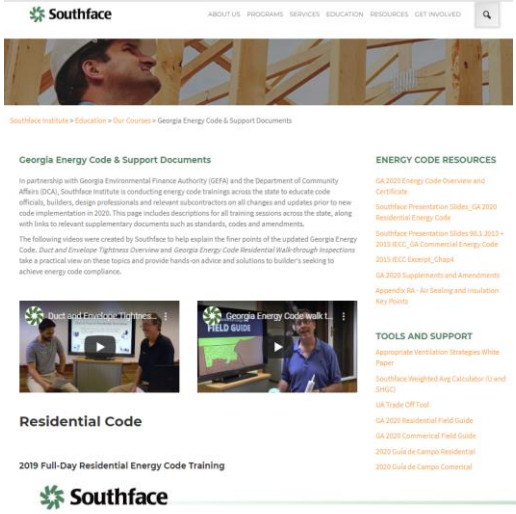
=> **Education** => **Our Courses** => **Energy Code** => **GA Energy Code**



- www.ashrae.org
- www.energycodes.gov
- www.dca.ga.gov
- www.iccsafe.org