

2009 International Energy Conservation Code (IECC) & Design Strategies to Achieve Compliance

Honolulu, Nov. 13 & 14, 2012

Lihue, Nov. 15, 2012

Kahului, Nov. 16, 2012

Hilo, Nov. 19, 2012

Kona, Nov. 20, 2012

Erik Kolderup, PE

Kolderup Consulting

erik@kolderupconsulting.com

www.kolderupconsulting.com

Howard Wiig

DBEDT, Energy Efficiency Branch

hwiig@dbedt.hawaii.gov

energy.hawaii.gov



Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-EE0000216

Sponsor: State of Hawaii, Department of Business, Economic Development and Tourism

Disclaimer: This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the State of Hawaii, nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government, the State of Hawaii or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government, the State of Hawaii or any agency thereof.

Task Order Number 2.F

Agenda

Morning Session

INTRODUCTION

8:00	Introduction
8:15	Residential requirements
9:15	BREAK
9:30	Commercial requirements
10:30	Preview of 2012 IECC, green building codes
11:00	Energy efficiency incentive programs
11:45	Lunch

Agenda

Afternoon Session

INTRODUCTION

1:00	Introduction
1:15	Design strategies for AC residence
2:30	BREAK
2:45	Design strategies for small commercial project
3:45	Wrap up
4:00	Adjourn

Status of County Energy Codes

INTRODUCTION

County	Version	Adoption Date
Hawaii	Amended IECC 2006	October 2010
Honolulu	Amended IECC 2006	November 2009
Kauai	Amended IECC <u>2009</u>	January 2010
Maui	Amended IECC 2006	October 2009

Primary amendments in 2006 adoptions:

- Unconditioned spaces covered
- Alternative roof insulation requirements
- Commissioning required

Anticipated IECC 2009 Adoptions

INTRODUCTION

- Honolulu
- Kauai
- Maui
- Hawaii

IECC 2009 Contents

INTRODUCTION

Chapter 1 Administration

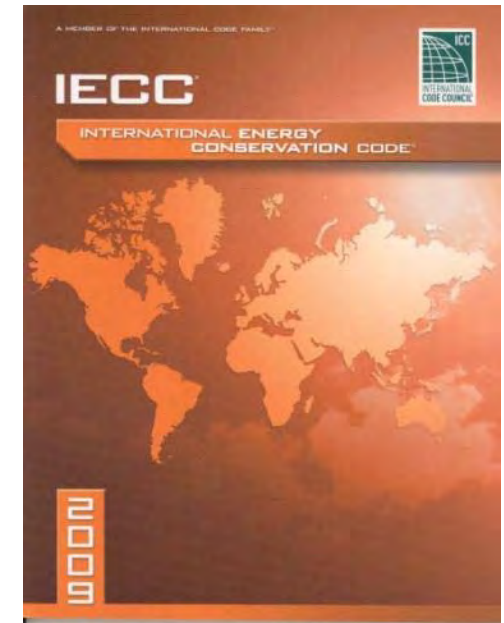
Chapter 2 Definitions

Chapter 3 General Requirements

Chapter 4 Residential Energy Efficiency

Chapter 5 Commercial Energy Efficiency

Chapter 6 Referenced Standards



What's Changed Since IECC 2006?

INTRODUCTION

New in
2009 IECC

- General requirements

- Roof insulation compliance when sheathing or insulation exposed in existing roof (101.4.3)
- Commercial lighting compliance with change in space usage (101.4.4)
- Full compliance triggered by change from unconditioned to conditioned space (101.4.5)

What's Changed Since IECC 2006? (continued)

New in
2009 IECC

- Residential requirements
 - Some envelope requirements more stringent
 - Residential window SHGC = 0.30
 - New requirements added
 - Building envelope tightness verification
 - Duct leakage pressure test
 - Lighting efficacy limits
 - Pool controls and covers
 - Moisture control requirements (e.g., vapor retarders) moved to IRC
 - No mechanical trade-offs allowed
 - A few performance path assumptions changed

What's Changed Since IECC 2006? (continued)

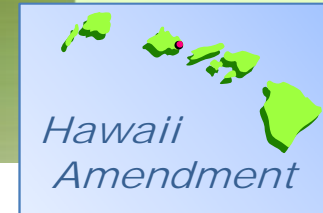
New in
2009 IECC

- Commercial requirements

- Compliance alternative updated from ASHRAE Standard 90.1-2004 to 90.1-2007 (501.1)
- Separate envelope requirements for high-rise residential vs. other commercial (502.1.1)
- Skylight requirements more stringent (502.3)
- Updated HVAC equipment efficiency tables (503.2.3)
- Demand control ventilation for some spaces (503.2.5.1)
- Fan power limit for systems with >5hp (503.2.10)
- Supply air temperature reset for VAV systems (503.4.5.4)
- 50% high-efficacy lighting in dwelling units (505.1)
- Separate lighting control in daylight zones (505.2.2.3)
- Additional lighting power exemptions (505.5.1)
- Revised retail lighting allowance (505.5.2)
- Revised exterior lighting requirements (505.6.2)
- Expanded rules for Total Building Performance calculations (506)

Hawaii Amendments

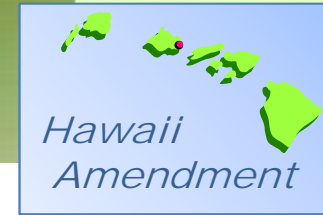
INTRODUCTION



- **General requirements:**
 - Envelope requirements apply also to unconditioned, habitable spaces (101.5.2)
- **Residential amendments:**
 - Wall insulation tradeoffs (Table 402.1.1)
 - Ceiling insulation alternatives (402.1.6)
 - Steel-frame wall insulation alternatives (402.2.5)
 - Exemption for north-facing and shaded windows (402.3.3)
 - Air leakage exemption for unconditioned dwellings (402.4.1.1)
 - Air leakage requirements for jalousie windows (402.4.4)

Hawaii Amendments (continued)

INTRODUCTION



- Commercial amendments:
 - No roof insulation required with cool roof membrane, if elevation < 2400 ft (502.2.1)
 - Area weighted average allowed for window SHGC compliance (502.3.3)
 - Commissioning and completion requirements (503.2.9)
 - Hotel thermostat and lighting controls (505.2.3)
 - Tenant electrical submetering (505.7)



2009 IECC

CHAPTER 1

ADMINISTRATION

Scope

ADMINISTRATION

101.2

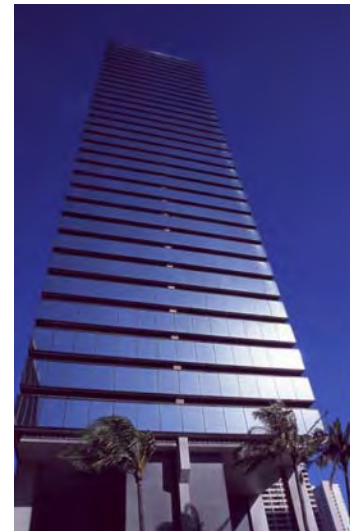
Residential Requirements

- 1- and 2-family dwellings (R-3)
- Multi-family (R-2 \leq 3 stories)
- Residential care/assisted living (R-4 \leq 3 stories)



Commercial Requirements

- All other buildings
 - Including R-1 (hotels)



Applicability Historic Buildings

ADMINISTRATION

101.4.2

- Exempt from energy code
 - State or National Register of Historic Places
 - State or local historic designation
 - Contributing resource in historic district



Applicability

Additions, Alterations, Renovations or Repairs

ADMINISTRATION

101.4.3

- Code applies to new and altered portions
 - Including re-roofing
 - Roof insulation when sheathing or insulation exposed
- Exceptions:
 - Glass replaced in existing sash
 - Exposed roof & wall cavities that are filled with insulation
 - Construction where cavities are not exposed
 - Reroofing where sheathing not exposed
 - Lighting renovations that replace less than 50% of fixtures
 - Lighting renovations that replace only bulb/ballast

New in
2009 IECC

Applicability

Additions, Alterations, Renovations or Repairs

ADMINISTRATION

101.4.3

- Options for additions:
 1. Comply on its own
 2. Existing + addition comply as single building



Source: www.energycodes.gov

Applicability Changes

ADMINISTRATION

101.4

- **Change of occupancy (101.4.4)**
 - Must comply if peak energy demand increases
 - For example, retail to restaurant
 - Commercial lighting power requirement applies (505.5) if space use changes
 - For example, retail to office
- **Change of space conditioning (101.4.5)**
 - Full compliance required for unconditioned space that is converted to conditioned space

New in
2009 IECC

New in
2009 IECC

Applicability Mixed Occupancy

ADMINISTRATION

101.4.6

- Residential + commercial mixed occupancy
 - Residential code applies to residential portions
 - Commercial code applies to commercial portions



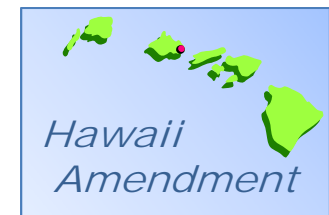
Source: www.energycodes.gov

Compliance Low Energy Buildings

ADMINISTRATION

101.5.2

- Exempt from envelope requirements:
 1. Low-energy conditioned space
 - Peak space conditioning energy is $< 1.0 \text{ W/ft}^2$ or 3.4 Btu/h-ft^2
 2. Non-habitable unconditioned space
 - Like garages, mechanical rooms, etc.
- Applies to portions of buildings



What this means:

Habitable space must comply with envelope requirements even if there is no AC

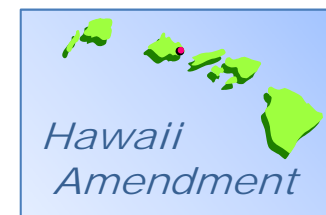
Construction Documents

General

ADMINISTRATION

103.1

- *...The responsible design professional shall provide on the plans a signed statement certifying that the project is in compliance with this code.*
- Exception:
 - Any building, electrical or plumbing work that is not required to be prepared, design, approved or observed by a licensed professional architect or engineer pursuant to chapter 464 Hawaii Revised Statutes

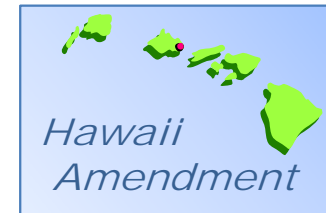


Inspections

ADMINISTRATION

104

- Section 104 deleted per Hawaii amendment





2009 IECC

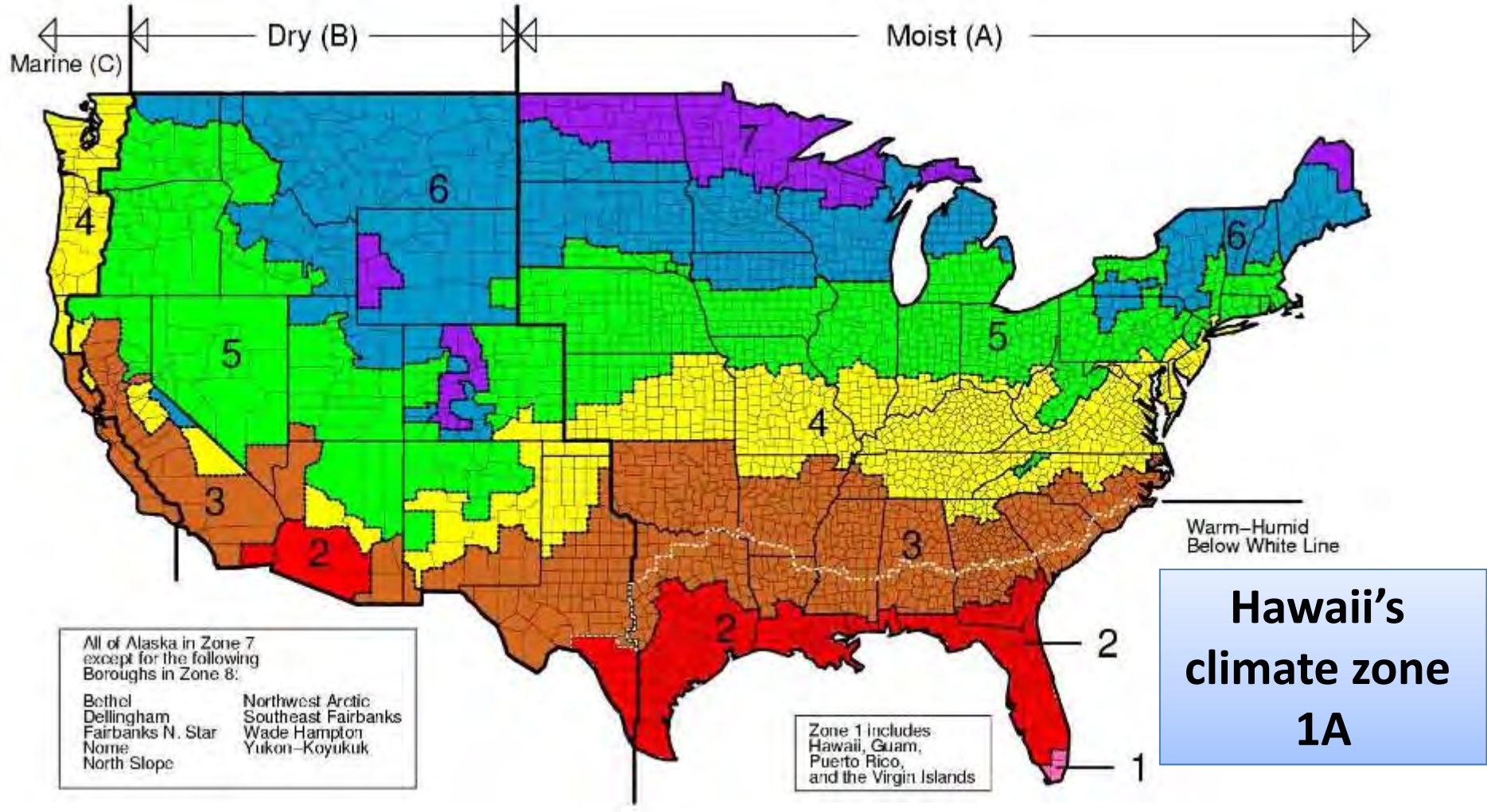
CHAPTER 3

GENERAL REQUIREMENTS

Climate Zones

GENERAL
REQUIREMENTS

301.1



Identification

GENERAL
REQUIREMENTS

303.1

- Insulation materials
 - Marked with R-value by manufacturer
- Blown roof/ceiling insulation
 - Thickness indicated by markers
- Windows
 - Label required for SHGC



Source: www.energycodes.gov

ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.35	0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2
Condensation Resistance	
51	—

Use this label to identify the energy product to provide ENERGY STAR information for the building with product performance. IECC ratings are determined by actual test measurements and a sample product. IECC also requires minimum safety and other test parameters. For more information, please contact the manufacturer or visit www.energycode.com.

Source: 2009 IECC Code Commentary



2009 IECC

CHAPTER 4

RESIDENTIAL ENERGY EFFICIENCY

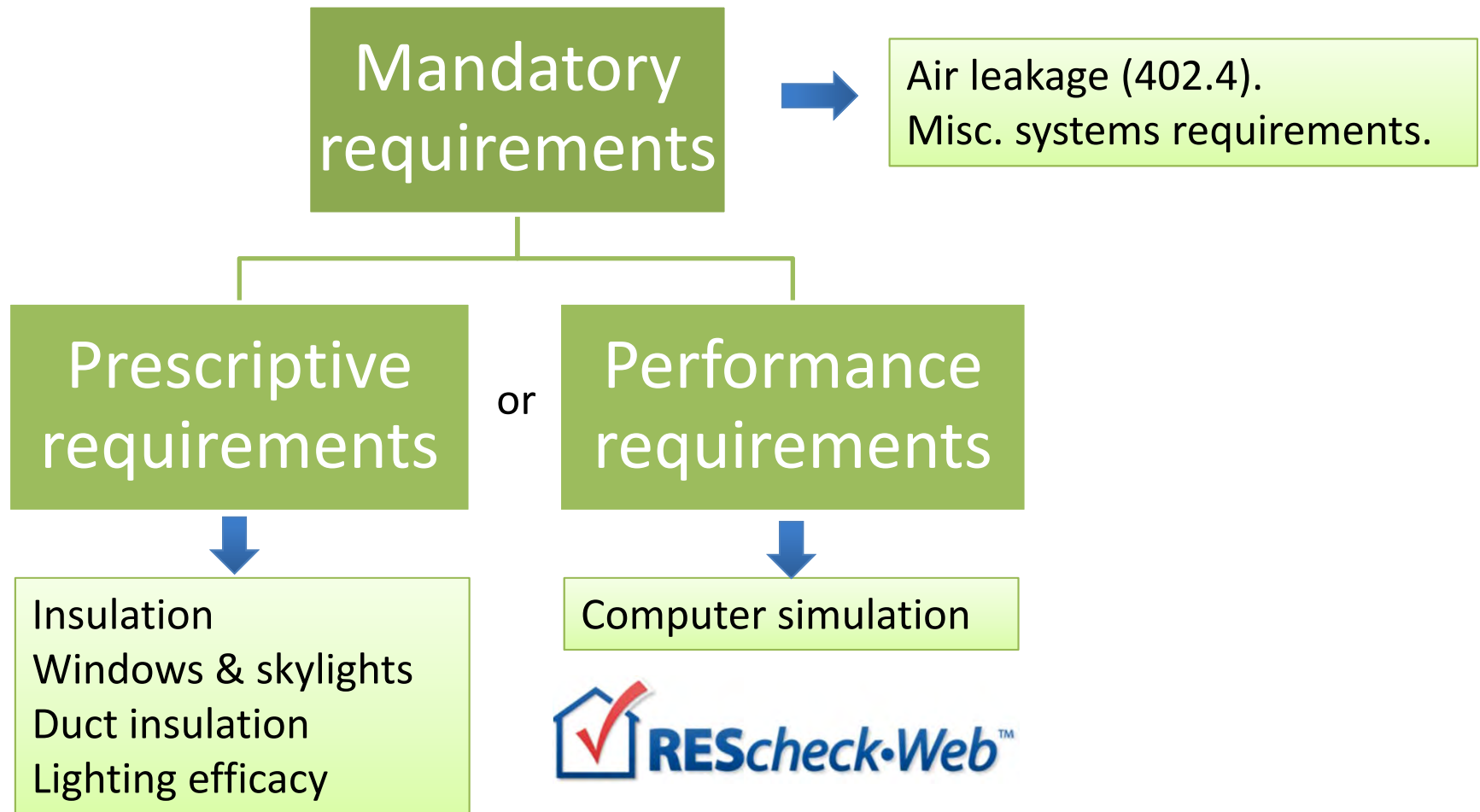
Overview of Residential Code Requirements

- Focus is envelope
 - Roof and wall insulation and alternatives
 - Window and skylight solar heat gain
 - Air leakage
- Ducts – seal, insulate, and test
- Limited AC and water heating requirements
 - Federal law sets most efficiency requirements
- No appliance requirements
- Lighting equipment
 - 50% of lamps to be high-efficacy lamps

Compliance

RESIDENTIAL
General

401.2

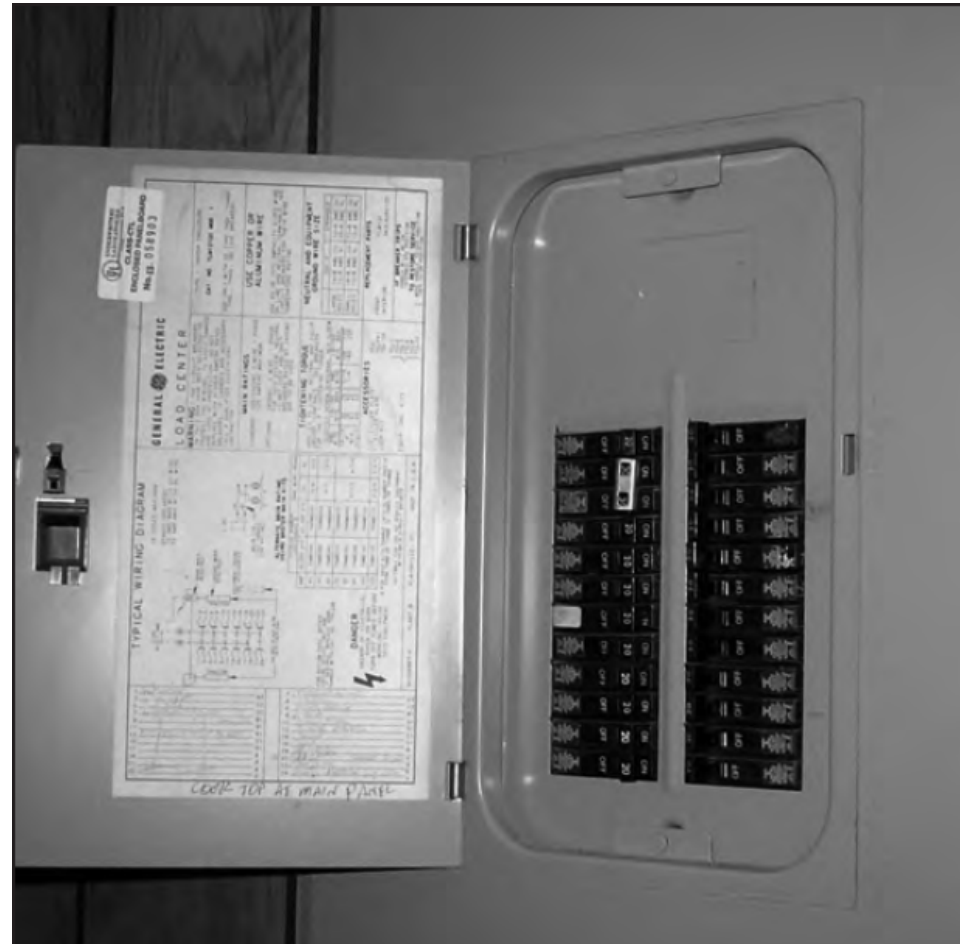


Certificate

RESIDENTIAL
General

401.3

- Post on elec. panel
- Include:
 - Insulation R-value
 - Window SHGC
 - AC efficiency



Source: 2009 IECC Code Commentary



2009 IECC

**SECTION 402 – BUILDING THERMAL ENVELOPE
RESIDENTIAL ENERGY EFFICIENCY**

Definitions

DEFINITIONS

202.

- U-factor
- Solar heat gain coefficient (SHGC)
- Shading coefficient
- Projection factor (PF)
- Radiant barrier
- Cool roof



Definitions

Thermal Transmittance

DEFINITIONS

202.

- U-factor
 - Thermal transmittance
 - Lower value = lower heat flow
 - Units = Btu/hr-°F-ft²
- U-factor = 1/R-value

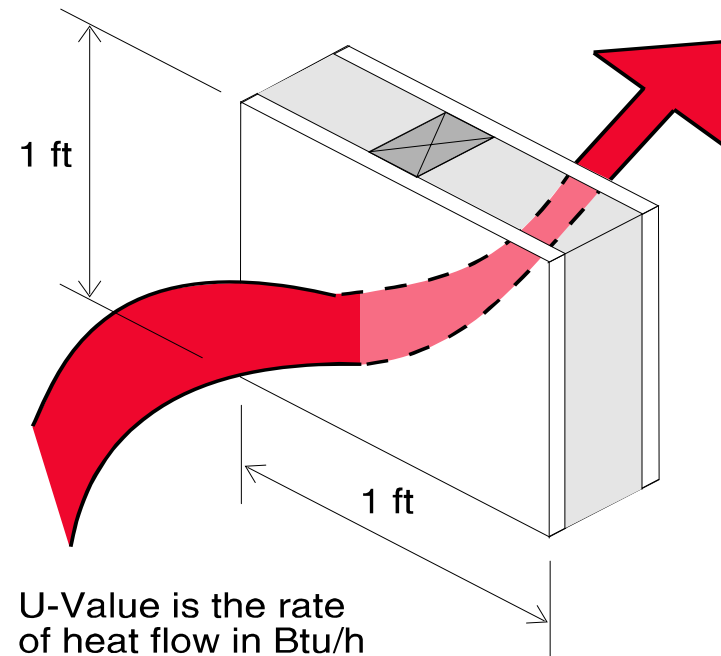
$$Q = U \cdot A \cdot (T_{out} - T_{in})$$

Heat flow (Btu/hr) is indicated by a line pointing to Q .

Surface area (ft²) is indicated by a line pointing to A .

Outdoor temperature (F) is indicated by a line pointing to T_{out} .

Indoor temperature (F) is indicated by a line pointing to T_{in} .



U-Value is the rate of heat flow in Btu/h through one ft² area when one side is 1° F warmer

Definitions

SHGC vs. SC

DEFINITIONS

202.

Solar heat gain coefficient (SHGC)

$$\text{SHGC} = \frac{\text{Solar heat gain entering the space}}{\text{Incident solar radiation}}$$

Value between 0 and 1

Shading coefficient (SC)

$$\text{SC} = \frac{\text{Solar heat gain entering the space}}{\text{Solar heat gain entering the space through 1/8" clear glass}}$$

$$\text{SHGC} \cong 0.87 \times \text{SC}$$

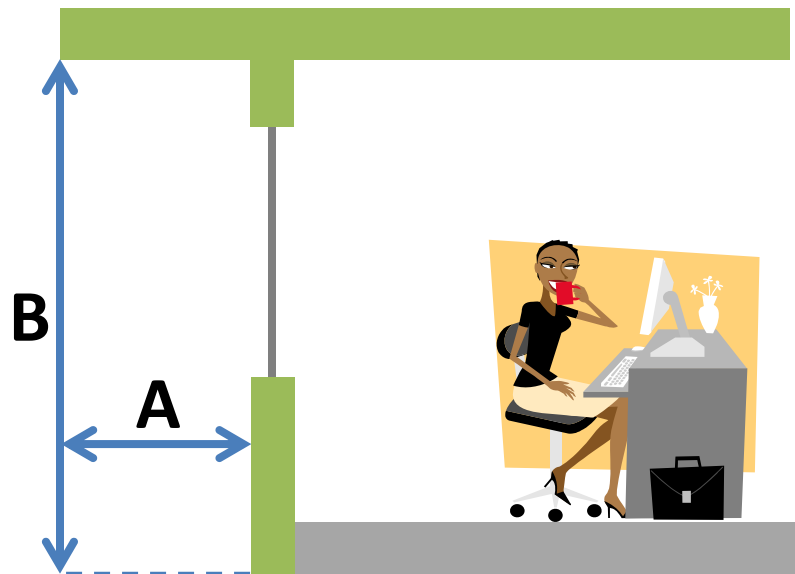
Definitions

Projection Factor (PF)

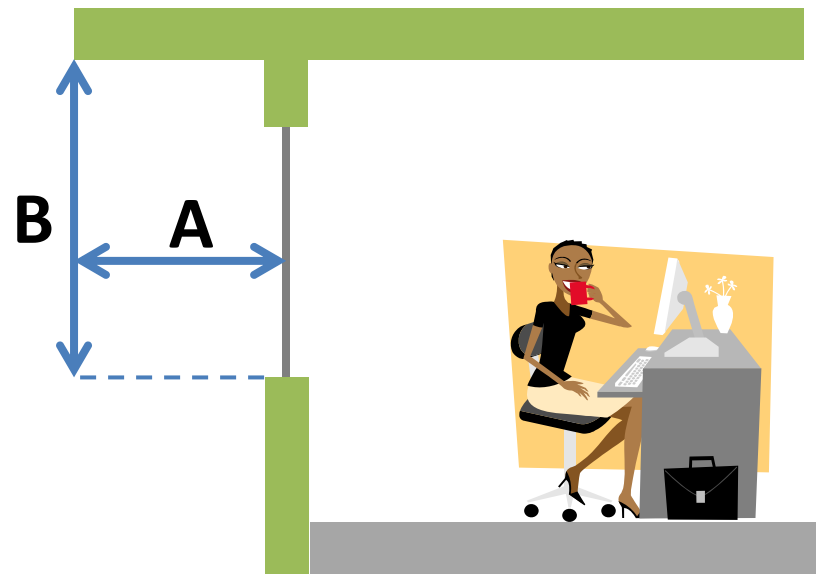


$$PF = \frac{A}{B}$$

Wall shading



Window shading



Definitions

Radiant Barrier

- Low emissivity surface
- Installed with low-e surface facing air gap
- Sometimes laminated to plywood roof deck
- Cuts radiant heat transfer
 - Best for cooling load reduction through roof
 - Cuts radiant heat load on ducts from hot roof deck



Definitions Cool Roof

- Reflective membrane
 - Typically white
- Several types
 - Single ply – TPO, PCV
 - Liquid applied
 - White-coated metal
- Desired properties
 - High solar reflectance
 - High emissivity
- Cool Roof Rating Council



Source: DOE/NREL

General (Prescriptive) Thermal performance options

RESIDENTIAL
Envelope

402.1

- Roof and walls

- Minimum insulation R-value, or
- Maximum U-factor, or
- Overall UA

+ Hawaii amendments
with alternatives

- Windows & skylights

- Maximum SHGC = 0.30
- Maximum U-factor (skylights only)
- Area-weighted average allowed
- Some exceptions

+ Hawaii amendments
with alternatives

General (Prescriptive) Opaque Envelope Criteria

RESIDENTIAL
Envelope

402.1.1

From Table 402.1.1 **←or→** From Table 402.1.3

IECC 2009 <u>without</u> Hawaii amendments	Minimum Insulation R-value (hr-ft ² -°F/Btu)	Maximum U-factor (Btu/hr-ft ² -°F)
Ceiling	30	0.035
Wood frame wall	13	0.082
Mass wall	3/4	0.197
Floor	13	0.064
Basement wall	0	0.360
Crawl space wall	0	0.477
Steel frame wall	13 + 5 (+3 if 24" o.c.)	0.082
Steel truss/frame ceiling	38	0.035

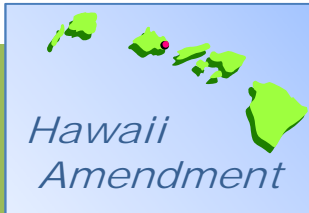


Section 402.2.5

General (Prescriptive) Opaque Envelope Criteria

RESIDENTIAL
Envelope

402.1.1



From Table 402.1.1 ← or → From Table 402.1.3

	Minimum Insulation R-value (hr-ft ² -°F/Btu)	Maximum U-factor (Btu/hr-ft ² -°F)
Ceiling	30	0.035
Wood frame wall	13	
Mass wall	3/4	
Floor	13	
Basement wall	0	
Crawl space wall	0	0.477
Steel frame wall	13 + 5 (+3 if 24" o.c.)	0.082
Steel truss/frame ceiling	38	0.035

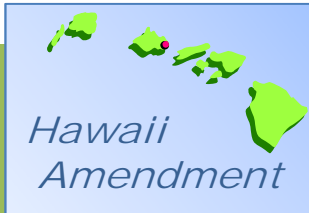
Wall exemptions:

1. Reflective surface (≥0.64)
2. 90% high efficacy lighting
3. Overhangs with projection factor ≥ 0.30 on non-north

General (Prescriptive) Opaque Envelope Criteria

RESIDENTIAL
Envelope

402.1.1



From Table 402.1.1 ←or→ From Table 402.1.3

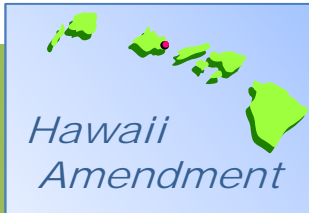
	Minimum Insulation R-value (hr-ft ² -°F/Btu)	Maximum U-factor (Btu/hr-ft ² -°F)
Ceiling	30	0.035
Wood frame wall	13	0.082
Mass wall	3/4	0.197
Floor	13	
Basement wall	0	
Crawl space wall	0	0.477
Steel frame wall	13 + 5 (+3 if 24" o.c.)	0.082
Steel truss/frame ceiling	38	0.035

Raised floor:
No insulation required

General (Prescriptive) Opaque Envelope Criteria

RESIDENTIAL
Envelope

402.1.1



From Table 402.1.1 ←or→ From Table 402.1.3

	Minimum Insulation R-value (hr-ft ² -°F/Btu)	Maximum U-factor (Btu/hr-ft ² -°F)
Ceiling	30	
Wood frame wall	13	
Mass wall	3/4	
Floor	13	
Basement wall	0	
Crawl space wall	0	
Steel frame wall	13 + 5 (+3 if 24" o.c.)	0.082
Steel truss/frame ceiling	38	0.035

Steel frame wall exemptions:

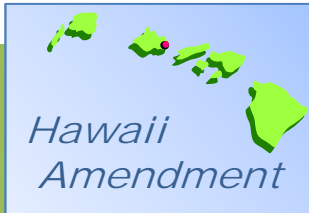
(if elevation < 2,400 ft)

1. Reflective surface (≥0.64)
2. 90% high efficacy lighting
3. Overhangs with projection factor ≥ 0.30 on non-north
4. SEER 14+ air conditioner

General (Prescriptive) Opaque Envelope Criteria

RESIDENTIAL
Envelope

402.1.1



From Table 402.1.1 ← or → From Table 402.1.3

	Minimum Insulation R-value (hr-ft ² -°F/Btu)	Maximum U-factor (Btu/hr-ft ² -°F)
Ceiling	30	0.035
Wood frame wall	13	0.082
Mass wall	3/4	0.197
Floor	13	0.064
Basement wall	0	
Crawl space wall	0	
Steel frame wall	13 + 5 (+3 if 24" o.)	
Steel truss/frame ceiling	38 30	0.035

Steel frame ceiling exemptions:
(if elevation < 2,400 ft)
1. Steep-slope roof with initial reflectance ≥ 0.25

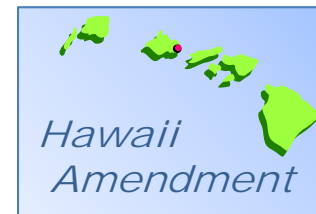
General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6

Design Option	Roof Insulation	Attic Ventilation	Radiant Barrier	Cool Roof	Roof Heat Gain Factor <0.05
1	R				
2		R	R		
3			R	R	
4					R

Above applies for elevations below 2,400 ft.
Use R-30 if elevation > 2,400 ft.

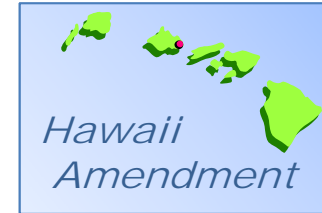


General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6.4

- Roof Insulation
 - With attic
 - R-30 above ceiling, or
 - R-19 at roof
 - Without attic
 - R-19 between framing members, or
 - R-15 above roof deck



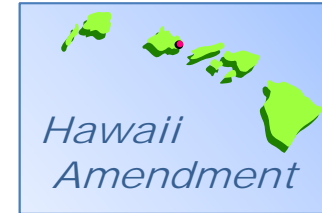
**Roof Design
Option #1**

General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6.5

- Attic ventilation (choose one)
 1. Baffled ridge vent + lower openings
 - 1 ft² free vent area per 300 ft² attic
 2. Solar-powered exhaust fan
 - 1 cfm per ft² of roof
 3. Upper + lower vents
 - 1 ft² free vent area per 150 ft² attic



**Roof Design
Option #2**

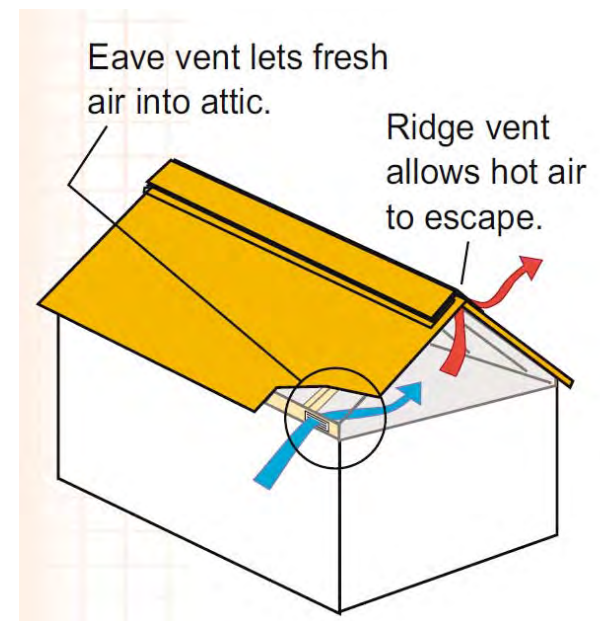
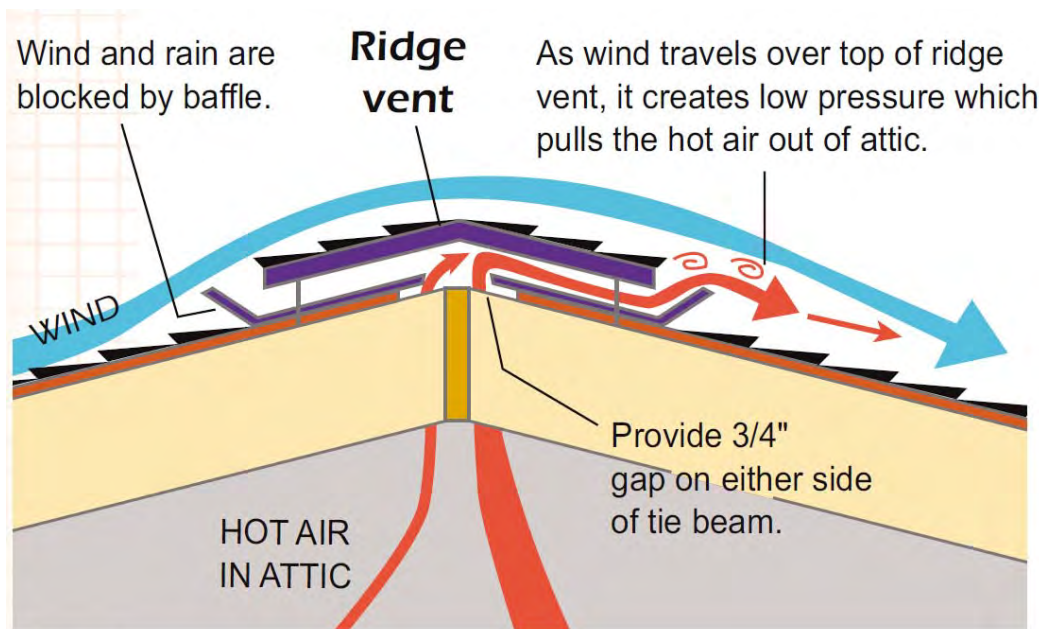
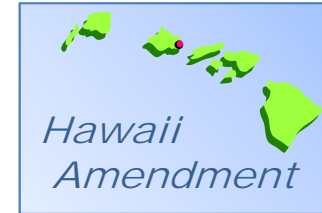
Combine with radiant barrier for compliance

General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6.5

- Attic ventilation (continued)

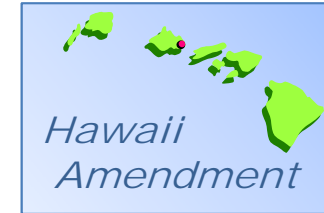


General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

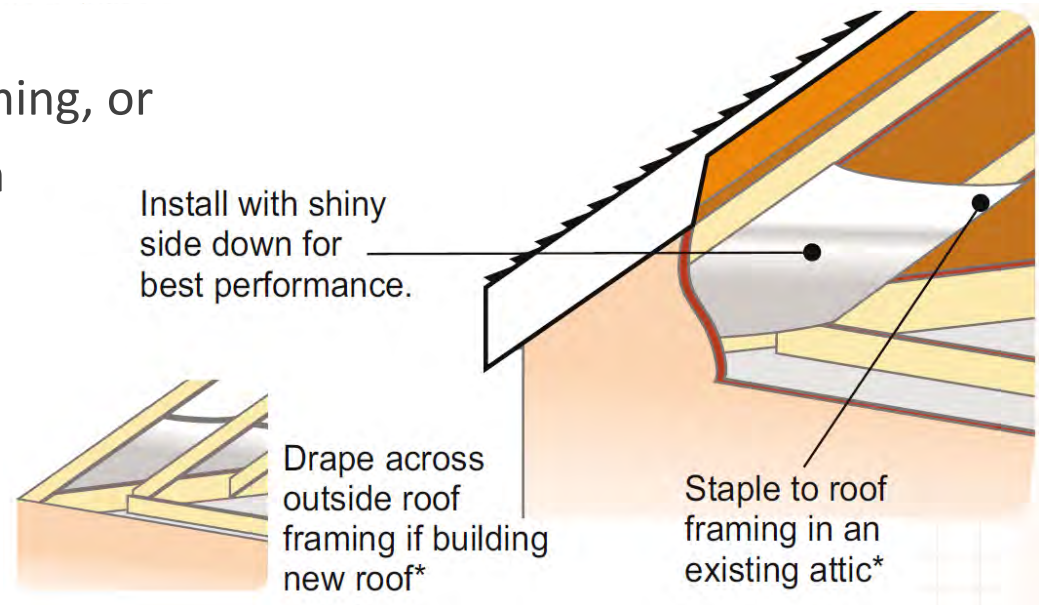
402.1.6.6

- Radiant barrier
 - Emissivity ≤ 0.05
 - Shiny side down
 - $\frac{3}{4}$ inch minimum air gap
 - Installation:
 - Attached to roof framing, or
 - Laminated to bottom of roof sheathing



Roof Design
Option #2/3

Combine with
attic ventilation or
cool roof for
compliance

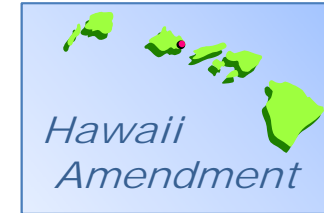


General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6.7

- Cool roof
 - Initial reflectance ≥ 0.70
 - Extended reflectance ≥ 0.55
 - Infrared emittance ≥ 0.75
 - Rated per Cool Roof Rating Council



**Roof Design
Option #3**

Combine with radiant barrier for compliance

General (Prescriptive) Ceiling Insulation Alternative

RESIDENTIAL
Envelope

402.1.6.8

- Roof heat gain factor ≤ 0.05

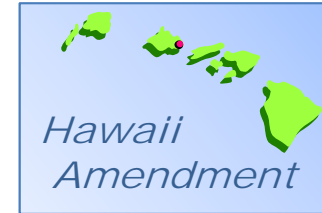
$$RHGF = U_r \cdot \alpha \cdot RB$$

where:

U_r = roof U-factor

α = roof surface absorptivity (1 – reflectance)

RB = 0.33 if radiant barrier installed, otherwise 1.0
(Radiant barrier installation requirements apply)



**Roof Design
Option #4**

Examples	α	RB	Max. U_r	Approx. Insulation R-value
Radiant barrier only	0.70	0.33	0.22	3.0
Cool roof only	0.30	1.0	0.17	4.3
Radiant barrier and cool roof	0.30	0.33	0.51	None

General (Prescriptive) Fenestration

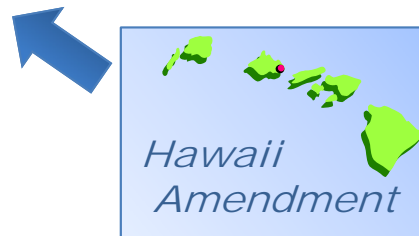
RESIDENTIAL
Envelope

402.3

- Windows

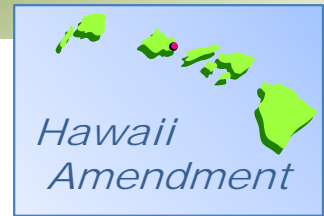
- Maximum U-factor = 1.20 = single-pane
- Maximum SHGC = 0.30
 - Area-weighted average allowed
- Exception for up to 15 ft²
- Hawaii exceptions, no requirement for:
 - North-facing windows
 - Shaded windows with PF ≥ 1.0

New in
2009 IECC



Windows Spreadsheet Compliance Option

RESIDENTIAL Envelope



Hawaii Area-Weighted Average SHGC Template

- Window area
- Orientation
- SHGC
- Overhang dimensions (if any)
- % window covered by screens

Calculates weighted-average SHGC

Hawaii Area-Weighted Average SHGC Template

The Hawaii Building Code Council for calculating compliance with the SHGC Required 502.3 of the IECC 2009.

Project Name: _____

Project Address or Plot Number: _____

Designer of Project: _____

Customer: _____

Window ID	Window Orientation	Window Height (inches)	Window Width (inches)	Window Area (inches ²)	Exemptions applied	Window SHGC	A	B	Projection Factor	Actual SHGC Screen
1	South Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
2	North Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
3	East Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
4	West Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
5	South Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
6	North Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
7	East Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
8	West Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
9	South Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
10	North Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
11	East Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
12	West Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
13	South Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
14	North Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
15	East Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
16	West Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
17	South Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
18	North Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
19	East Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75
20	West Facing	48	36	1728	None	0.75	0.75	0.75	1.0	0.75

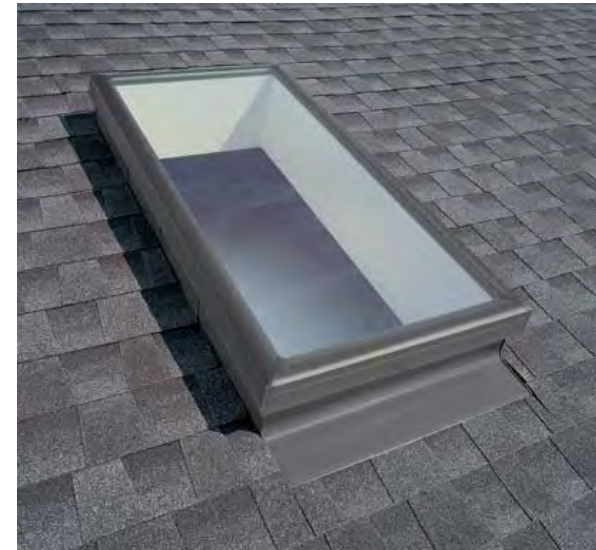
Spreadsheet and instructions at:
<http://energy.hawaii.gov/programs/achieving-efficiency/hawaii-energy-building-code>

General (Prescriptive) Fenestration (continued)

RESIDENTIAL
Envelope

402.3

- Skylights
 - Maximum U-factor = 0.75
 - Area-weighted average allowed
 - Maximum SHGC = 0.30
 - Area-weighted average allowed
 - Exception for up to 15 ft² (skylight + window)



www.veluxusa.com

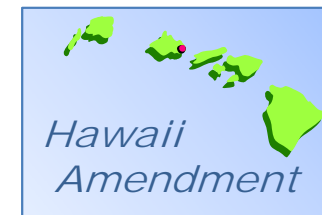
Air Leakage (Mandatory) Air Sealing and Insulation

New in
2009 IECC

RESIDENTIAL
Envelope

402.4.2

- Two options to demonstrate compliance
 1. Whole-house pressure test (402.4.2.1)
 - Air leakage <7 ACH when tested at pressure differential of 0.2 inches w.c.
 - Testing may occur any time after rough in and installation of building envelope penetrations
 2. Field verification/visual inspection (402.4.2.2)
 - Criteria in Table 402.4.2
- Hawaii exception
 - Unconditioned residential buildings
 - Nat. vent. free vent area > 14% of floor area
 - Interior doors can be secured open
 - Ceiling fan stub-in

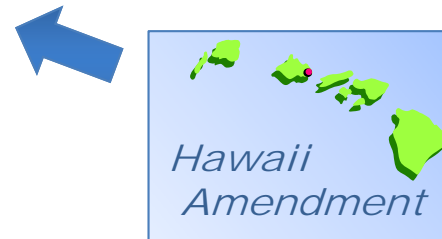


Air Leakage (Mandatory) Air Sealing and Insulation (continued)

RESIDENTIAL
Envelope

402.4.4

- Fenestration air leakage
 - Windows, skylights, sliding glass doors
 - Tested and labeled by manufacturer
 - Exception
 - Site built windows, skylights and doors
 - Jalousie windows ≤ 1.2 cfm/ft²





2009 IECC

SECTION 403 - SYSTEMS
RESIDENTIAL ENERGY EFFICIENCY

- No requirement for air conditioner or water heater equipment efficiency
 - Set by Federal standards
 - Applies to manufacturers/vendors

403.1 Controls (Mandatory)

- Thermostat

403.2 Ducts

403.3 Mechanical system piping insulation (Mandatory)

- R-3 insulation

403.4 Circulating hot water systems (Mandatory)

- R-2 insulation
- On/off switch

403.5 Mechanical ventilation (Mandatory)

- Intakes and exhausts have gravity or automatic dampers

403.6 Equipment sizing (Mandatory)

- Per International Mechanical Code (IMC)

403.7 Systems serving multiple dwelling units (Mandatory)

- Commercial requirements apply

403.9 Pools

- Insulation (Prescriptive) (403.2.1)
 - R-8 duct insulation in attic
 - R-6 duct insulation elsewhere
 - Exception for ducts within conditioned space
- Sealing (Mandatory) (403.2.2)
 - Joints and seams sealed per International Residential Code
 - **Testing required** (next slide)
- Building cavities (403.2.3)
 - Don't use them as ducts

Systems

Duct Tightness Verification

New in
2009 IECC

RESIDENTIAL
Systems

403.2

1. Post construction test

- Leakage to outdoors: ≤ 8 cfm/per 100 ft² of conditioned floor area or
- Total leakage: ≤ 12 cfm/per 100 ft² of conditioned floor area
 - At pressure differential of 0.1 in w.g. (25Pa)
- All register boots taped or otherwise sealed

2. Or rough-in test

- Total leakage ≤ 6 cfm/per 100 ft² of conditioned floor area
 - Tested at a pressure differential of 0.1 in w.g. (25Pa)
- All register boots taped or otherwise sealed
- If air handler not installed at time of test
 - Total air leakage ≤ 4 cfm/per 100 ft²



Source: www.energyconservatory.com

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

See also:

http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/duct_testing.pdf

Systems Pools (Mandatory)

New in
2009 IECC

RESIDENTIAL
Systems

403.9

- On/off switch
- Time switch
- Cover for heated pool
 - Unless 60% solar
or site recovered heat



Source: www.energycodes.gov



2009 IECC

SECTION 404 – ELECTRICAL & LIGHTING RESIDENTIAL ENERGY EFFICIENCY

Lighting Equipment (Prescriptive)

New in
2009 IECC

RESIDENTIAL
Power & Lighting

404.1

- A minimum of 50% of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps



Source: www.energycodes.gov

Definitions

New in
2009 IECC

DEFINITIONS

202.

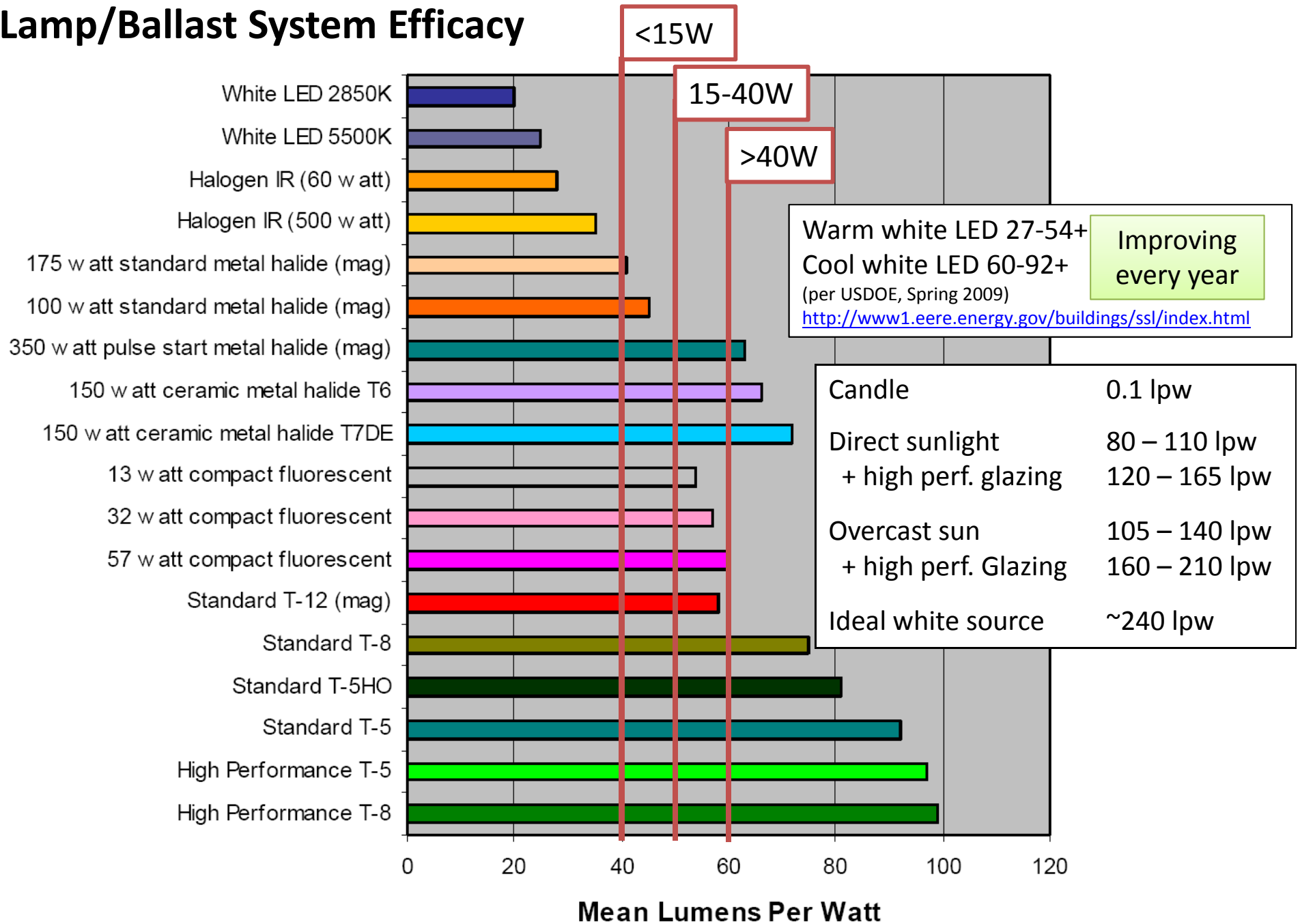
High-efficacy lamps

- “Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy based on lamp wattage”

Lamp Wattage	Efficacy
> 40 watts	60 lumens/watt
15-40 watts	50 lumens/watt
< 15 watts	40 lumens/watt



Lamp/Ballast System Efficacy





2009 IECC

**SECTION 405 – SIMULATED PERFORMANCE ALTERNATIVE
RESIDENTIAL ENERGY EFFICIENCY**

Simulated Performance Alternative

RESIDENTIAL
Performance

405.

Computer simulation method

**Proposed Design
Energy Cost**

≤

**Standard Reference Design
Energy Cost**



As designed performance



Specifications per Table 405.5.2(1)

- Mechanical = proposed
- Water heating = proposed
- Glazing limited to 15% floor area, equally distributed by orientation
- Wood frame ceiling
- Mass wall if proposed is mass, otherwise wood-framed
- Etc...

- No credit provided for efficient AC or water heating
- Potential savings for tight ducts

New in
2009 IECC

REScheck-Web - Google Chrome
https://energycode.pnl.gov/REScheckWeb/index.html

REScheck-Web™ Training House
2009 IECC

[Register](#) | [Forgotten Password?](#)

PROJECT ENVELOPE MECHANICAL

Code/Location
Code: 2009 IECC [What's my code?](#)
State: Hawaii
City: Hilo
County: Hawaii
If your city or county is not included here, choose a nearby location with similar weather conditions.

Project Type
 New Construction
 Addition/Alteration

Compliance Method
 UA Trade-Off
 Performance Alternative

Building Characteristics
 1- and 2-Family, Detached
 Multifamily

Conditioned Floor Area 1200 ft²
 All ducts and air handlers are located within conditioned spaces

Project Details (optional)
This information will appear on the compliance report.
Training House
Notes:

Passes: Compliance based on performance alternative 0.9%
Compliance Method: Equipment Performance +0.9% [Explanation of results...](#)

REScheck-Web - Google Chrome
 https://energycode.pnl.gov/REScheckWeb/index.html

REScheck-Web™ Training House
 2009 IECC

[Register](#) | [Forgotten Password?](#)

PROJECT ENVELOPE MECHANICAL

Row: Orientation - Front Faces: South

Add:

	Component	Assembly	Gross Area or Slab Perimeter	Orientation	Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor	SHGC	De Ins
1	Ceiling	Cathedral	1200 ft ²		30.0	0.0	0.034		
2	Wall	Wood Frame, 16in. o.c.	400 ft ²	Front	13.0	0.0	0.082		
3	Window	Metal Frame, Single Pane	200 ft ²	Front			1.200	0.30	
4	Wall	Wood Frame, 16in. o.c.	400 ft ²	Right Side	13.0	0.0	0.082		
5	Wall	Wood Frame, 16in. o.c.	400 ft ²	Back	13.0	0.0	0.082		
6	Wall	Wood Frame, 16in. o.c.	400 ft ²	Left Side	13.0	0.0	0.082		
7	Floor	Unheated Slab-On-Grade	200 ft			0.0	1.042		

Passes: Compliance based on performance alternative 0.9%

Compliance Method: Equipment Performance +0.9%

Residential Compliance Checklists

- Design checklist
- Plan review checklist

IECC 2009 with Hawaii Amendments				
RESIDENTIAL DESIGN CHECKLIST				
Project: _____				
Code Section	Description	Documentation Requirement	NA	Complete
103.1	Construction documents	Signed statement on plans	<input type="checkbox"/>	<input type="checkbox"/>
402.1	Wood-frame ceiling insulation <input type="checkbox"/> Table 402.1.1 insulation R-value <input type="checkbox"/> Table 402.1.3 U-factor <input type="checkbox"/> 402.1.4 alternatives <input type="checkbox"/> 402.1.4 Total UA alternative	Insulation location and R-value indicated on plans. Radiant barrier location, if applicable. Cool roof specifications if applicable.	<input type="checkbox"/>	<input type="checkbox"/>
402.1	Steel-frame roof insulation <input type="checkbox"/> Table 402.1.1 insulation R-value <input type="checkbox"/> Table 402.1.3 U-factor <input type="checkbox"/> 402.2.5 exception <input type="checkbox"/> 402.1.4 Total UA alternative		<input type="checkbox"/>	<input type="checkbox"/>
402.1	Wood-frame wall insulation <input type="checkbox"/> Table 402.1.1 insulation R-value <input type="checkbox"/> Table 402.1.3 U-factor <input type="checkbox"/> Table 402.1.1 exceptions <input type="checkbox"/> 402.1.4 Total UA alternative		<input type="checkbox"/>	<input type="checkbox"/>
402.1	Steel-frame wall insulation <input type="checkbox"/> Table 402.1.1 insulation R-value <input type="checkbox"/> Table 402.1.3 U-factor <input type="checkbox"/> 402.2.5 exceptions <input type="checkbox"/> 402.1.4 Total UA alternative		<input type="checkbox"/>	<input type="checkbox"/>
402.1	Mass wall insulation <input type="checkbox"/> Table 402.1.1 insulation R-value <input type="checkbox"/> Table 402.1.3 U-factor <input type="checkbox"/> Table 402.1.1 exceptions <input type="checkbox"/> 402.1.4 Total UA alternative		<input type="checkbox"/>	<input type="checkbox"/>
402.3	Windows Table 402.1.1 SHGC ≤ 0.30 <input type="checkbox"/> 15 ft ² area exemption <input type="checkbox"/> Area-weighted average <input type="checkbox"/> North-facing window exemption <input type="checkbox"/> Shaded window exemption		SHGC indicated on plans	<input type="checkbox"/>
402.3	Skylights Table 402.1.1 SHGC ≤ 0.30 <input type="checkbox"/> 15 ft ² area exemption <input type="checkbox"/> Area-weighted average Table 402.1.3 U-factor ≤ 0.75 <input type="checkbox"/> 15 ft ² area exemption <input type="checkbox"/> Overall envelope compliance	SHGC and U-factor indicated on plans.	<input type="checkbox"/>	<input type="checkbox"/>
402.4	Air leakage <input type="checkbox"/> Envelope sealing <input type="checkbox"/> Unconditioned dwelling exemption	Sealing requirements indicated on plans, if applicable.	<input type="checkbox"/>	<input type="checkbox"/>



2009 IECC

CHAPTER 5

COMMERCIAL ENERGY EFFICIENCY

Scope

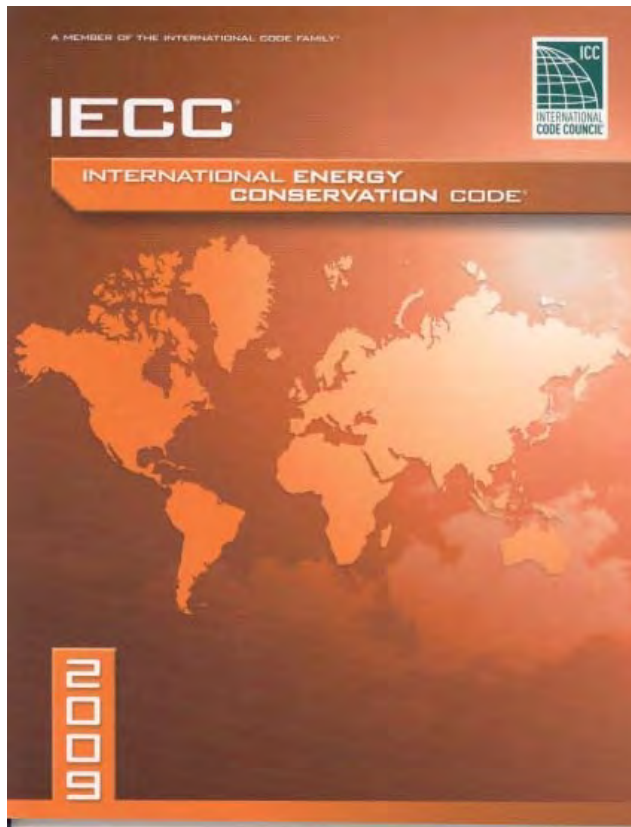
COMMERCIAL
General

501.1

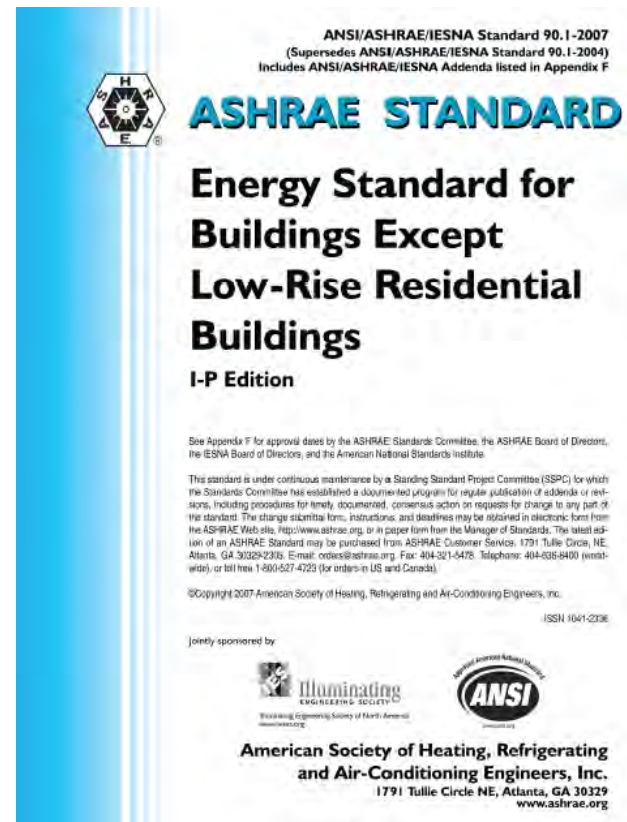
One or the other

2009 IECC

ASHRAE Standard 90.1



or

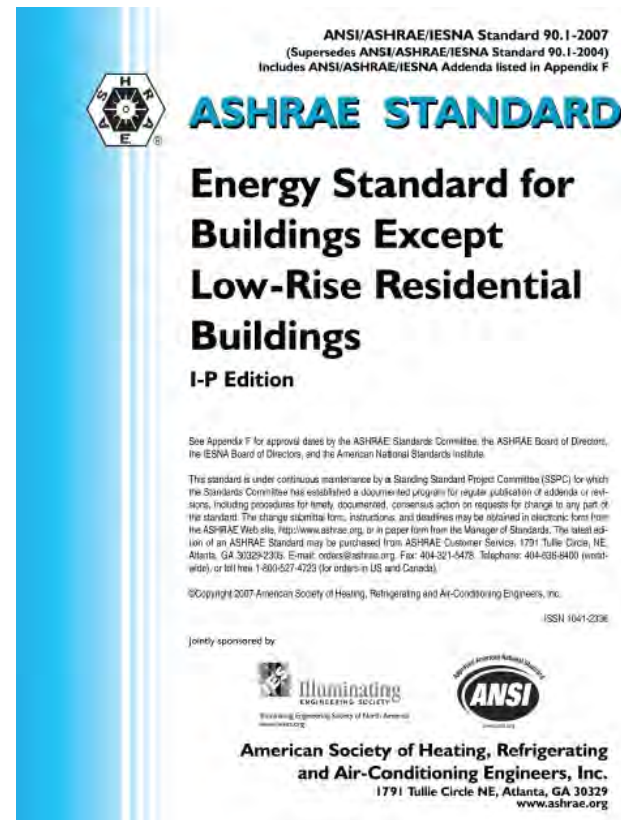


Scope (continued)

COMMERCIAL
General

501.1

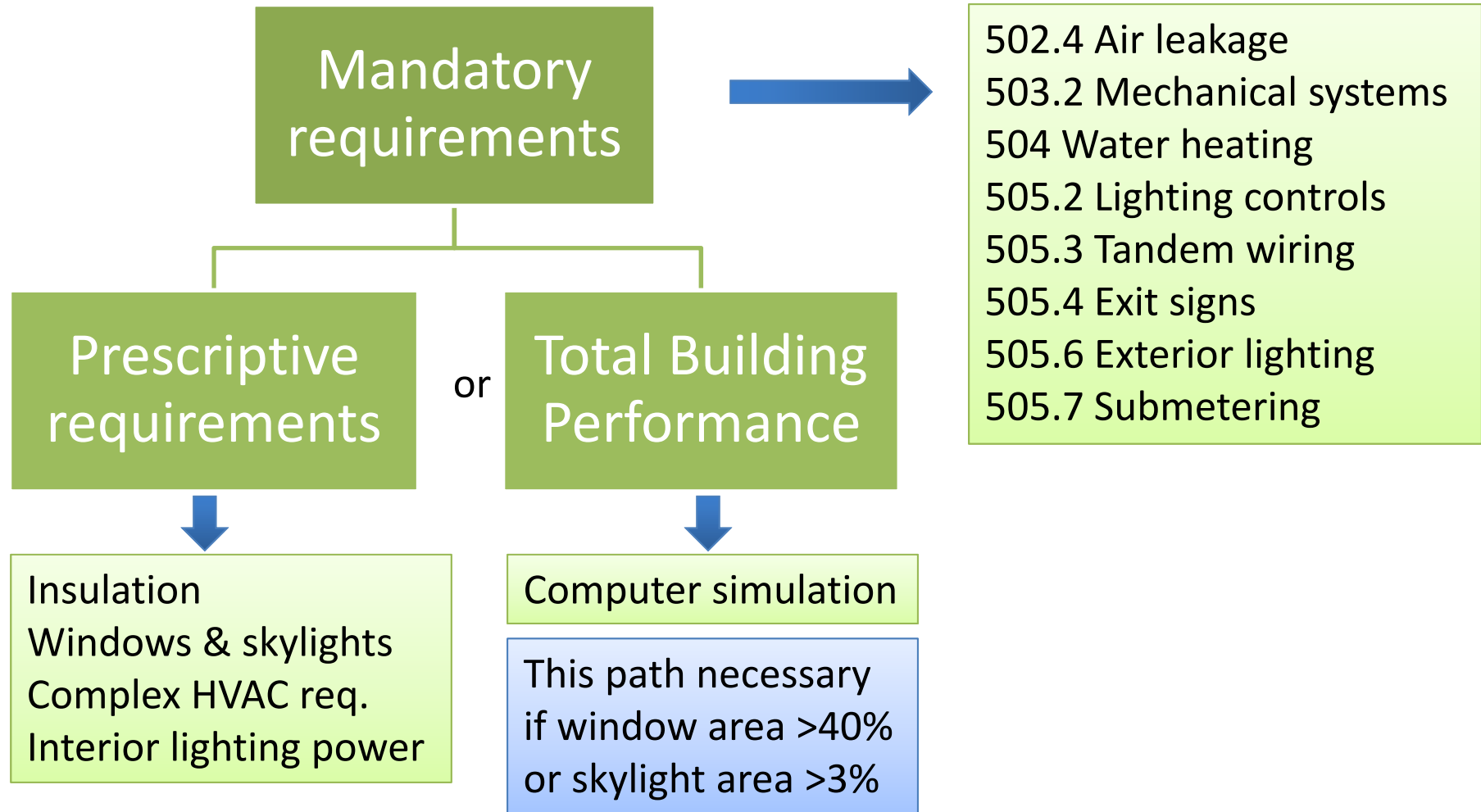
- ASHRAE Standard 90.1
 - 2007 version
 - “Energy Standard for Buildings Except Low-Rise Residential Buildings”
 - Baseline for LEED 2009
 - User’s Manual available
 - www.ashrae.org



Application

COMMERCIAL
General

501.2





2009 IECC

SECTION 502

BUILDING ENVELOPE REQUIREMENTS

General (Prescriptive) Roof and Wall Insulation

COMMERCIAL
Envelope

502.1

New in
2009 IECC

	Type	Min. Insulation		Max. U-factor	
		Group R	Other	Group R	Other
Roof	Insulation entirely above deck	R-20ci	R-15ci	U-0.048	U-0.063
	Metal building	R-19 +R-5 block	R-19 +R-5 block	U-0.065	U-0.065
	Attic and other	R-38	R-30	U-0.027	U-0.034
Walls	Mass	R-5.7ci	None	U-0.151	U-0.58
	Metal building	R-16	R-16	U-0.093	U-0.093
	Metal framed	R-13	R-13	U-0.124	U-0.124
	Wood framed and other	R-13	R-13	U-0.089	U-0.089

- No requirement:
- Below grade wall
 - Floors
 - Slab-on-grade floors

Table 502.2(1) Table 502.1.2

U-factor units, Btu/hr-ft²-°F

Roof Insulation Entirely Above Deck

COMMERCIAL
Envelope

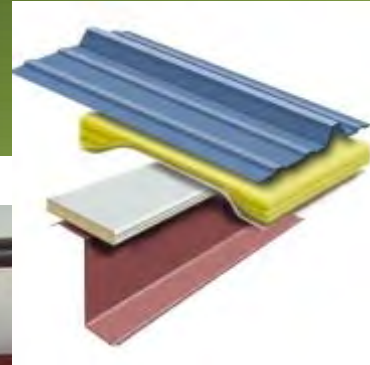
R-20 for group R buildings
R-15 for other buildings



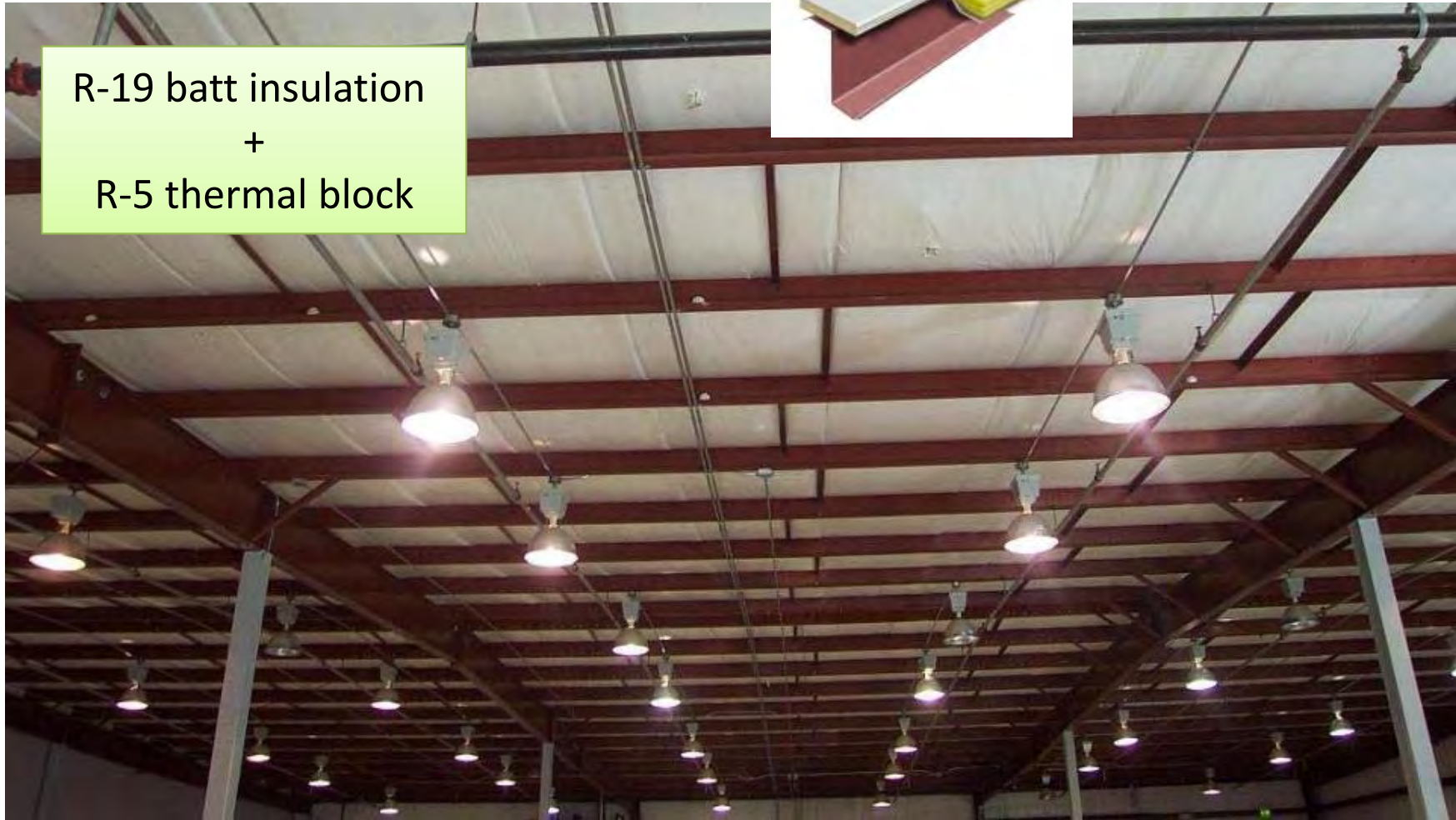
Photos courtesy of PIMA (Polyisocyanurate Insulation Manufacturers Association), via www.energycodes.gov

Roof Insulation Metal Building

COMMERCIAL
Envelope



R-19 batt insulation
+
R-5 thermal block



Source: www.energycodes.gov

Roof Insulation Below Deck “Attic and Other”

COMMERCIAL
Envelope



R-38 for group R buildings
R-30 for other buildings



Insulation Materials

COMMERCIAL
Envelope

- Batt insulation
 - Fiberglass, cellulose, cotton (R-3 to R-4 per inch typical)
- Loose fill insulation
 - Fiberglass, cellulose (R-3 to R-4 per inch typical)
- Foam board
 - Polyisocyanurate (R-6/inch typical)
 - Extruded polystyrene (R-5/inch typical)
 - Expanded polystyrene (R-4/inch typical)
- Spray foam
 - Polyurethane (R-6/inch)
 - “Icynene” (R-3.6/inch typical)
 - Soy based (R-3.6/inch typical)
- Straw (R-2.4 to 3.0 per inch typical)
- Gas-filled panels (up to R-20/inch)
- Aerogel (up to R-20/inch)



Roof Assembly Exceptions

COMMERCIAL
Envelope

502.2.1

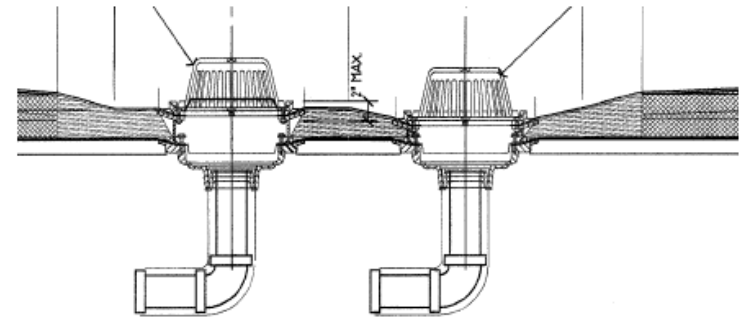
For elevation < 2400 ft

1. Tapered insulation above deck

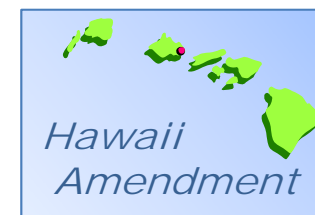
- Area-weighted U-factor allowed
- If thickness varies < 1inch

2. Cool roof

- No insulation required
- Initial reflectance ≥ 0.70
- Extended reflectance ≥ 0.55
- Rated per Cool Roof Rating Council



Source: www.energycodes.gov



Fenestration (Prescriptive)

COMMERCIAL
Envelope

502.3

- Fenestration (window and skylight) requirements
 1. Maximum area
 2. Maximum U-factor
 3. Maximum solar heat gain coefficient (SHGC)



Fenestration (Prescriptive) Maximum Area

COMMERCIAL
Envelope

502.3.1

- Window area
 - Maximum 40% of gross wall area
- Skylight area
 - Maximum 3% of gross roof area



Otherwise, use
Total Building Performance
compliance option



Fenestration (Prescriptive) Maximum U-factor

COMMERCIAL
Envelope

502.3.2

- Windows $\leq U-1.20$
 - Any window can comply, e.g. single-pane, metal frame
- Skylights $\leq U-0.75$
 - Examples:
 - Double-pane with thermal-break metal frame
 - Double-pane low-e with metal frame
 - Tubular skylight

New in
2009 IECC

TABLE 303.1.3(1)
DEFAULT GLAZED FENESTRATION U-FACTOR

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

Fenestration (Prescriptive) Projection Factor Definition

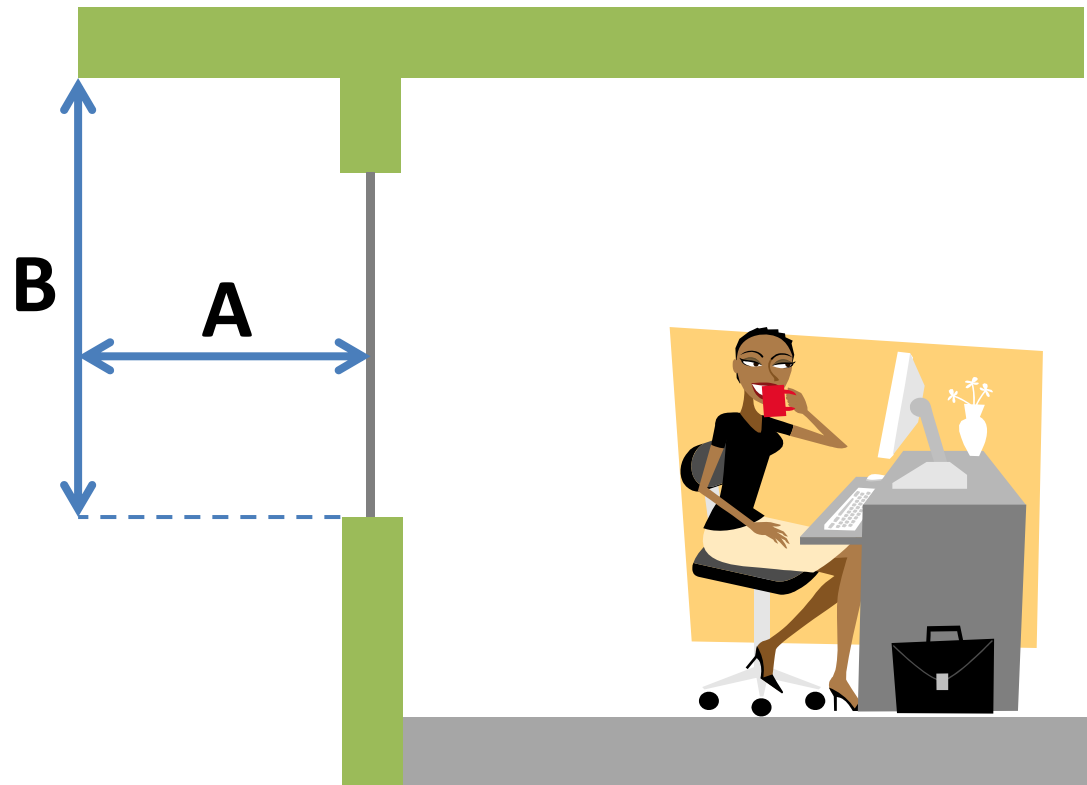
COMMERCIAL
Envelope

502.3.2



**Projection
Factor**

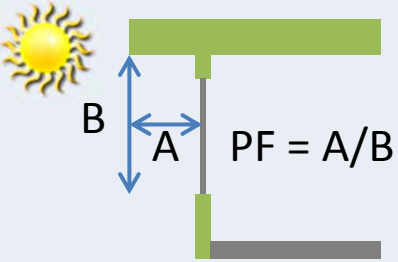
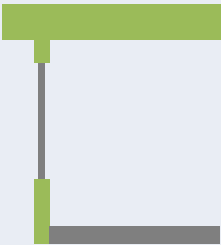
$$PF = \frac{A}{B}$$



Fenestration (Prescriptive) Maximum SHGC

COMMERCIAL
Envelope

502.3.2

Projection Factor			
			
	< 0.25	$0.25 \leq PF < 0.50$	≥ 0.5
Maximum SHGC	0.25	0.33	0.40

Skylight max. SHGC is 0.35

Otherwise, use area-weighted average or Total Building Performance option

TABLE 303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC

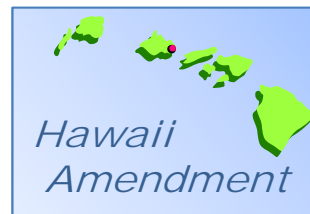
SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	Tinted	Clear	Tinted	
0.8	0.7	0.7	0.6	0.6

Fenestration (Prescriptive) Area-weighted average

COMMERCIAL
Envelope

502.3.3

- Area-weighted SHGC allowed for commercial fenestration compliance
 - Some windows can exceed limit if average complies
 - Section added as Hawaii amendment





2009 IECC

SECTION 503
BUILDING MECHANICAL SYSTEMS

General

COMMERCIAL
Mechanical

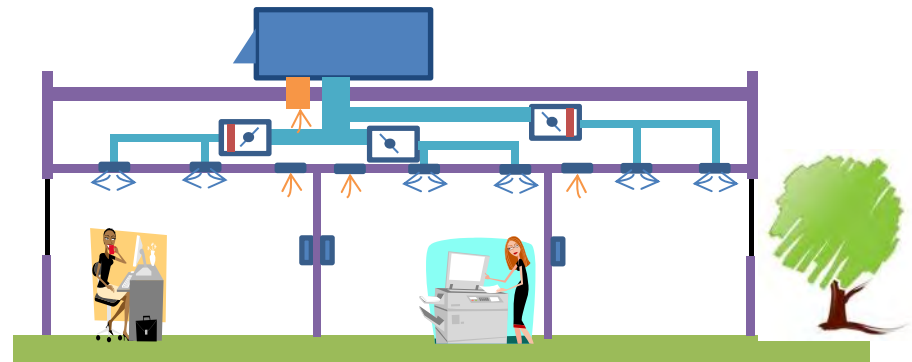
503.1

Mandatory
requirements
(503.2)

Simple system
requirements
(503.3)

Complex system
requirements
(503.4)

Single-zone
unitary/package
systems ←



Mandatory Requirements

COMMERCIAL
Mechanical

503.2

- 503.2.1 Calculation of heating and cooling loads
- 503.2.2 Equipment and system sizing
- 503.2.3 HVAC equipment performance requirements
- 503.2.4 HVAC system controls
- 503.2.5 Ventilation
- 503.2.6 Energy recovery ventilation systems
- 503.2.7 Duct and plenum insulation and sealing
- 503.2.8 Piping insulation
- 503.2.9 Mechanical system commissioning
- 503.2.10 Air system design and control

Mandatory Requirements

HVAC equipment performance requirements

COMMERCIAL
Mechanical

503.2.3

- Minimum efficiency tables for:
 - Unitary air conditioners (SEER, EER, IPLV)
 - Packaged terminal air conditioners (EER)
 - Furnaces (AFUE, E_c , E_t)
 - Boilers (AFUE, E_c , E_t)
 - Condensing units (EER, IPLV)
 - Chillers (EER, kW/ton)
 - Cooling towers (gpm/hp)
- Equal to Standard 90.1-2007



Mandatory Requirements

HVAC equipment performance requirements

COMMERCIAL
Mechanical

503.2.3

Comparison of 2006 to 2009



Cooling Capacity (kBtu/hr)	2006 IECC	2009 IECC
< 65 (packaged)	10.0 SEER	13.0 SEER
< 65 (split)	9.7 SEER	13.0 SEER
65 – 135	10.3 EER	11.2 EER
135 – 240	9.7 EER	11.0 EER
240 – 760	9.5 EER	10.0 EER
> 760	9.2 EER	9.7 EER

Mandatory Requirements Ventilation

COMMERCIAL
Mechanical

503.2.5

- Outdoor air per International Mechanical Code
 - Natural or mechanical
- Demand controlled ventilation (503.2.5.1)
 - If space > 500 ft²
 - And > 40 people / 1000 ft²
 - And system outdoor air > 3,000 cfm

New in
2009 IECC

Theater, auditorium, ballroom, etc.

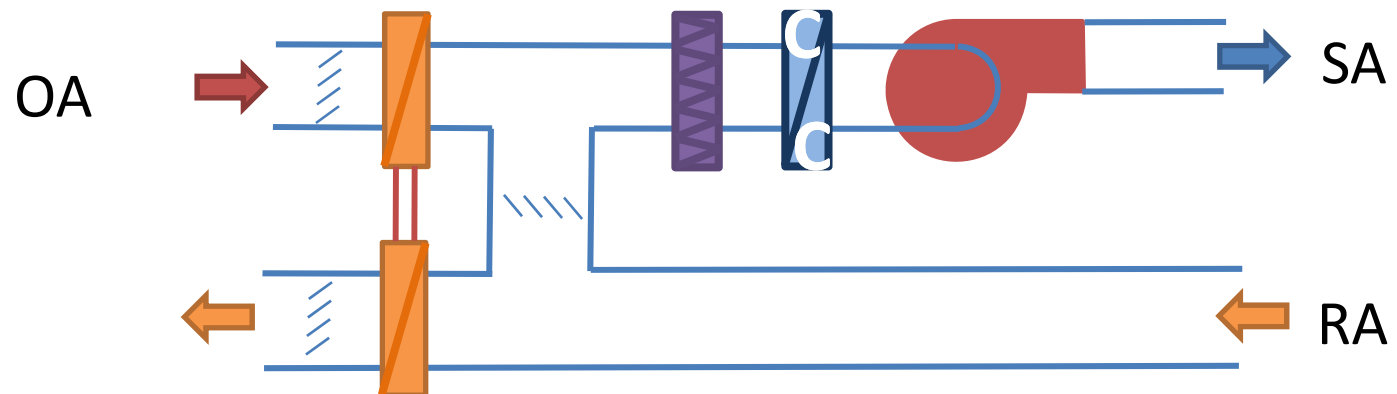
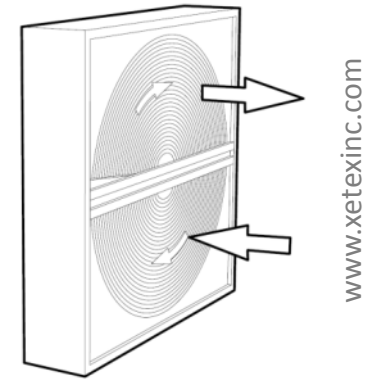


Mandatory Requirements Energy Recovery Ventilation

COMMERCIAL
Mechanical

503.2.6

- Energy recovery required if:
 - Supply air $\geq 5,000$ cfm
 - Outdoor air fraction $\geq 70\%$
- Some exceptions apply
 - Such as lab with VAV



Mandatory Requirements

Duct and Plenum Insulation & Sealing

COMMERCIAL
Mechanical

503.2.7

- Insulate supply ducts, return ducts, and plenums:
 - R-5 in unconditioned spaces
 - R-8 outside
- Duct construction requirements (503.2.7.1)



Source: www.energycodes.gov

Mandatory Requirements Piping Insulation

COMMERCIAL
Mechanical

503.2.8

TABLE 503.2.8
MINIMUM PIPE INSULATION
(thickness in inches)

FLUID	NOMINAL PIPE DIAMETER	
	≤ 1.5"	> 1.5"
Steam	1½	3
Hot water	1½	2
Chilled water, brine or refrigerant	1½	1½

Some
exceptions
apply

For SI: 1 inch = 25.4 mm.

- Based on insulation having a conductivity (k) not exceeding 0.27 Btu per inch/h · ft² · °F.
- For insulation with a thermal conductivity not equal to 0.27 Btu · inch/h · ft² · °F at a mean temperature of 75°F, the minimum required pipe thickness is adjusted using the following equation:

$$T = r[(1 + t/r)^{K/k} - 1]$$

where:

T = Adjusted insulation thickness (in).

r = Actual pipe radius (in).

t = Insulation thickness from applicable cell in table (in).

K = New thermal conductivity at 75°F (Btu · in/hr · ft² · °F).

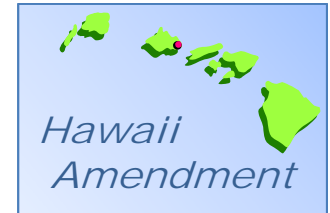
k = 0.27 Btu · in/hr · ft² · °F.

Mandatory Requirements Commissioning & Completion

COMMERCIAL
Mechanical

503.2.9

“Prior to the issuance of a certificate of occupancy, the design professional shall provide a written statement of system completion in accordance with Sections 503.2.9.1 through 503.2.9.3.”



- System commissioning (503.2.9.1)
- Commissioning plan (503.2.9.2)
- Systems adjusting and balancing (503.2.9.3)
 - Air balancing
 - Hydronic balancing

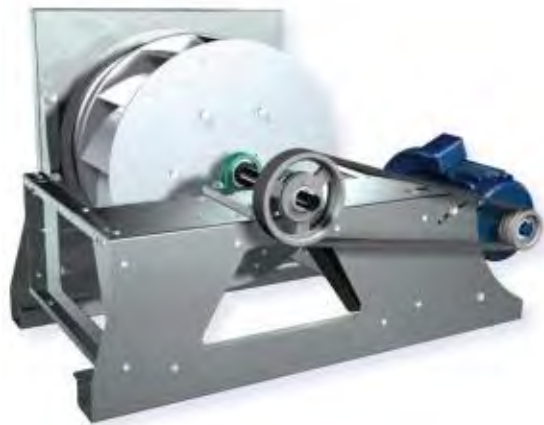
Mandatory Requirements Air System Design & Control

New in
2009 IECC

COMMERCIAL
Mechanical

503.2.10

- Allowable fan horsepower (503.2.10.1)
 - If total system fan power > 5 hp
 - Sets maximum allowed fan horsepower
 - Requires that fan brake horsepower be listed on plans
 - Requires that fan motor be no larger than first available size greater than the brake horsepower



Simple HVAC Systems (Prescriptive)

COMMERCIAL
Mechanical

503.3

- Mandatory requirements apply
 - Just covered them
- That's it!
 - Economizers not required in Hawaii climate (503.3.1)



Complex HVAC Systems (Prescriptive)

COMMERCIAL
Mechanical

503.4

- ~~503.4.1 Economizers~~
- 503.4.2 VAV fan control
- 503.4.3 Hydronic system controls
- 503.4.4 Heat rejection equipment fan speed control
- 503.4.5 Systems serving multiple zones
- 503.4.6 Heat recovery for service water heating
- 503.4.7 Hot gas bypass limitation

Will not be covering these today



2009 IECC

SECTION 504

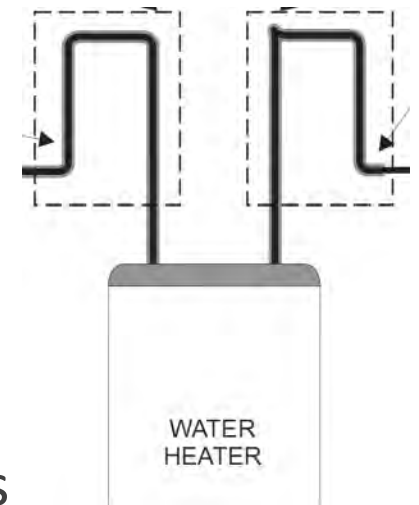
SERVICE WATER HEATING

Service Water Heating

COMMERCIAL
Water Heating

504.

- 504.2 Equipment performance efficiency
- 504.3 Temperature controls
- 504.4 Heat traps
- 504.5 Pipe insulation
 - 1 inch for recirculating systems
 - ½ inch on first 8 ft in non-recirculating systems
- 504.6 Hot water system controls
 - Auto or manual control of circulation pump or heat trace



Service Water Heating Pools

COMMERCIAL
Water Heating

504.7

- On/off switch
- Time switch
- Cover for heated pool
 - Unless 60% solar or site recovered



Source: www.energycodes.gov



2009 IECC

SECTION 505

ELECTRICAL POWER & LIGHTING SYSTEMS

Electrical Power and Lighting Systems

COMMERCIAL
Power & Lighting

505.

- 505.1 General (Mandatory)
- 505.2 Lighting controls (Mandatory)
- 505.3 Tandem wiring (Mandatory)
- 505.4 Exit signs (Mandatory)
- 505.5 Interior lighting power requirements (Prescriptive)
- 505.6 Exterior lighting power (Mandatory)
- 505.7 Electrical energy consumption (Mandatory)

Electrical Power and Lighting Systems

COMMERCIAL
Power & Lighting

505.

- Requirements apply:
 - New lighting system
 - Renovation of existing lighting system
 - Change in occupancy that increases energy (101.4.4)
- Exceptions:
 - Historic buildings (101.4.2)
 - Lighting in dwelling units
 - If $\geq 50\%$ of fixtures are high efficacy (505.1)
 - Renovations that replace fewer than 50% of fixtures (101.4.3)
 - Renovations that replace only bulb/ballast (101.4.3)

New in
2009 IECC

Definitions

DEFINITIONS

202.

High-efficacy lamps

- “Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy based on lamp wattage”

Lamp Wattage	Efficacy
> 40 watts	60 lumens/watt
15-40 watts	50 lumens/watt
< 15 watts	40 lumens/watt



Lighting Controls (Mandatory)

Interior Lighting Controls

COMMERCIAL
Power & Lighting

505.2.1

- Manual control for each space
 - Exceptions:
 - Security or emergency areas
 - Egress stairways or corridors



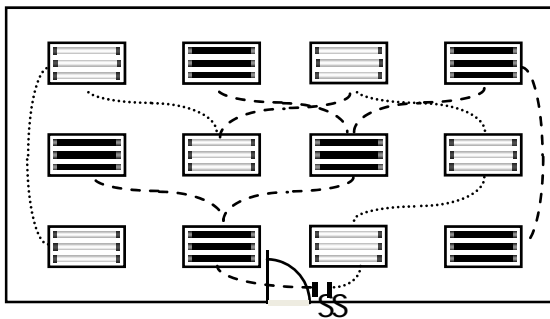
Lighting Controls (Mandatory) Light Reduction Controls

COMMERCIAL
Power & Lighting

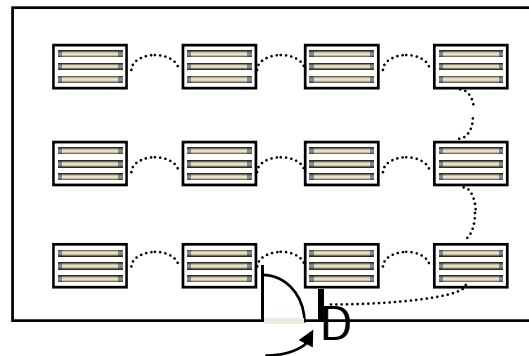
505.2.2.1

- Allow occupants to reduce lighting
 - By at least 50%
 - In a reasonably uniform illumination pattern

Alternating Luminaires

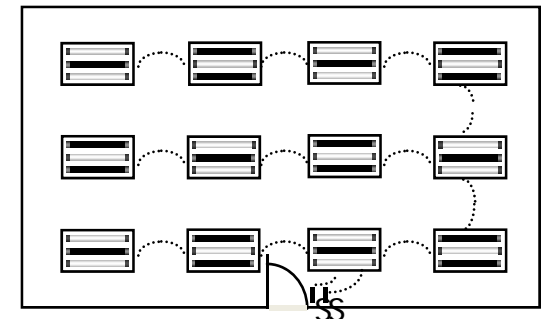


Dimming All Fixtures



Dimmer Switch

Alternating Lamps



Source: www.energycodes.gov

Lighting Controls (Mandatory)

Light Reduction Controls (continued)

COMMERCIAL
Power & Lighting

505.2.2.1

- Exceptions:
 - Areas with only one luminaire
 - Areas controlled by occupancy sensor
 - Corridors, storerooms, restrooms or public lobbies
 - Sleeping units
 - Spaces with <0.6 w/ft²



Source: www.energycodes.gov

Lighting Controls (Mandatory) Automatic Lighting Shutoff

COMMERCIAL
Power & Lighting

505.2.2.2

- Automatic shutoff in buildings $>5,000$ ft²
 - Time-of-day schedule
 - Occupant sensor
- Exceptions
 - Sleeping unit
 - Patient care spaces
 - Occupant safety
- Occupant override (505.2.2.2.1)
- Holiday scheduling (505.2.2.2.2)



Lighting Controls (Mandatory) Daylight Zone Control

New in
2009 IECC

COMMERCIAL
Power & Lighting

505.2.2.3

- Separate controls for lighting in daylight zones
 - Exception: spaces with 2 or fewer fixtures

Adjacent to vertical fenestration



Under skylights



See definition of “DAYLIGHT ZONE” in Section 202

Lighting Controls (Mandatory)

Sleeping Unit Controls

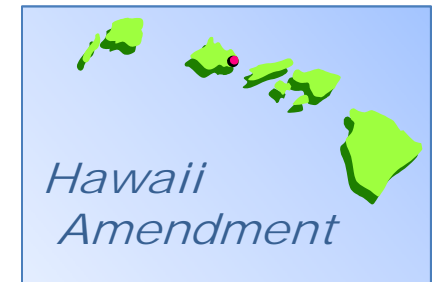
COMMERCIAL
Power & Lighting

505.2.3

Sleeping units in Group R-1 occupancies shall be equipped with a method of adjusting thermostat set points and turning off all permanently installed light fixtures and all outlets powering portable light fixtures and entertainment devices when the unit is unoccupied.

Exception: Bathroom night lights, not exceeding 3 watts

...



Lighting Controls (Mandatory) Sleeping Unit Controls (continued)

COMMERCIAL
Power & Lighting

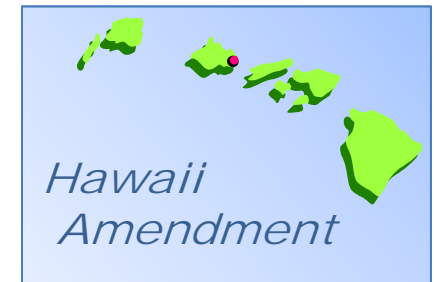
505.2.3

...

Each sleeping unit in Group R-1 occupancies shall be equipped with one or more of the following devices or systems:

1. A master switch at the main entry door activated by a room card that must be inserted upon entry,
2. A sensor capable of detecting when the room is occupied, or
3. An electronic control system capable of detecting when the room is occupied.

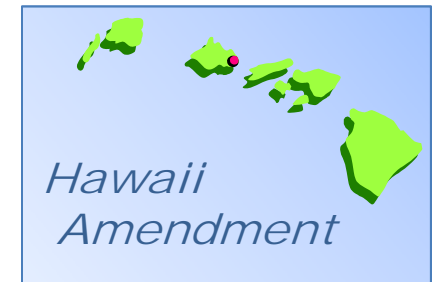
...



Lighting Controls (Mandatory) Sleeping Unit Controls (continued)

COMMERCIAL
Power & Lighting

505.2.3



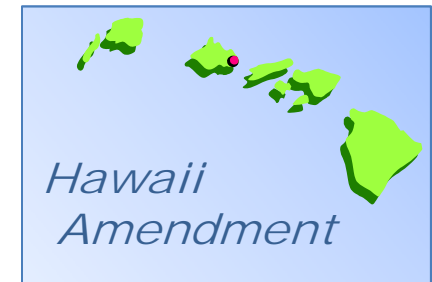
Lighting Controls (Mandatory) Sleeping Unit Controls (continued)

COMMERCIAL
Power & Lighting

505.2.3

...

Operable doors leading from a conditioned space to a balcony or patio in sleeping units of Group R-1 occupancies shall be provided with interlock controls to disable heating and cooling of the space while the door is open.



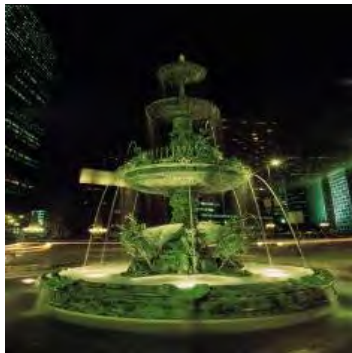
Lighting Controls (Mandatory)

Exterior Lighting Controls

COMMERCIAL
Power & Lighting

505.2.4

- For dusk-to-dawn lighting:
 - Astronomical time switch or photosensor
- For all other:
 - Astronomical time switch OR photosensor + time switch
- Time switches must have 10 hour battery backup



Source: www.energycodes.gov

Interior Lighting Power Requirements (Prescriptive)

COMMERCIAL
Power & Lighting

505.5

**Connected
Lighting Power
(505.5.1)**



- Exceptions (505.5.1)
- Screw lamp holders (505.5.1.1)
- Low-voltage lighting (505.5.1.2)
- Other luminaires (505.5.1.3)
- Line-voltage track and plug-in busway (505.5.1.4)

≤

**Interior Lighting Power
Allowance
(505.5.2)**



- W/ft² allowance (Table 505.5.2)
- Additional retail allowance (footnote to Table 505.5.2)

Interior Lighting Power Requirements Exceptions

COMMERCIAL
Power & Lighting

505.5.1

- Connected power for following not included in calculations:
 - Professional sports arena playing field
 - Sleeping unit lighting
 - Emergency lighting automatically off during normal building operation
 - Lighting in spaces specifically designed for use by occupants with special lighting needs including visual impairment and other medical and age related issues
 - Lighting in interior spaces specifically designated as a registered interior historic landmark
 - Casino gaming areas
- Lighting equipment used for the following exempt if in addition to general lighting and controlled by an independent control device
 - Task lighting for medical and dental procedures
 - Display lighting for exhibits in galleries, museums and monuments
- Theatrical, stage, film, and video production
- Used for photographic processes
- Integral to equipment or instrumentation installed by manufacturer
- Plant growth or maintenance
- Advertising or directional signage
- Food warming and food prep equipment (in restaurant buildings and areas)
- Lighting equipment that is for sale
- Lighting demonstration equipment in lighting education facilities
- Approved because of safety or emergency considerations, exclusive of exit lights
- Integral to both open and glass-enclosed refrigerator and freezer cases
- In retail display windows when the display is enclosed by ceiling-height partitions
- Furniture-mounted supplemental task lighting controlled by automatic shutoff

New in
2009 IECC

Interior Lighting Power Requirements Allowance – Table 505.5.2

COMMERCIAL
Power & Lighting

505.5.2

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare—clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ^b	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For buildings with more than one area type, sum allowances for overall building power allowance

Interior Lighting Power Requirements Additional Retail Allowance

COMMERCIAL
Power & Lighting

New in
2009 IECC

505.5.2

Footnote to Table 505.5.2



Use-it-or-lose-it allowance

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

Calculate the additional lighting power as follows:

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

where:

- Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.
- Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.
- Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.
- Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

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

Exterior Lighting (Mandatory)

COMMERCIAL
Power & Lighting

505.6

- Covered when power is supplied through building service
- Two requirements:
 1. Efficient sources (505.6.1)
 2. Maximum lighting power (505.6.2)
- Exceptions:
 - Low-voltage landscape lighting
 - “Where approved because of historical, safety, signage or emergency considerations”



Source: www.energycodes.gov

Exterior Lighting (Mandatory) Exterior Building Grounds Lighting

COMMERCIAL
Power & Lighting

505.6.1

- Efficient lighting sources
 - If luminaire power > 100 watts
 - Then efficacy \geq 60 lumens/watt
- Exceptions:
 - Motion sensor control
 - Other exempt lighting (per 505.6.2)



Source: www.energycodes.gov

Typical options:

Full-size fluorescent
Pulse-start metal halide
Ceramic metal halide
High pressure sodium
Low-pressure sodium

Exterior Lighting (Mandatory)

Exterior Building Lighting Power

COMMERCIAL
Power & Lighting

505.6.2

1. Base site allowance
2. Tradable surfaces
 - Sum allowance for all surfaces
3. Nontradable surfaces
 - Each surface comply separately



Some exceptions

- Such as signage, athletic fields, monuments, etc.

Exterior Lighting (Mandatory)

Exterior Building Lighting Power

COMMERCIAL
Power & Lighting

505.6.2

Exterior lighting zones

TABLE 505.6.2(1)
EXTERIOR LIGHTING ZONES

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

New in
2009 IECC

Exterior Lighting (Mandatory)

Exterior Building Lighting Power

COMMERCIAL
Power & Lighting

505.6.2

1. Base site allowance

New in
2009 IECC

Exterior Lighting Zone	Base Site Allowance
Zone 1	500 W
Zone 2	600 W
Zone 3	750 W
Zone 4	1300 W

Exterior Lighting (Mandatory) Tradable Surfaces

New in
2009 IECC

COMMERCIAL
Power & Lighting

505.6.2

2. Tradable Surfaces

	Zone 1	Zone 2	Zone 3	Zone 4
Uncovered Parking Areas				
Parking areas and drives	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 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft ²	0.14 W/ft ²	0.16 W/ft ²	0.2 W/ft ²
Stairways	0.75 W/ft ²	1.0 W/ft ²	1.0 W/ft ²	1.0 W/ft ²
Pedestrian tunnels	0.15 W/ft ²	0.15 W/ft ²	0.2 W/ft ²	0.3 W/ft ²
Building Entrances and Exits				
Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
Entry canopies	0.25 W/ft ²	0.25 W/ft ²	0.4 W/ft ²	0.4 W/ft ²
Sales Canopies				
Free-standing and attached	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)	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	10 W/linear foot	10 W/linear foot	30 W/linear foot

Tradable Surfaces
(Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas may be traded.)

Exterior Lighting (Mandatory) Nontradable Surfaces

New in
2009 IECC

COMMERCIAL
Power & Lighting

505.6.2

3. Nontradable Surfaces

		Zone 1	Zone 2	Zone 3	Zone 4
<p>Nontradable Surfaces (Lighting power density 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.)</p>	Building facades	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	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	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

Electrical Energy Consumption (Mandatory)

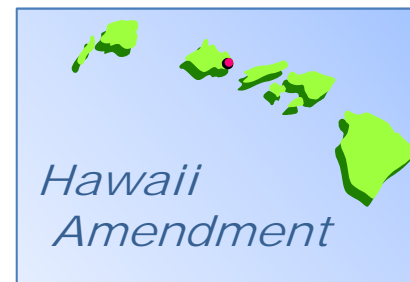
COMMERCIAL
Power & Lighting

505.7

In new buildings with tenants, metering shall be collected for the entire building and individually for each tenant occupying 1,000 square feet (93 m²) or more.

Tenants shall have access to all data collected for their space.

A tenant is defined as “one who rents or leases from a landlord”.





2009 IECC

SECTION 506
TOTAL BUILDING PERFORMANCE

Total Building Performance

COMMERCIAL
Performance

506.

- Examples of when it's appropriate:
 - Window area > 40% of wall area
 - Window SHGC doesn't meet prescriptive requirement
 - Skylight area > 3% of roof area
 - Skylight performance doesn't meet prescriptive criteria
 - Lighting power exceeds prescriptive limit
 - Opaque constructions fail to meet prescriptive requirement
- Allows tradeoffs between HVAC, water heating and lighting energy

Total Building Performance

COMMERCIAL
Performance

506.

Computer simulation method

**Proposed Design
Energy Cost**

≤

**Standard Reference Design
Energy Cost**



As designed performance



- Hourly, full-year simulation
- DOE2, eQUEST, EnergyPlus, Trace, etc.

Specifications per Section 506.5.1

- HVAC system type specified
- Glazing limited to 40% wall area
- Skylights limited to 3% roof area
- Lighting power per Table 505.5.2
- Mass wall if proposed is mass, otherwise steel-framed
- Etc...

2009 IECC

COMCHECK COMPLIANCE SOFTWARE

COMcheck Compliance Software

- Two versions

- Desktop
- Web interface



- Envelope and lighting comply separately

- Tradeoffs between not permitted

- Produces mechanical requirements checklist

- Does not implement Total Building Performance calculation

COMcheck-Web - Google Chrome
 https://energycode.pnl.gov/COMcheckWeb/index.html

COMcheck-Web™ Hawaii training - commercial
 2009 IECC

Email Address Password Log In
 Register | Forgotten Password?

New Project PROJECT ENVELOPE INT. LIGHTING EXT. LIGHTING MECHANICAL Reports

Code/Location
 Code: 2009 IECC
 State: Hawaii
 City: Hilo
 If your location is not included here, choose a nearby location with similar weather conditions.

Project Type
 New Construction Addition Alterations

Project Details (optional)
 This information will appear on the compliance report. Edit Project Details...
 Notes:

Building Use
 Add Area Type Delete

	Area Category	Area Description	
1	Office		10

Total Area: 10000

Exterior Lighting Areas
 Zone: Light industrial area with limited nighttime use

Add Exterior Area Duplicate Delete

	Exterior Lighting Area	Area Description	Quantity	W/Unit
1	Parking area	Front parking lot	5000 ft2	0.06

Envelope Passes +0.22% Interior Lighting Passes +34% Exterior Lighting Passes +40%

COMcheck-Web - Google Chrome
 https://energycode.pnl.gov/COMcheckWeb/index.html

COMcheck-Web™ Hawaii training - commercial
 2009 IECC

Email Address Password Log In
 Register | Forgotten Password?

New Project PROJECT ENVELOPE INT. LIGHTING EXT. LIGHTING MECHANICAL Reports

Row: Edit Duplicate Move Up Move Down Delete Orientation
 Add: Roof Skylight Ext. Wall Window Door Basement Floor Visible Light Transmittance

	Component	Assembly	Construction Details	Gross Area or Slab Perimeter	Cavity Insulation R-Value	Continuous Insulation R-Value	U-Factor	SHGC	Projection Factor
1	Roof	Insulation Entirely Above Deck		10000 ft ²		20.0	0.048		
2	Ext. Wall	Steel-Framed, 16in. o.c.		3000 ft ²	19.0	0.0	0.110		
3	Window	Metal Frame, Single Pane	Glazing: Tinted	1000 ft ²			1.200	0.57	0.50
4	Floor	Unheated Slab-On-Grade	undefined	400 ft		0.0			

Envelope Passes +0.22%
 Interior Lighting Passes +34%
 Exterior Lighting Passes +40%

COMcheck-Web - Google Chrome
 https://energycode.pnl.gov/COMcheckWeb/index.html

COMcheck-Web™ Hawaii training - commercial
 2009 IECC

Email Address Password Log In
 Register | Forgotten Password?

New Project PROJECT ENVELOPE INT. LIGHTING EXT. LIGHTING MECHANICAL Reports

Row: Edit Duplicate Move Up Move Down Delete
 Options: Exemptions and Allowances

Add: Linear Fluorescent Compact Fluorescent HID Incandescent Halogen Track Lighting

Component	Fixture ID	Fixture Description	Lamp Description / Wattage Per Lamp	Ballast	Lamps Per Fixture	Number of Fixtures	Fixture Wattage
1 Office (10000 ft ²)	Allowed wattage = 10000W Proposed wattage = 6600W						
2 Linear Fluorescent			48 in. T8 30W (Super ...	Electronic	2	120	55
Interior Lighting Totals:		Allowed wattage = 10000 Proposed wattage = 6600					

Envelope Passes +0.22%
 Interior Lighting Passes +34%
 Exterior Lighting Passes +40%

Interior Lighting Passes: Design 34% better than Code



Hawaii training - commercial

2009 IECC

Email Address Password Log In

Register | Forgotten Password?

Create and save a copy of the currently loaded project

New Project

PROJECT ENVELOPE INT. LIGHTING EXT. LIGHTING MECHANICAL

Reports

Row: Edit Duplicate Move Up Move Down Delete

Options: Exemptions

Add: Linear Fluorescent Compact Fluorescent HID Incandescent Halogen

	Component	Fixture ID	Fixture Description	Lamp Description / Wattage Per Lamp	Ballast	Lamps Per Fixture	Number of Fixtures	Fixture Wattage
1	Front parking lot (Parking area, 5000 ft ²)		Non-tradable Wattage: Allowed = 0W Proposed = 540W					
2	HID			Metal Halide 150W	Pulse Start	1	3	180

Tradable Wattage Totals: Allowed = 0 Proposed = 0 Supplemental Wattage: 600W

Envelope Passes +0.22%

Interior Lighting Passes +34%

Exterior Lighting Passes +40%

Exterior Lighting: Passes using supplemental allowance watts. Design 40% better than Code



2009 IECC

COMMERCIAL COMPLIANCE CHECKLIST

Commercial Compliance Checklists

- Design checklist
- Plan review checklist

IECC 2009 with Hawaii Amendments COMMERCIAL PLAN REVIEW CHECKLIST

IECC 2009 with Hawaii Amendments COMMERCIAL DESIGN CHECKLIST				
Project: _____				
Code Section	Description	Documentation Requirement	NA	Complete
GENERAL REQUIREMENTS				
103.1	Construction documents	Signed statement on plans	<input type="checkbox"/>	<input type="checkbox"/>
ENVELOPE REQUIREMENTS				
502.1	Roof – insulation entirely above deck Roof – metal building Roof – attic or other <input type="checkbox"/> Table 502.2(1) insulation R-value <input type="checkbox"/> Table 502.1.2 U-factor <input type="checkbox"/> 502.2.1 Cool roof exception	Insulation location and R-value indicated on plans. Cool roof specifications if applicable.	<input type="checkbox"/>	<input type="checkbox"/>
502.1	Wall – mass Wall – metal building Wall – metal framed Wall – wood framed and other <input type="checkbox"/> Table 502.2(1) insulation R-value <input type="checkbox"/> Table 502.1.2 U-factor	Insulation location and R-value indicated on plans.	<input type="checkbox"/>	<input type="checkbox"/>
502.3.1	Windows – maximum area <input type="checkbox"/> 40% of gross wall area		<input type="checkbox"/>	<input type="checkbox"/>
502.3.2	Windows – solar heat gain <input type="checkbox"/> SHGC ≤ 0.25 if projection factor < 0.25 <input type="checkbox"/> SHGC ≤ 0.33 if projection factor 0.25-0.50 <input type="checkbox"/> SHGC ≤ 0.40 if projection factor ≥ 0.50 <input type="checkbox"/> Area-weighted average	SHGC indicated on plans. Overhang dimensions on plans, if applicable.	<input type="checkbox"/>	<input type="checkbox"/>
502.3.1	Skylights – maximum area <input type="checkbox"/> 3% of gross roof area		<input type="checkbox"/>	<input type="checkbox"/>
502.3.2	Skylights – solar heat gain <input type="checkbox"/> SHGC ≤ 0.35 <input type="checkbox"/> Area-weighted average	SHGC indicated on plans.	<input type="checkbox"/>	<input type="checkbox"/>
502.3.2	Skylights – U-factor <input type="checkbox"/> U-factor ≤ 0.75	U-factor indicated on plans.	<input type="checkbox"/>	<input type="checkbox"/>
502.4	Air leakage <input type="checkbox"/> 502.4.1 Window and door assemblies <input type="checkbox"/> 502.4.2 Curtain wall, storefront glazing and commercial entrance doors <input type="checkbox"/> 502.4.3 Sealing of the building envelope <input type="checkbox"/> 502.4.4 Outdoor air intakes and exhaust openings <input type="checkbox"/> 502.4.6 Loading dock weatherseals <input type="checkbox"/> 502.4.8 Recessed lighting	Sealing requirements indicated on plans, if applicable.	<input type="checkbox"/>	<input type="checkbox"/>

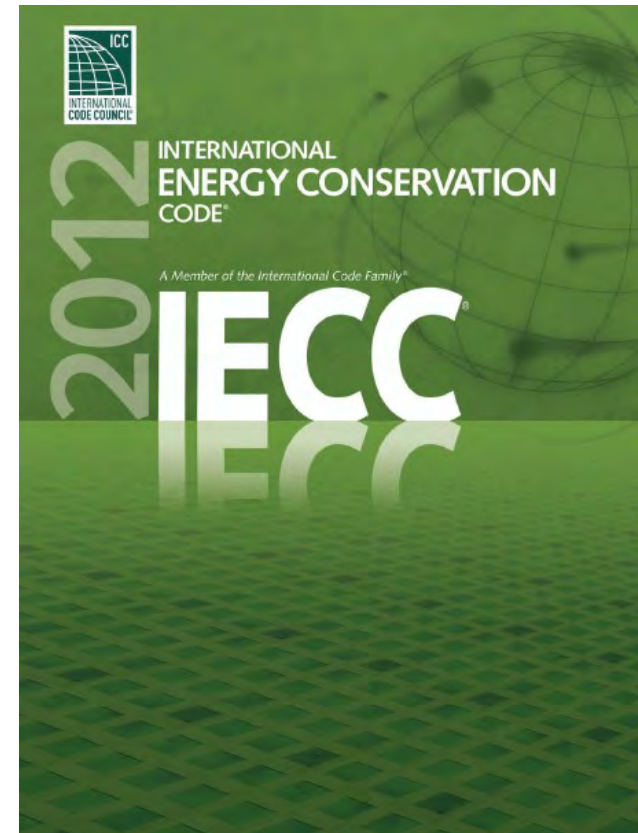


2012 IECC

2012 IECC PREVIEW

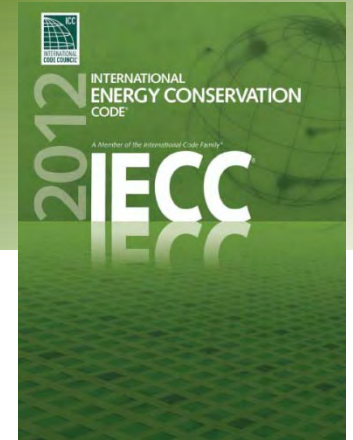
2012 IECC

Why care about the
2012 IECC?



2012 IECC

Changes vs. 2009 IECC

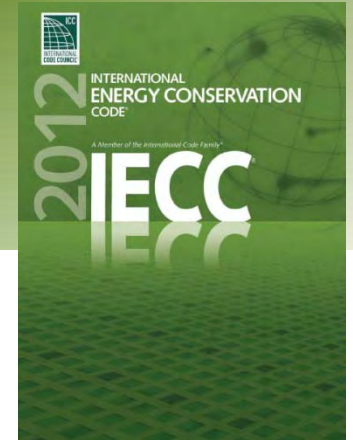


- New format
 - Residential and commercial stand alone
- Residential
 - Window U-factor more stringent
 - Double-pane low-e
 - Blower door test required
 - Mechanical ventilation required
 - Per International Residential Code
 - Fan efficiency requirement
 - 75% high efficacy lighting

2012 IECC

Changes vs. 2009 IECC (continued)

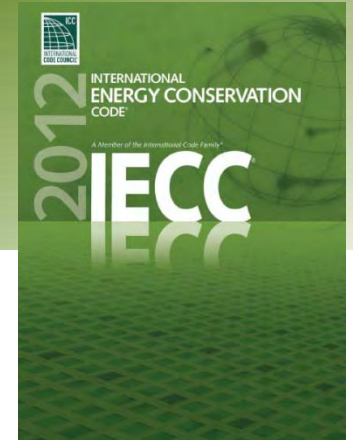
- Commercial envelope
 - Most insulation requirements more stringent
 - Roof, wall, floor
 - Cool roof required for low-slope (< 2-in-12)



2012 IECC

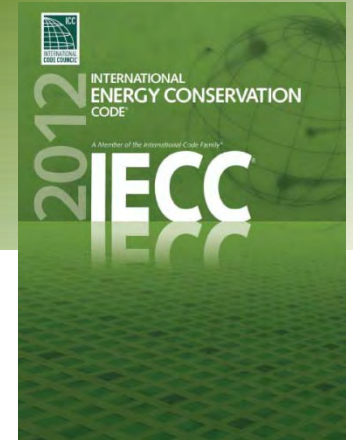
Changes vs. 2009 IECC (continued)

- Commercial windows
 - Window U-factor more stringent
 - Double-pane low-e complies
 - Window area limit 30%
 - 40% allowed if ½ floor area is daylighted



2012 IECC

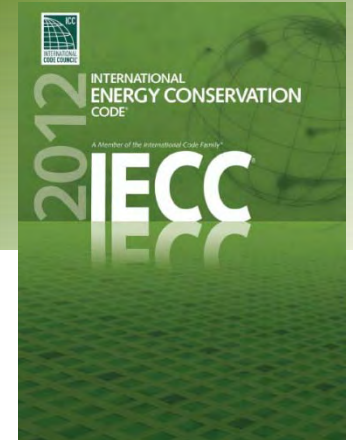
Changes vs. 2009 IECC (continued)



- Commercial skylights
 - Skylight limit increased to 5%
 - If daylighting controls installed
 - Skylights required in some large (>10,000 ft²) spaces

2012 IECC

Changes vs. 2009 IECC (continued)

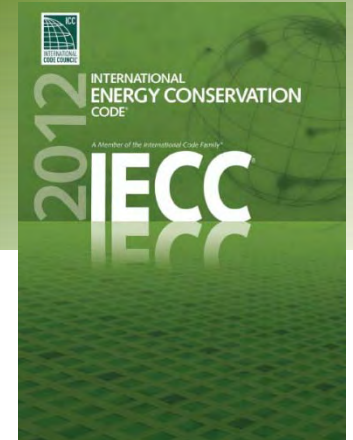


- Commercial lighting
 - Lighting occupancy sensors required
 - Classrooms
 - Conference/meeting rooms
 - Break rooms
 - Private offices
 - Restrooms
 - Storage rooms
 - Janitorial closets
 - New lighting power allowance
 - Space-by-space method added
 - New commissioning requirement

2012 IECC

Changes vs. 2009 IECC (continued)

- Commercial mechanical
 - New commissioning requirement



2012 IECC Preview of Hawaii Amendments

- Discussion



2009 IECC

WRAP UP

Resources DBEDT Webpage

- Download amendments
- County contacts
- FAQs
- Window spreadsheet
- Checklists
- Links

Hawaii.gov DBEDT Home Text Size: Smaller / Larger / Reset Stay Connected

Home About Energy Programs Resources Developer & Investor Center News & Media Search...

Hawaii Energy Building Code

In February 2012 the Hawaii State Building Code Council approved the 2009 International Energy Conservation Code (IECC) with amendments. The code sets energy efficiency requirements for both residential and nonresidential buildings. For the status of individual county code adoptions follow the links below.

Upcoming Events

[Hawaii State Energy Code Technical Seminar](#)

Instructions to Purchase the 2009 IECC

The 2009 IECC is available for purchase online from the International Code Council at www.iccsafe.org; follow links to "Store" and "2009 International Codes". The document may also be available at other online retailers.

Hawaii State Amendments

The State Building Code Council approved amendments to the 2009 IECC to add compliance flexibility and adapt the requirements to Hawaii's unique climate.

[Download the approved amendments \(January 30, 2012 version\)](#)

County Energy Codes

Energy codes are adopted and enforced at the county level. Use the following links to check current status.

Hawaii County

Webpage: www.hawaiicounty.gov/public-works-building

Contact: Jai Ho Cheng, jcheng@co.hawaii.hi.us

Honolulu County

Webpage: www1.honolulu.gov/council/ocs/roh/ (see Chapter 32)

Contact: Tim Hiu, t.hiu@honolulu.gov

Kauai County

Webpage: www.kauai.gov/default.aspx?tabid=64

Contact: Doug Haigh, dhaigh@kauai.gov

Maui County


Webpage: www.co.maui.hi.us/index.aspx?nid=1208

Contact: Ralph Nagamine, Ralph.Nagamine@co.maui.hi.us

Hawaii State Energy Office



Dept. of Business, Economic Development & Tourism
235 S. Beretania, 5th Floor
Honolulu, Hawaii 96813

Phone: (808) 587-3807
Fax: (808) 586-2536
Email: energyoffice@dbedt.hawaii.gov



Our island environment is not only the basis for our quality of life, it is also the lifeblood of our economy. We look at environmental issues with future generations in mind, and as we explore Hawaii's boundless, clean energy potential, we trust they will benefit from our stewardship.

-Governor Neil Abercrombie

<http://energy.hawaii.gov/programs/achieving-efficiency/hawaii-energy-building-code>

Resources

- From ICC (www.iccsafe.org)
 - 2009 IECC
 - 2009 IECC & commentary
 - 2009 IECC & ASHRAE Std 90.1-2007
- www.energycodes.gov/resource-center/eLearning
 - Building Energy Codes eLearning
 - Presentations, videos, other resources
 - REScheck, COMcheck
- DBEDT Resources
 - <http://energy.hawaii.gov/resources/hawaii-state-energy-office-publications>
 - Includes *Hawaii Homeowner's Guide to Energy, Comfort & Value*
- Hawaii Commercial Building Guide for Energy Efficiency
 - At: www.kolderupconsulting.com/resources

Questions?

Erik Kolderup

Kolderup Consulting

erik@kolderupconsulting.com

Howard Wiig

DBEDT

Energy Efficiency Branch

hwiig@dbedt.hawaii.gov