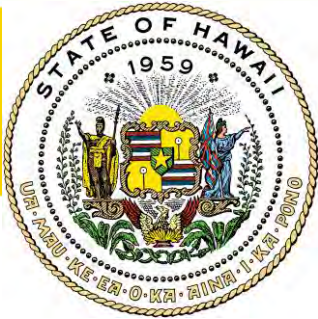


CADMUS



## 2015 IECC with Hawaii Amendments

*Howard Wiig, Hawaii State Energy Office*  
*Eric Makela, Cadmus*

Section I

# INTRODUCTION



# Structure of the 2015 IECC

## Table of Contents

### Commercial Provisions

Chapter 1 – Scope and Administration

Chapter 2 – Definitions

Chapter 3 – General Requirements

Chapter 4 – Commercial Energy Efficiency

Chapter 5 – Existing Buildings

Chapter 6 – References Standards

### Residential Provisions

Chapter 1 – Scope and Administration

Chapter 2 – Definitions

Chapter 3 – General Requirements

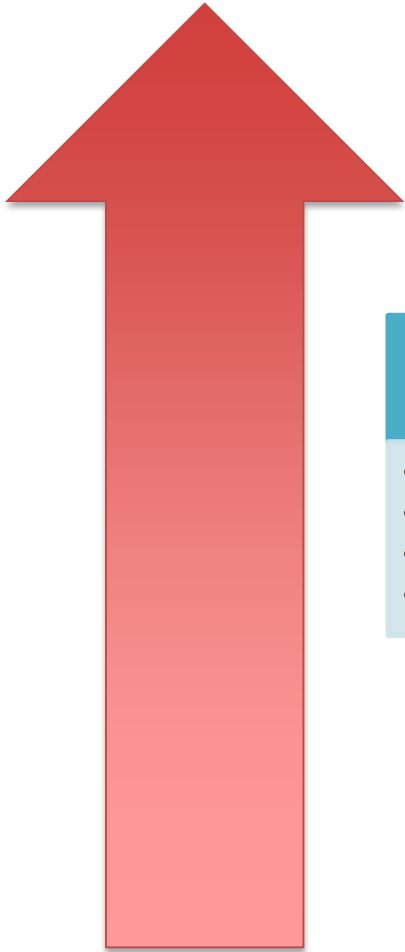
Chapter 4 – Residential Energy Efficiency

Chapter 5 – Existing Buildings

Chapter 6 – References Standards



# Energy Savings Potential



## Cumulative Residential energy savings compared to the 2006 IECC

- 2 GWh/yr in 2016
- 369 GWh/yr in 2026
- 687 GWh/yr in 2030
- 1,317 GWh/yr in 2036

## Cumulative Commercial energy savings compared to ASHRAE Standard 90.1-2004

- 158 GWh/yr in 2016
- 715 GWh/yr in 2026
- 1,304 GWh/yr in 2030
- 2,516 MWh/yr in 2036

## Cumulative Net Savings

- 160 GWh/yr in 2016
- 1,084 GWh/yr in 2026
- 1,991 GWh/yr 2030
- 3,833 GWh/yr in 2036

How Much is a Gigawatt:  
Power for approximately 200,000 homes



Section II

# RESIDENTIAL PROVISIONS: AN OVERVIEW





Section R401

# General



# Compliance Options

## Tropical Zone

### Section R401.2.1

- Residential buildings in tropical zone at elevations below 2,400ft
- Best suited for sites with large yards of dense landscaping

## Prescriptive

### Sections R401-R404

- No trade-offs permitted
- No tools needed
- Historically the preferred compliance option of designers in Hawaii

## Total UA Alternative

### Section R402.1.5

- U-factor and assembly area used to determine trade off
- Calculation performed using approved method
- U.S. DOE REScheck

## Performance

### Section R405

- Mandatory provisions must be met
- Simulated energy performance analysis for heating, cooling and SHW
- Proposed design must have annual energy cost less than or equal to energy cost of reference design

## Energy Rating Index

### Section R406

- Mandatory provisions must be met
- Building envelope requirements of 2009 IECC



# Option One - Tropical Zone

## R401.2.1

Applies to residential buildings in the tropical zone at elevations below 2,400ft above sea level. Includes provisions for:

- No air-conditioning
- 50% Air-conditioned space
- Renewable energy
- Fenestration
- Lighting
- Roofs
- Ceiling fans
- Overhangs
- Smaller homes



<http://www.kauaivacationrentals.com>



<http://hawaiibigislandvacationrental.com>





# Tropical Zone as Amended (1)

- Terms “occupied space” and “conditioned space” replaced with dwelling unit.
- Air-conditioning permitted in no more than one-half of dwelling unit.
- Rewards no air-conditioning.
- Dwelling units are not heated.



- Solar, wind or other renewable energy source must supply at least 90 percent of SWH energy.



# Tropical Zone as Amended (2)

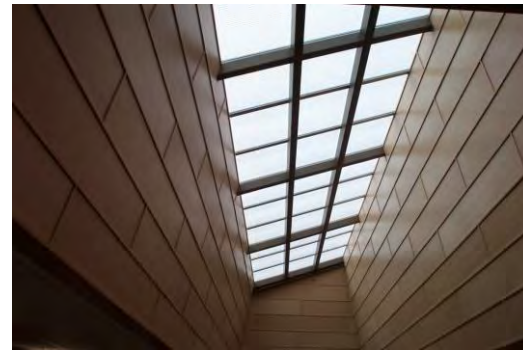
- Glazing must have a maximum SHGC as specified in Table R402.2.1.

**Table R402.2.1. Window SHGC Requirements**

| Projection Factor of overhang from base of average window sill | SHGC |
|--|------|
| < .30  | .25  |
| .30 - .50  | .40  |
| ≥.50   | N/A  |

Exception: North-facing windows with pf > .20 are exempt from the SHGC requirement. Overhangs shall extend 2 feet on each side of window or to nearest wall, whichever is less.

- Skylights in dwelling units shall have a maximum U-factor as specified in Table R402.1.2.



- Lighting must meet requirements of R404.



# Tropical Zone: Roofs

- The roof/ceiling complies with one of the following options:
  1. Comply with one of the roof surface options in Table C402.3 and install R-13 insulation or greater.
  2. Install R-19 insulation or greater.
- Attics above insulation are vented and unvented if below insulation.

**Table C402.3**  
**Minimum Roof Reflectance and Emittance Options**

Three-year aged solar reflectance of 0.55 and 3-year aged thermal emittance of 0.75

Three-year-aged solar reflectance index of 64

Exception: The roof/ceiling assembly is permitted to comply with R407.

- Roof surfaces have a minimum slope of  $\frac{1}{4}$  inch per foot of run to avoid ponding.



# Table R407 Tropical Zone Points Option - Wood Framed Walls

| Walls              |   | Standard Home Points | Tropical Home Points |
|--------------------|---|----------------------|----------------------|
| <b>Wood Framed</b> |   |                      |                      |
|                    | R-13 Cavity Wall Insulation   | 0                    | 1                    |
|                    | R-19 Roof Insulation  | -1                   | 0                    |
|                    | R-19 Roof Insulation + Cool roof membrane <sup>1</sup> or Radiant Barrier <sup>3</sup>    | 0                    | 1                    |
|                    | R-19 Roof Insulation + Attic Venting <sup>2</sup>   | 0                    | 1                    |
|                    | R-30 Roof Insulation  | 0                    | 1                    |
|                    | R-13 Wall Insulation + high reflectance walls <sup>4</sup>                                | 1                    | 2                    |
|                    | R-13 Wall insulation + 90% high efficacy lighting and Energy Star Appliances <sup>5</sup> | 1                    | 2                    |
|                    | R-13 Wall Insulation + exterior shading wpf=0.3 <sup>6</sup>                              | 1                    | 2                    |
|                    | Ductless Air Conditioner <sup>7</sup>   | 1                    | 1                    |
|                    | 1.071 X Federal Minimum SEER for Air Conditioner  | 1                    | 1                    |
|                    | 1.142 X Federal Minimum SEER for Air Conditioner  | 2                    | 2                    |
|                    | No air conditioning installed   | Not Applicable       | 2                    |
|                    | House floor area ≤ 1,000 ft <sup>2</sup>  | 1                    | 1                    |
|                    | House floor area ≥ 2,500 ft <sup>2</sup>  | -1                   | -1                   |
|                    | Energy Star Fans <sup>8</sup>   | 1                    | 1                    |
|                    | Install 1 kW or greater of solar electric   | 1                    | 1                    |



# Table R407 Tropical Zone Points Option - Metal Framed Walls

| Walls               |   | Standard Home Points  | Tropical Home Points |
|---------------------|---|-----------------------|----------------------|
| <b>Metal Framed</b> |   |                       |                      |
|                     | R-13 +R 3 Wall Insulation   | 0                     | 1                    |
|                     | R-13 cavity Wall insulation + R-0   | -1                    | 0                    |
|                     | R-13 Wall Insulation + high reflectance walls <sup>4</sup>                                | 0                     | 1                    |
|                     | R-13 wall insulation + 90% high efficacy lighting and Energy Star Appliances <sup>5</sup> | 1                     | 2                    |
|                     | R-13 Wall Insulation + exterior shading wpf=0.3 <sup>6</sup>                              | 0                     | 1                    |
|                     | R-30 Roof Insulation  | 0                     | 1                    |
|                     | R-19 Roof Insulation  | -1                    | 0                    |
|                     | R-19 + Cool roof membrane <sup>1</sup> or Radiant Barrier <sup>3</sup>                    | 0                     | 1                    |
|                     | R-19 Roof Insulation + Attic Venting <sup>2</sup>   | <u>0</u>              | <u>1</u>             |
|                     | Ductless Air Conditioner <sup>7</sup>   | <u>1</u>              | <u>1</u>             |
|                     | 1.071 X Federal Minimum SEER for Air Conditioner  | <u>1</u>              | <u>1</u>             |
|                     | 1.142 X Federal Minimum SEER for Air Conditioner  | <u>2</u>              | <u>2</u>             |
|                     | No air conditioning installed   | <u>Not Applicable</u> | <u>2</u>             |
|                     | House floor area ≤ 1,000 ft <sup>2</sup>  | <u>1</u>              | <u>1</u>             |
|                     | House floor area ≥ 2,500 ft <sup>2</sup>  | <u>-1</u>             | <u>-1</u>            |
|                     | Energy Star Fans <sup>7</sup>   | <u>1</u>              | <u>1</u>             |
|                     | Install 1 kW or greater of solar electric   | <u>1</u>              | <u>1</u>             |



# Tropical Zone: Ventilation

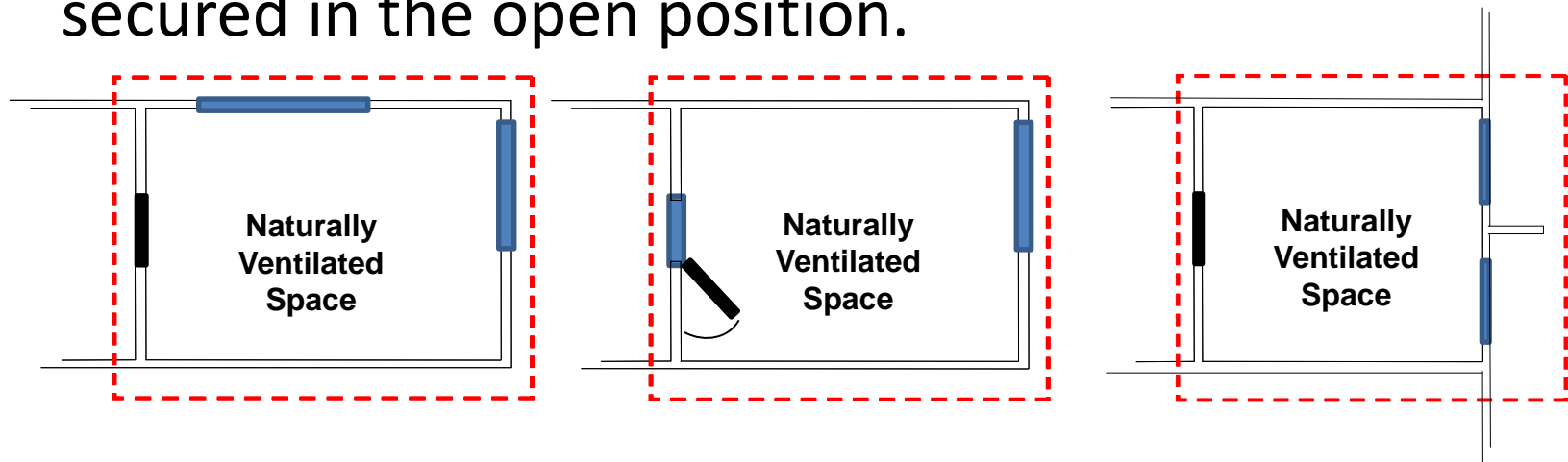


- Ventilation area equal to at least 14% of floor area must be provided by operable fenestration or ventilation fan.
- Jalousie windows shall have an air infiltration rate of no more than 1.2 cfm per square foot (6.1 L/s/m<sup>2</sup>).



# Tropical Zone: Ventilation

- Bedrooms with exterior walls facing two different directions must have operable fenestration or exterior walls facing two different directions.
- Interior doors to bedrooms must be capable of being secured in the open position.





# Tropical Zone: Ceiling Fans

- A ceiling fan or ceiling fan rough-in must be provided for bedrooms and the largest space not used as a bedroom.





# Tropical Zone: Air Sealing

- Walls, floors and ceilings separating air conditioned spaces from non-air conditioned spaces shall be constructed to limit air leakage in accordance with the requirements in Table R402.4.1.1.





Section R402

# Option Two - Prescriptive Building Thermal Envelope



# Table R402.1.2 Insulation and Fenestration Requirements by Component

| Climate Zone | Fenestration U-Factor | Skylight U-Factor | Glazed Fenestration SHGC | Ceiling R-Value | Wood Frame Wall R-Value | Mass Wall R-Value | Floor R-Value   | Basement R-Value | Slab R-Value | Crawl Space Wall R-Value |
|--------------|-----------------------|-------------------|--------------------------|-----------------|-------------------------|-------------------|-----------------|------------------|--------------|--------------------------|
| 1            | NR                    | 0.75              | 0.25                     | 30              | 13                      | 3/4               | NA <sup>1</sup> | 0                | 0            | 0                        |

<sup>1</sup>Proposed County Amendment

# Specific Insulation Requirements

## R402.2 Hawaii Specific

**R402.2 Specific insulation requirements (Prescriptive).** In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.13.

**Exception:**

Above-grade walls and ceilings shall be permitted to comply with [Section R407 Tropical Code](#).



# Glazed Fenestration SHGC

## R402.3.2 Hawaii Specific

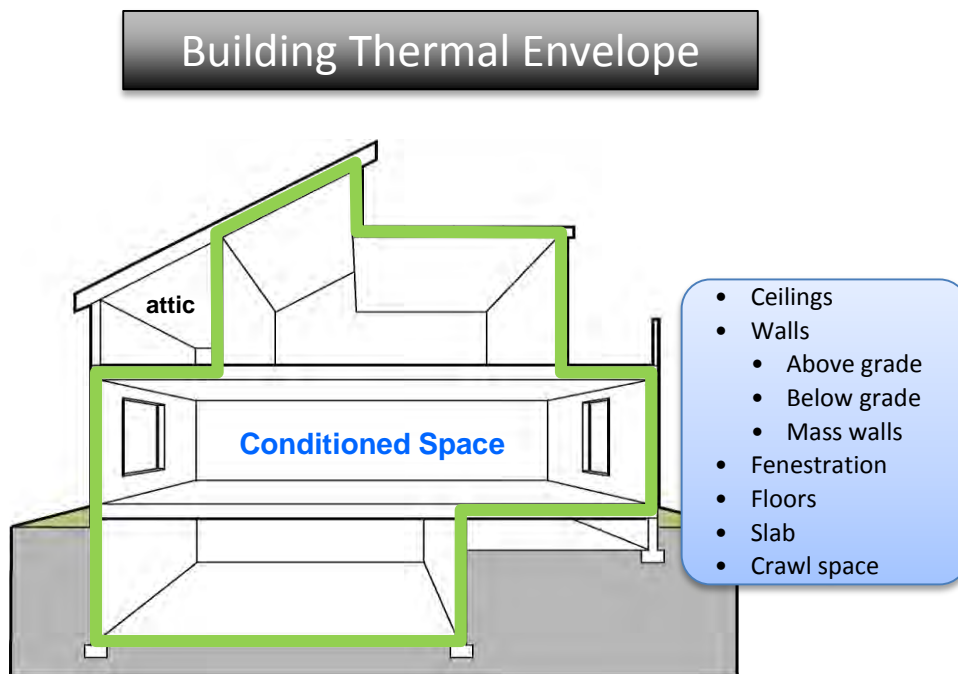
**Glazed fenestration SHGC.** Fenestration-shall have a maximum solar heat gain coefficient as specified in Table R402.1.2. An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.



# Air Leakage (Mandatory)

## R402.4

All components must be installed in accordance with manufacturer's instructions and in accordance with Table R402.4.1.1. An approved third party is permitted to inspect components for compliance (R402.4.1.1 Installation).



- Homes must be tested and verified as having  $\leq 5$  ACH when tested at pressure differential of 0.2 inches w.g. (50 Pa).
- Testing may be conducted by a third party and can occur any time after rough-in and installation of building envelope penetrations.



# Testing R402.4.1.2

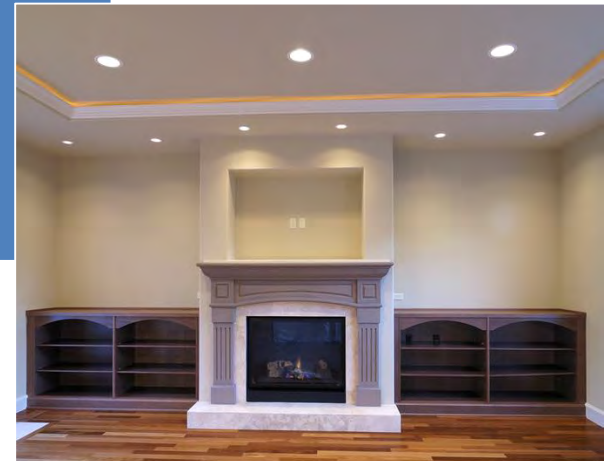


# Recessed Lighting

## R402.4.5

### R402.4.5

Recessed lighting must be IC-rated and labeled with an air leakage rate not more than 2 cfm when tested at a pressure differential of 75 Pa.







Section R403

# Systems



# Duct Testing (Mandatory) and Duct Leakage (Prescriptive)

## R403.3.3 and R403.3.4

# Duct Tightness Verification

### Rough-In Test

Total leakage  $\leq 4$  cfm/per 100 ft<sup>2</sup> of conditioned floor area when tested at a pressure differential of 0.1 in w.g. (25Pa) across roughed-in system, including manufacturer's air handler enclosure, and all register boots taped or otherwise sealed.

If air handler not installed at time of test, total air leakage  $\leq 3$  cfm/per 100 ft<sup>2</sup>.

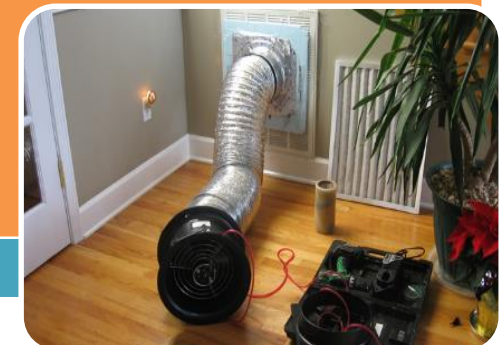
### Post Construction Test

Total leakage  $\leq 4$  cfm/per 100 ft<sup>2</sup> of conditioned floor area when tested at a pressure differential of 0.1 in w.g. (25Pa) across entire system, including manufacturer's air handler enclosure, and all register boots taped or otherwise sealed.

Exception: Test not required if air handler and all ducts are within conditioned space.

### Written Report

Qualified third parties permitted to conduct duct testing.



# Solar Water Heating

## R403.5.4 Hawaii Specific

- **Section R403.5.5 Solar water heating.** Solar water heating systems are required for new single-family residential construction pursuant to HRS 196-6.5.





Section 404

# Electrical Power and Lighting Systems



# Lighting Equipment R404.1

- A minimum of 75 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps.



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



# Ceiling Fans

## R404.2 Hawaii Specific

- **R404.2 Ceiling Fans (Mandatory).** A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as bedroom.



# Option Three - Simulated Performance Alternative R405

- Mandatory requirements of prescriptive path must be met to comply with performance path.
- Proposed design must have annual energy cost *less than or equal to* annual energy cost of standard referenced design.
- Hawaii specific amendments to Table R405.5.2(1) permit energy neutral trade-offs.

| Table R405.5.2(1)<br>SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS |  |  |
|---|--|--|
| BUILDING COMPONENT  | STANDARD REFERENCE DESIGN  | PROPOSED DESIGN  |
| Heating Systems   | <p><del>As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of section C403 of the ICC Commercial Provisions.</del></p> <p>Fuel type: <u>same as proposed design</u></p> <p>Efficiencies:<br/> <u>Electric: Air source heat pump with prevailing federal minimum standards</u><br/> <u>Nonelectric furnaces: natural gas furnace with prevailing federal minimum standards</u><br/> <u>Nonelectric boilers: natural gas boiler with prevailing federal minimum standards</u></p> <p>Capacity: sized in accordance with Section R403.7</p> | <p>As proposed</p> <p>As proposed</p> <p>As proposed</p> <p>As proposed</p> <p>As proposed</p> |
| Cooling systems   | <p><del>As proposed</del></p> <p>Fuel type: <u>Electric</u></p> <p>Efficiency: <u>in accordance with prevailing federal minimum standards</u></p> <p>Capacity: sized in accordance with Section R403.7</p>   | <p>As proposed</p> <p>As proposed</p>  |
| Service water heating   | <p><del>As proposed</del></p> <p>Fuel type: <u>same as proposed design</u></p> <p>Efficiency: <u>in accordance with prevailing federal minimum standards</u></p> <p>Use: Same as proposed design</p>   | <p>As proposed</p> <p><u>As proposed</u></p> <p><u>gal/day = 30+(10x Nbr)</u></p>              |



# Points Option

## R407 NEW!

### SECTION R407

### POINTS OPTION

- **R407.1 General (Prescriptive).** Above-grade walls and roofs are permitted to comply with the points option as an alternative to complying with Section R401.2.1 and R402.2.
- **R407.2 Requirements.** One or more efficiency measures shall be selected for roof and *above-grade* wall systems from Table R407.1 that cumulatively equal or exceed 0 (zero) points.
- As an alternative, *above-grade walls* and roofs are permitted to comply separately by scoring 0 (zero) or greater.





# Table R407

## Points Option - Wood Framed Walls

| Walls              |   | Standard Home Points | Tropical Home Points |
|--------------------|---|----------------------|----------------------|
| <b>Wood Framed</b> |   |                      |                      |
|                    | R-13 Cavity Wall Insulation   | 0                    | 1                    |
|                    | R-19 Roof Insulation  | -1                   | 0                    |
|                    | R-19 Roof Insulation + Cool roof membrane <sup>1</sup> or Radiant Barrier <sup>3</sup>    | 0                    | 1                    |
|                    | R-19 Roof Insulation + Attic Venting <sup>2</sup>   | 0                    | 1                    |
|                    | R-30 Roof Insulation  | 0                    | 1                    |
|                    | R-13 Wall Insulation + high reflectance walls <sup>4</sup>                                | 1                    | 2                    |
|                    | R-13 Wall insulation + 90% high efficacy lighting and Energy Star Appliances <sup>5</sup> | 1                    | 2                    |
|                    | R-13 Wall Insulation + exterior shading wpf=0.3 <sup>6</sup>                              | 1                    | 2                    |
|                    | Ductless Air Conditioner <sup>7</sup>   | 1                    | 1                    |
|                    | 1.071 X Federal Minimum SEER for Air Conditioner  | 1                    | 1                    |
|                    | 1.142 X Federal Minimum SEER for Air Conditioner  | 2                    | 2                    |
|                    | No air conditioning installed   | Not Applicable       | 2                    |
|                    | House floor area ≤ 1,000 ft <sup>2</sup>  | 1                    | 1                    |
|                    | House floor area ≥ 2,500 ft <sup>2</sup>  | -1                   | -1                   |
|                    | Energy Star Fans <sup>8</sup>   | 1                    | 1                    |
|                    | Install 1 kW or greater of solar electric   | 1                    | 1                    |



# Table R407

## Points Option - Metal Framed Walls

| Walls               |   | Standard Home Points | Tropical Home Points |
|---------------------|---|----------------------|----------------------|
| <b>Metal Framed</b> |   |                      |                      |
|                     | R-13 +R 3 Wall Insulation   | 0                    | 1                    |
|                     | R-13 cavity Wall insulation + R-0   | -1                   | 0                    |
|                     | R-13 Wall Insulation + high reflectance walls <sup>4</sup>                                | 0                    | 1                    |
|                     | R-13 wall insulation + 90% high efficacy lighting and Energy Star Appliances <sup>5</sup> | 1                    | 2                    |
|                     | R-13 Wall Insulation + exterior shading wpf=0.3 <sup>6</sup>                              | 0                    | 1                    |
|                     | R-30 Roof Insulation  | 0                    | 1                    |
|                     | R-19 Roof Insulation  | -1                   | 0                    |
|                     | R-19 + Cool roof membrane <sup>1</sup> or Radiant Barrier <sup>3</sup>                    | 0                    | 1                    |
|                     | R-19 Roof Insulation + Attic Venting <sup>2</sup>   | <u>0</u>             | <u>1</u>             |
|                     | Ductless Air Conditioner <sup>7</sup>   | <u>1</u>             | <u>1</u>             |
|                     | 1.071 X Federal Minimum SEER for Air Conditioner  | <u>1</u>             | <u>1</u>             |
|                     | 1.142 X Federal Minimum SEER for Air Conditioner  | <u>2</u>             | <u>2</u>             |
|                     | No air conditioning installed   | Not Applicable       | <u>2</u>             |
|                     | House floor area $\leq$ 1,000 ft <sup>2</sup>   | <u>1</u>             | <u>1</u>             |
|                     | House floor area $\geq$ 2,500 ft <sup>2</sup>   | <u>-1</u>            | <u>-1</u>            |
|                     | Energy Star Fans <sup>7</sup>   | <u>1</u>             | <u>1</u>             |
|                     | Install 1 kW or greater of solar electric   | <u>1</u>             | <u>1</u>             |



# Table R407

## Points Option- Footnotes

- <sup>1</sup> Cool roof with three-year aged solar reflectance of 0.55 and 3-year aged thermal emittance of 0.75 or 3-year aged solar reflectance index of 64.
- <sup>2</sup> One cfm/ft<sup>2</sup> attic venting.
- <sup>3</sup> Radiant barrier shall have an emissivity of no greater than 0.05 as tested in accordance with ASTM E-408. The radiant barrier shall be installed in accordance with the manufacturer's installation instructions.
- <sup>4</sup> Walls with covering with a reflectance of  $\geq 0.64$ .
- <sup>5</sup> Energy Star rated appliances include refrigerators, dishwashers, and clothes washers and must be installed for the Certificate of Occupancy
- <sup>6</sup> The wall projection factor is equal to the horizontal distance from the surface of the wall to the farthest most point of the overhang divided by the vertical distance from the first floor level to the bottom most point of the overhang.
- <sup>7</sup> All air conditioning systems in the house must be ductless to qualify for this credit.
- <sup>8</sup> Install ceiling fans in all bedrooms and the largest space that is not used as a bedroom.



Section III

# COMMERCIAL PROVISIONS: AN OVERVIEW





Section C401

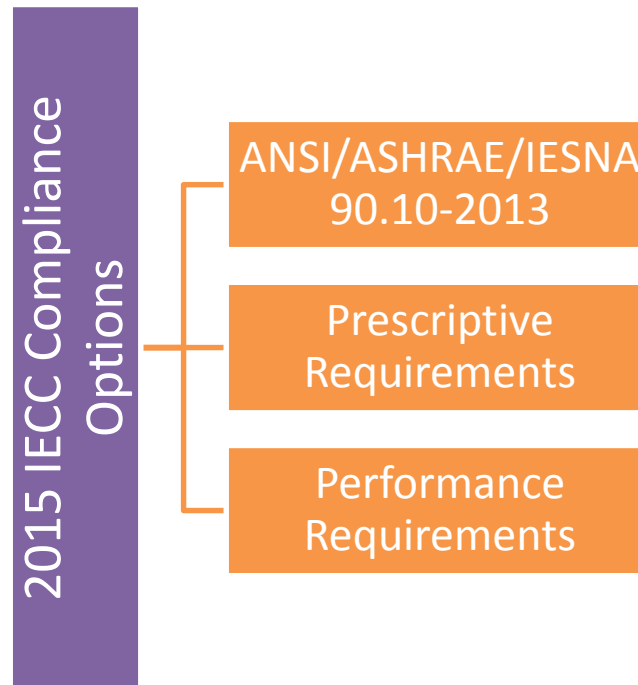
# General



# Scope and Application

## C401.1 and C401.2

**C401.1 Scope.** The provisions of this chapter are applicable to *commercial buildings* and their *build sites*.





Section C402

# Building Envelope



# Table C402.1.3 Opaque Thermal Envelope Insulation Minimum Requirements, R-Value Method

| Climate Zone                        | 1                      |                        |
|-------------------------------------|------------------------|------------------------|
|                                     | All Other              | Group R                |
| <b>Roofs</b>                        |                        |                        |
| Insulation entirely above roof deck | R-20ci                 | R-25ci                 |
| Metal buildings                     | R-19 + R-11 LS         | R-19 + R-11 LS         |
| Attic and other                     | R-38                   | R-38                   |
| <b>Walls, above grade</b>           |                        |                        |
| Mass                                | R-5.7ci                | R-5.7ci                |
| Metal building                      | R-13 + R-6.5ci         | R-13 + R-6.5ci         |
| Metal framed                        | R-13 + R-5ci           | R-13 + R-5ci           |
| Wood framed and other               | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 |
| <b>Walls, below grade</b>           |                        |                        |
| Below-grade wall                    | NR                     | NR                     |
| <b>Floors</b>                       |                        |                        |
| Mass                                | NR                     | NR                     |
| Joist-framing                       | NR                     | NR                     |
| <b>Slab-on-grade floors</b>         |                        |                        |
| Unheated slabs                      | NR                     | NR                     |
| Heated slabs                        | R-7.5 for 12" below    | R-7.5 for 12" below    |
| <b>Opaque doors</b>                 |                        |                        |
| Nonswinging                         | R-4.75                 | R-4.75                 |





# Thermal Resistance of Above-Grade Walls

## C402.2.3 Hawaii Specific

**C402.2.3 Thermal resistance of above-grade walls.** The minimum thermal resistance (R-value) of materials installed in the wall cavity between framing members and continuously on the walls shall be as specific in Table C401.3, based on framing type and construction materials used in the wall assembly.

### Exceptions:

Continuous insulation for wood and metal framed walls are not required when one of the following conditions are met:

- Walls have a covering with a reflectance of  $\geq 0.64$
- Walls have overhangs with a projection factor equal to or greater than 0.3. The projection factor is the horizontal distance from the surface of the wall to the farthest most point of the overhang divided by the vertical distance from the first floor level to the bottom most point of the overhang.

The R-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3. Mass walls shall include walls:

1. Weighing not less than 35 psf (170 kg/m<sup>2</sup>) of wall surface area.
2. Weighing not less than 25 psf (120 kg/m<sup>2</sup>) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m<sup>3</sup>).
3. Having a heat capacity exceeding 7 Btu/ft<sup>2</sup>·°F (144 kJ/m<sup>2</sup>·K).
4. Having a heat capacity exceeding 5 Btu/ft<sup>2</sup>·°F (103 kJ/m<sup>2</sup>·K), where the material weight is not more than 120 pcf (1900 kg/m<sup>3</sup>).



# Roof Solar Reflectance and Thermal Emittance

## C402.3

- Low-sloped roofs in CZ 1-3 must comply with one or more options in Table C402.3.

Table C402.3

### Minimum Roof Reflectance and Emittance Options

Three-year aged solar reflectance of 0.55 and 3-year aged thermal emittance of 0.75

Three-year-aged solar reflectance index of 64



# Table C402.4 Building Envelope Fenestration Maximum U-factor and SHGC Requirements

| Climate Zone                 | 1         | 2         | 3         | 4 EXCEPT MARINE | 5 AND MARINE 4 | 6         | 7       |
|------------------------------|-----------|-----------|-----------|-----------------|----------------|-----------|---------|
| <b>Vertical Fenestration</b> |           |           |           |                 |                |           |         |
| <b>U-factor</b>              |           |           |           |                 |                |           |         |
| Fixed fenestration           | 0.50      | 0.50      | 0.46      | 0.38            | 0.38           | 0.36      | 0.29    |
| Operable fenestration        | 0.65      | 0.65      | 0.60      | 0.45            | 0.45           | 0.43      | 0.37    |
| Entrance doors               | 1.10      | 0.83      | 0.77      | 0.77            | 0.77           | 0.77      | 0.77    |
| <b>SHGC</b>                  |           |           |           |                 |                |           |         |
| Orientation                  | SEW/N     | SEW/N     | SEW/N     | SEW/N           | SEW/N          | SEW/N     | SEW/N   |
| PF < 0.2                     | 0.25/0.33 | 0.25/0.33 | 0.25/0.33 | 0.40/0.53       | 0.40/0.53      | 0.40/0.53 | 0.45/NR |
| 0.2 ≤ PF < 0.5               | 0.30/0.37 | 0.30/0.37 | 0.30/0.37 | 0.48/0.58       | 0.48/0.58      | 0.48/0.58 | NR/NR   |
| PF ≥ 0.5                     | 0.40/0.40 | 0.40/0.40 | 0.40/0.40 | 0.64/0.64       | 0.64/0.64      | 0.64/0.64 | NR/NR   |
| <b>Skylights</b>             |           |           |           |                 |                |           |         |
| U-factor                     | 0.75      | 0.65      | 0.55      | 0.50            | 0.50           | 0.50      | 0.50    |
| SHGC                         | 0.35      | 0.35      | 0.35      | 0.40            | 0.40           | 0.40      | NR      |



# Maximum Area C402.4.1

Percentage of Vertical Fenestration Area to Gross Wall Area

- Allowed up to 30% maximum of above-grade wall area
- In Climate Zones 1-6, up to 40% maximum of above-grade wall area permitted with daylight controls



# Increased Vertical Fenestration Area with Daylight Responsive Controls C402.4.1.1

**Up to 40% vertical fenestration area  
allowed in Climate Zones 1-6 if:**

No less than 50%  
of the net floor  
area is within a  
daylight zone in  
buildings 2 stories  
or less

No less than 25%  
of the net floor  
area is within a  
daylight zone in  
buildings with 3  
or more stories

Daylight  
responsive  
controls are  
installed in  
daylight zones

VT of vertical  
fenestration is  $\geq$   
1.1 times SHGC



# Minimum Skylight Fenestration Area

## C402.4.2

- Limited to  $\leq 3\%$  of Roof Area (C402.4.1)
- Up to 5% allowed if automatic daylighting controls installed in daylight zones under skylights (C402.4.1.2)

In certain types of enclosed spaces  $> 2,500 \text{ ft}^2$  directly under a roof with not less than 75% of the ceiling area with a ceiling height  $> 15 \text{ ft}$

- total daylight zone under skylights to not be  $<$  half the floor area and must provide either
  - A minimum skylight area to daylight zone under skylights of not less than 3% where all skylights have a VT of at least 0.40 **OR**
  - A minimum skylight effective aperture of at least 1%

### Exceptions

- Climate zones 6-8
- Spaces with LPDs  $< 0.5 \text{ W/ft}^2$
- Documented shaded spaces
- Daylight area under rooftop monitors is  $> 50\%$  of floor area
- Spaces where total area minus area of daylight zones adjacent to vertical fenestration is less than  $2,500 \text{ ft}^2$  and where lighting is controlled per C405.2.5



# Area-Weighted SHGC

## C402.4.3.5 Hawaii Specific

**C402.4.3.5 Area-weighted SHGC.** In commercial buildings, an area-weighted average of fenestration products shall be permitted to satisfy SHGC requirements.





# Air Barriers and Construction

## C402.5.1 and C402.5.1.1

### Air Barrier Requirements

- Continuous for all assemblies part of the thermal envelope and across joints and assemblies
- Joints and seams to be sealed and securely installed
- Penetrations and joints and seals associated with penetrations must be sealed in a manner compatible with construction material and location
- Recessed lighting to comply with C402.5.7. Where similar objects are installed that penetrate the air barrier, make provisions to maintain integrity of air barrier

Placement  
Allowed

---

Inside of building  
envelope

---

Outside of building  
envelope

---

Located within assemblies  
composing envelope

---

Any combination thereof

---





# Air Barrier Compliance Options

## C402.5.1.2

### Compliance Options

Materials

Assemblies

Testing



## C402.5.1.2.1 Materials

Materials with air permeability  $\leq 0.004$  cfm/ft<sup>2</sup> under pressure differential of 0.3 in. w.g. when tested in accordance with ASTM E 2178 comply with materials provision.

| Materials  | Thickness (Minimum) |
|--|---------------------|
| Plywood  | 3/8 in.             |
| Oriented strand board .  | 3/8 in              |
| Extruded polystyrene insulation board                              | ½ in                |
| Foil-back polyisocyanurate insulation board.                       | ½ in                |
| Closed-cell spray foam with minimum density of 1.5 pcf             | 1-1/2 in            |
| Open-cell spray foam with density between 0.4 and 1.5 pcf          | 4.5 in              |
| Exterior or interior gypsum board                                  | ½ in                |
| Cement board   | ½ in                |
| Built up roofing membrane  |                     |
| Modified bituminous roof membrane                                  |                     |
| Fully adhered single-ply roof membrane                             |                     |
| Portland cement/sand parge or gypsum plaster                       | 5/8 in              |
| Cast-in-place and precast concrete                                 |                     |
| Fully grouted concrete block masonry                               |                     |
| Sheet metal or aluminum  |                     |
| Solid or hollow masonry constructed of clay or shale masonry units |                     |



## C402.5.1.2.2 Assemblies

Assemblies of materials and components (sealants, tapes, etc.) with average air leakage  $\leq 0.04$  cfm/ft<sup>2</sup> under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2357, 1677 or 283 comply with assemblies provision.

Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating

Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches or more

Portland cement/sand parge, stucco or plaster minimum  $\frac{1}{2}$  thick



## C402.5 Air Barrier Testing Alternative

Thermal envelope of buildings must comply with either the materials or assemblies provision **OR** be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge or equivalent method approved by code official.

**Building thermal envelope with a tested air leakage rate of  $\leq 0.40$  cfm/ft<sup>2</sup> complies with air leakage requirements**





Section C403

# Building Mechanical Systems



# Equipment Sizing and HVAC Equipment Performance Requirements

## C403.2.2 and C403.2.3

### Equipment Sizing

The output capacity of HVAC equipment must be less than the loads determined using ANSI/ASHRAE/ACCA 183 or another approved method and adjusted for energy heat recovery systems.

### Performance Requirements

Equipment must meet the efficiency requirements of Tables C403.2.3(1) – C403.2.3(9) and be verified by an approved certification program or have an efficiency rating from the manufacturer.



# Table C403.2.3(2) Minimum Efficiency Requirements: Electrically Operated Unitary and Applied Heat Pumps (Partial)

| Equipment Type                       | Size Category                       | Heating Section Type          | Subcategory or Rating Condition | Minimum Efficiency |                | Test Procedure |
|--------------------------------------|-------------------------------------|-------------------------------|---------------------------------|--------------------|----------------|----------------|
|                                      |                                     |                               |                                 | Before 1/1/2016    | After 1/1/2016 |                |
| Air cooled (cooling mode)            | < 65,000 Btu/h                      | All                           | Split System                    | 13.0 SEER          | 14.0 SEER      | AHRI 210/240   |
|                                      |                                     |                               | Single Package                  | 13.0 SEER          | 14.0 SEER      |                |
| Through-the-wall, air cooled         | ≤ 30,000 Btu/h                      | All                           | Split System                    | 12.0 SEER          | 12.0 SEER      |                |
|                                      |                                     |                               | Single Package                  | 12.0 SEER          | 12.0 SEER      |                |
| Single-duct high-velocity air cooled | < 65,000 Btu/h                      | All                           | Split System                    | 11.0 SEER          | 11.0 SEER      |                |
| Air cooled (cooling mode)            | ≥ 65,000 Btu/h and <135,000 Btu/h   | Electric Resistance (or None) | Split System and Single Package | 11.0 EER           | 11.0 EER       |                |
|                                      |                                     |                               |                                 | 11.2 IEER          | 12.0 IEER      |                |
|                                      |                                     | All other                     | Split System and Single Package | 10.8 EER           | 10.8 EER       |                |
|                                      |                                     |                               |                                 | 11.0 IEER          | 11.8 SEER      |                |
|                                      | ≥ 135,000 Btu/h and < 240,000 Btu/h | Electric Resistance (or None) | Split System and Single Package | 10.6 EER           | 10.6 EER       |                |
|                                      |                                     |                               |                                 | 10.7 IEER          | 11.6 IEER      |                |
|                                      |                                     | All other                     | Split System and Single Package | 10.4 EER           | 10.4 EER       |                |
|                                      |                                     |                               |                                 | 10.5 IEER          | 11.4 IEER      |                |
|                                      | ≥ 240,000 Btu/h                     | Electric Resistance (or None) | Split System and Single Package | 9.5 EER            | 9.5 EER        |                |
|                                      |                                     |                               |                                 | 9.6 IEER           | 9.6 IEER       |                |
|                                      |                                     | All other                     | Split System and Single Package | 9.3 EER            | 9.3 EER        |                |
|                                      |                                     |                               |                                 | 9.4 IEER           | 9.4 IEER       |                |



# HVAC System Controls

## C403.2.4

### C403.2.4.1 Thermostatic controls

- Individual HVAC zones must be capable of responding to temperatures within that zone. Humidity control devices must be provided for systems with humidification, dehumidification, or both.

### C403.2.4.2 Off-hour controls

- Individual HVAC zones must be equipped with setback controls that are controlled by either an automatic clock or programmable control system.



[www.forwardthinking.honeywell.com](http://www.forwardthinking.honeywell.com)





# Door Switches

## C403.2.4.2.4 Hawaii Specific

**C403.2.4.2.4 Door switches.** Opaque and glass doors opening to the outdoors in hotel and motel sleeping units, guest suites and time-share condominiums, shall be provided with controls that disable the mechanical cooling, or reset the cooling setpoint to 90° F or greater within five minutes of the door opening. Mechanical cooling may remain enabled if the outdoor air temperature is below the space temperature.



# Duct and Plenum Insulation and Sealing

## C403.2.9 Mandatory

### Required for Supply and Return Ducts and Plenums

- Located in Unconditioned Space – R6 Insulation
- Ducts Located Outside the Building Envelope – R8 Insulation in CZ 1-4 and R12 in CZ 5-8
- Located in Envelope Assembly – Must Be Separated from Building Exterior with R8 Insulation in CZ 1-4 and R12 in CZ 5-8

#### Exceptions:

- Ducts Located within Equipment
- Maximum Design Temperature Difference (Interior – Exterior) is  $< 15^{\circ}\text{F}$



# Mechanical Systems Commissioning and Completion C403.2.11 Mandatory

- HVAC Commissioning
  - Applies to buildings with a total building equipment capacity  $\geq$ 
    - 480,000 Btu/h cooling capacity, or
    - 600,000 Btu/h heating capacity
  - Requires:
    - Commissioning plan
    - Systems adjusting and balancing
    - Functional performance testing
      - Equipment
      - Controls
      - Economizers
  - Preliminary commissioning report
  - Construction documents and O&M Manuals
  - Final commissioning report and air balancing report





Section C405

# Electrical Power and Lighting Systems



# Occupant Sensor Controls

## C405.2.1

### Occupant sensor controls

The following space types must have occupant sensor controls installed to control lights:

- Classrooms/lecture/training rooms
- Conference/meeting/multipurpose rooms
- Copy/print rooms
- Lounges
- Employee lunch and break rooms
- Private offices
- Restrooms
- Storage rooms
- Janitorial closets
- Locker rooms
- Other spaces 300ft<sup>2</sup> or less that are enclosed by floor-to-ceiling height partitions
- Warehouses

### Sensor control function

Occupant sensors for all spaces except warehouses must:

- Automatically turn off lights within 30 minutes of all occupancies leaving space
- Be manual on or controlled to automatically turn lighting on to not more than 50% power
- Include manual control to allow occupants to turn lights off

### Warehouse control function

Lighting in aisleways and open areas must be individually controlled with occupant sensors that automatically reduce lighting power by >50% when areas are unoccupied



## Time-Switch Controls C405.2.2

**Each area that is not provided with occupant sensor controls must have time-switch controls**

Exceptions: Automatic controls are not required in sleeping areas, spaces where patient care is directly provided, spaces where auto lighting would endanger safety or security, lighting intended for continuous operation, shop and laboratory classrooms

Each space with time-switch controls must also have a manual control for lighting reduction and include an override switching device that has:

- A 7-day clock
- 7 different day types/week
- An automatic holiday “shutoff”
- Program backup capabilities
- Limits for controlled lighting to be on for less than 2 hours
- Capability to control lighting for areas <5,000 ft<sup>2</sup>



## Light-Reduction Controls C405.2.2.2

Light-reduction controls must allow occupants to reduce connected lighting:

- By at least 50%
- In a reasonably uniform illumination pattern

### Light-reduction methods include:

- Controlling all lamps or luminaires
- Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps.
- Switching of the middle lamp luminaires independently of the outer lamps.
- Switching each luminaire or lamp



## Daylight-responsive controls C405.2.3

Daylight-responsive controls must be provided to control electric lights within daylight zones in:

- Spaces with total of more than 150W of general lighting within sidelight daylight zones
- Spaces with total of more than 150W of general lighting within toplight daylight zones





# Table C405.4.2(1) Interior Lighting Power Allowances: Building Area Method (partial)

| Building Area Type          | LPD (w/ft <sup>2</sup> ) |
|-----------------------------|--------------------------|
| Automotive facility         | .80                      |
| Convention Center           | 1.01                     |
| Courthouse                  | 1.01                     |
| Dining: Bar lounge/leisure  | 1.01                     |
| Dining: Cafeteria/fast food | 0.90                     |
| Dining: Family              | 0.95                     |
| Dormitory                   | 0.57                     |
| Exercise Center             | 0.84                     |
| Fire Station                | 0.67                     |
| Gymnasium                   | 0.94                     |
| Health Care Clinic          | 0.90                     |



# Table C405.4.2(2) Interior Lighting Power Allowances: Space-by-Space Method (partial)

| Common Space Types                      | LPD (w/ft <sup>2</sup> )            |
|---|-------------------------------------|
| Atrium First 40 ft in height            | 0.03 per ft. in total height        |
| Atrium Above 40ft in height             | 0.40 + 0.02 per ft. in total height |
| Audience/seating area                   |                                     |
| For Auditorium                          | 0.63                                |
| For Performing Arts Theatre             | 2.43                                |
| For Motion Picture Theatre              | 1.14                                |
| Class Room/Lecture/Training             | 1.24                                |
| Conference/Meeting/Multipurpose         | 1.23                                |
| Corridor                                | 0.66                                |
| Dining Area                             |                                     |
| In a penitentiary                       | 0.96                                |
| In a facility for the visually impaired | 1.90                                |
| Bar/Lounge/Leisure Dining               | 1.07                                |
| Family Dining Area                      | 0.89                                |
| Electrical/Mechanical                   | 0.95                                |
| Food Preparation                        | 1.21                                |



# 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  |



# Table C405.5.2(2) Individual Lighting Power Allowances for Building Exteriors (Partial)

|  |  | Lighting Zones         |                        |                        |                        |
|--|--|------------------------|------------------------|------------------------|------------------------|
|  |  | Zone 1                 | Zone 2                 | Zone 3                 | Zone 4                 |
| Base Site Allowance<br>(Base allowance is usable in tradable or nontradable surfaces)  |  | 500 W                  | 600 W                  | 750 W                  | 1300 W                 |
| Tradeable Surfaces<br>(Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas are tradeable) | <b>Uncovered Parking Areas</b>                                       |                        |                        |                        |                        |
|  | Parking areas and drives   | 0.04 W/ft <sup>2</sup> | 0.06 W/ft <sup>2</sup> | 0.10 W/ft <sup>2</sup> | 0.13 W/ft <sup>2</sup> |
|  | <b>Building Grounds</b>  |                        |                        |                        |                        |
|  | 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 <sup>2</sup> | 0.14 W/ft <sup>2</sup> | 0.16 W/ft <sup>2</sup> | 0.2 W/ft <sup>2</sup>  |
|  | Stairways  | 0.75 W/ft <sup>2</sup> | 1.0 W/ft <sup>2</sup>  | 1.0 W/ft <sup>2</sup>  | 1.0 W/ft <sup>2</sup>  |
|  | Pedestrian Tunnels   | 0.15 W/ft <sup>2</sup> | 0.15 W/ft <sup>2</sup> | 0.2 W/ft <sup>2</sup>  | 0.3 W/ft <sup>2</sup>  |
| <b>Building Entrances and Exits</b>  |  |                        |                        |                        |                        |



# Lighting System Functional Testing

## C408.3

- Test lighting control system to ensure control hardware and software are calibrated, adjusted, programmed and in proper working condition per the design and manufacturer's instructions
  - Applies to
    - Occupancy sensor controls
    - Time-switch controls
    - Daylight responsive controls



# Sub-Metering

## C405.10 Hawaii Specific

**C405.10 Sub-metering (Mandatory).** In new buildings with tenants, metering shall be collected for the entire building and individually for each tenant occupying 1,000 ft<sup>2</sup> (total enclosed and unenclosed) (93 m<sup>2</sup>) or more. Tenants shall have access to data collected for their space. A tenant is defined as “one who rents or leases from a landlord.





Section C406

# Additional Efficiency Package Options



# Requirements

## C406.1

Buildings must comply with at least one additional efficiency feature:

1. More efficient HVAC
2. Reduced lighting power density
3. Enhanced lighting controls
4. On-site renewable energy
5. Dedicated outdoor air system
6. High-efficiency SWH







## Howard C. Wiig

Energy Analyst, Hawaii State Energy Office  
Office (808) 587-3811

[hwiig@dbedt.hawaii.gov](mailto:hwiig@dbedt.hawaii.gov)

