# International Energy Conservation Code

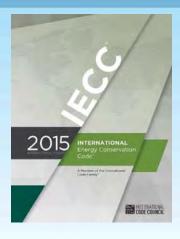
## **Howard Wiig**

Hawaii State Energy Office

## **Erik Kolderup**

**Kolderup Consulting** 

April 2018











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# **Learning Objectives**

Determine applicability and requirements for the Tropical-Zone compliance option for low-rise dwellings.

Identify complying residential envelope constructions.

Evaluate design options with the residential points option.

Determine commercial building envelope compliance.

Determine allowed interior and exterior lighting power

Use residential and commercial checklists to identify relevant requirements.







## **Sponsors**

































# Agenda - Morning

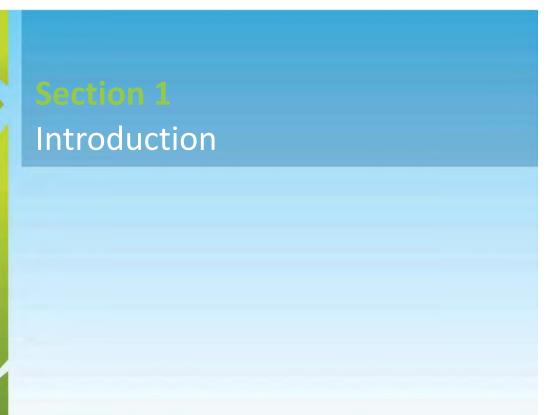
8:00	Introduction
8:15	Residential – Tropical Zone option
8:45	Residential – Envelope
9:15	Residential – Systems
9:30	Residential – Additions & alterations
9:45	BREAK
10:00	Commercial – Envelope
10:30	Commercial – Systems
10:50	Commercial – Electrical & lighting
11:30	Adjourn

-

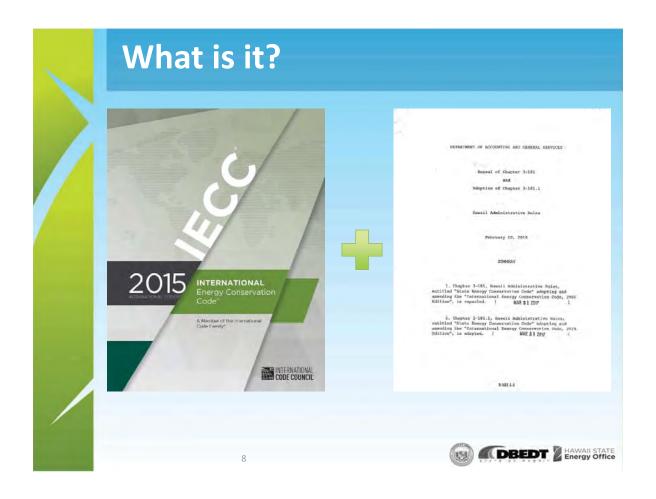


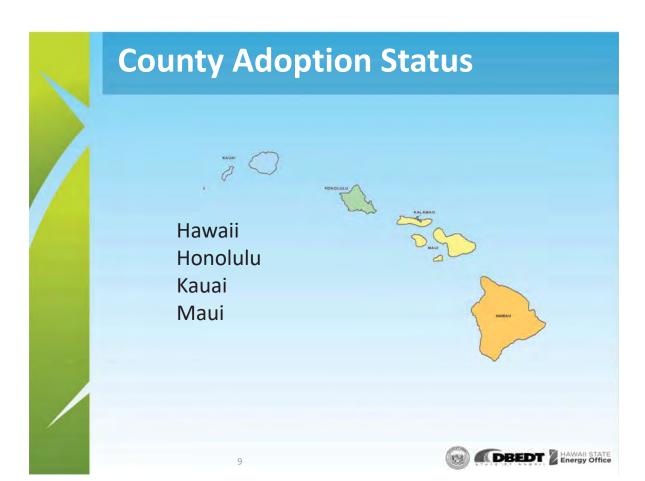
# Agenda - Afternoon

1:00	Introduction
1:15	Residential – Tropical Zone option
1:45	Residential – Envelope
2:15	Residential – Systems
2:30	Residential – Additions & alterations
2:45	BREAK
3:00	Commercial – Envelope
3:30	Commercial – Systems
3:50	Commercial – Electrical & lighting
4:30	Adjourn



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## **2015 IECC Structure**

#### **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

\* See also Hawai'i State Energy Conservation Code amendments



# Who needs to comply?

#### **Residential Requirements**

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

## **Commercial Requirements**

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









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EK36

# Who needs to comply?

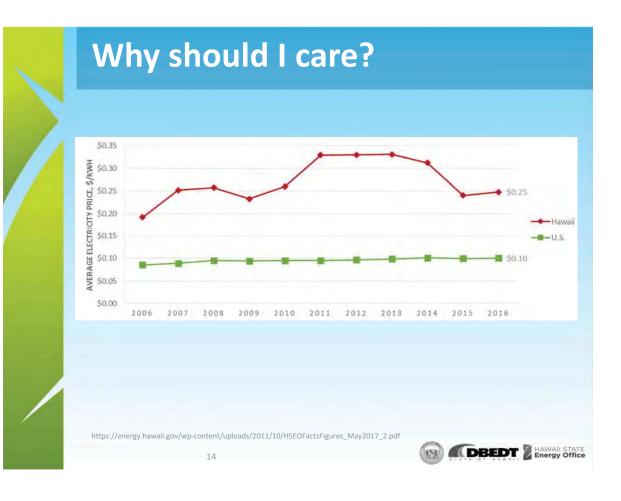
- New construction
- Additions
- Alterations
  - Several exceptions
- Change of occupancy
  - When change results in increase in energy
  - Conversions to dwellings

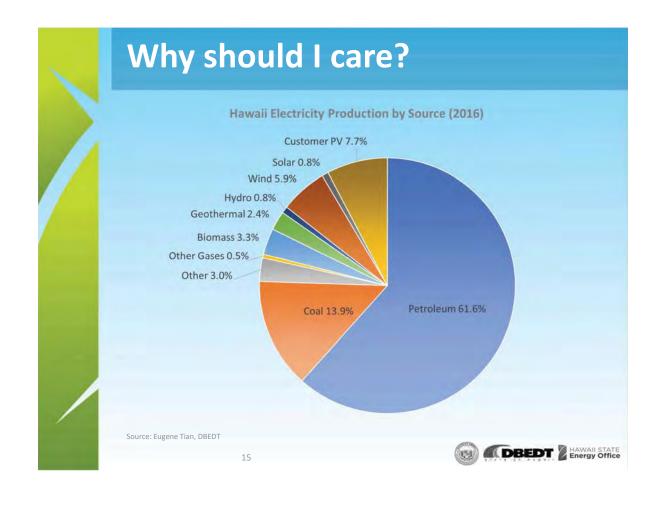
EK36

the low-energy exception amendment doesn't work as intended because all spaces with less than 1W/sf space conditioning are exempt from the envelope requirements. The would include all unconditioned space, not just cases without habitable space.

# Why should I care?

- Energy savings
  - Lower utility bills
  - Reduced oil imports
  - Lower emissions
- Value
- Comfort
- Already required for State buildings





## How do I comply?

- Review checklist for relevant requirements
- Include required design information on plans (e.g. R-value)
- Include signed compliance certification on plans

	Resident	Cade Settles		
Cortification	Responsible Besign prefessional certification on plans	\$101.1°		Digred statement on plans
Construction documents	Individe     Implication R-values     Implication R-values     Implication R-values     Implication R-values     Implication R-values     Implication R-values	F103.3		
Boof - aread fraces	DR-56 or U-8.695, D Total UA alternative, or IT from aption	8402.1, 8402.1.5. 8407*	Same 8.10 systems:  12 or, Sett resulption:  5 to 8 or, spray from:	Dimilation location on plans Dimilation Rivelus on plans
fined < metal inscs	□ 8-38 or M-6-37s. □ 8-36 + 8-3, or □ 8-34 + 8-5, or □ form UAL adjustmenting, or □ form contain	8402.1, 8402.2, 8402.1.5, 8407*	Mutal frame creates a thermal bridge, and more couldation to required. "It is and 8-3" letter to continuous resolution, typically fram bound.	C strutation focusion on plans  D troublister A velve as plans
Roof - miętai jaryt	B No in 244, 246 or 246 framing, or  8.49 in any framing  Cotal (sta alternative, or  Points coton	8402.1, 8402.2, 8402.1.3, 6407*		O moutation becation an plant O moutation it solve by grant
Wall - wood have	D 11 st U 0.004 D Total U4 afterwater, or	RADD LS. RADD LS. RADD**	Some 6-13 options:  1.5 in. but modulor  2.03.5 in. opray form:	O simulation incessor on plans O simulation & value on plans
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Wall - mass (Chitu ar concerns)	☐ 5-3 extense, 8-4 infense er U-6.357 ☐ Fotor UA othernotine, or ☐ Zounts option	8402.1	Regards of the extense or interior equilation, figurally found board. (Microstografi equilation does not comply	☐ Impletion location on plans ☐ Impletion R-value on glass

	COUNTY OF
To the best of my knowledge, this project is design substantially conforms to (COGE NAME) (2016 IECC as amended) for building envelope componer.	
COMPLIANCE METHOD  Tropical Zone, R401,2:1  Prescriptive, R402  Points Option, R407  Simulated Performance, R41  Energy Rating Index, R406	95
INFORMATION IN CONSTRUING Resident Resident Reviews  Roof insulation Type and lociling Roof insulation type and lociling Roof insulation Revalue  Wall insulation Repaired and local Window SMEC  At leakage testing requirem	ation tance (if approxime) stilleri
NOTES	
SIGNATURE:	DATE
NAME	
TITLE:	

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# How do I comply?

## **Information required on construction documents** (See checklist)

#### Section C103.2

- 1. Insulation materials and their R-values.
- Fenestration U-factors and solar heat gain coefficients (SHGCs).
- Area-weighted U-factor and solar heat gain coefficient (SHGC) calculations.
- 4. Mechanical system design criteria.
- Mechanical and service water heating system and equipment types, sizes and efficiencies.
- 6. Economizer description.
- 7. Equipment and system controls.
- 8. Fan motor horsepower (hp) and controls.
- 9. Duct sealing, duct and pipe insulation and location.
- Lighting fixture schedule with wattage and control narrative.
- 11. Location of daylight zones on floor plans.
- 12. Air sealing details.

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# Where do I get more info?

- 2015 IECC
  - https://codes.iccsafe.org
- Hawaii amendments & support info
  - http://energy.hawaii.gov/hawaii-energy-building-code/2015-iecc-update
- Email contact
  - Howard Wiig, howard.c.wiig@hawaii.gov



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# **Section 2**Residential - Overview



## **Compliance Options - Residential**

## **Tropical Zone**

- ≤50% air conditioned,
- not heated, and
- elevation < 2,400 feet

## Prescriptive

Wall and roof options:

- Prescriptive
- 2. Total UA
- 3. Points option
- Simulated performance alternative
- Energy rating index (ERI)















# **Highlights - Residential**

- **New Tropical Zone option**
- New points option for walls and roof
- Air leakage testing blower door
- Window SHGC
- Duct leakage testing
- High efficacy lighting



# **Checklists - Residential**

- Tropical Zone
- Prescriptive requirements
- Additions and alterations
- Points option tables

	Regulement	Ende Section	PLAN Paylety Freesa	
Tropic of zone qualification	It Stiffs of occupied space has AC     Her heating installed     Direction v 2,400 ft <sup>2</sup>	5401.7.1*	Dwellings that do not ment all these orders must use another compliance option.	CLAC space clearly into and (if applicable)
Certification	Responsible design professional certification on plans	4303.7		Citypes statement on plans
Construction documents	trotusie  • Insulation Rivatives  • Renestration Orfactors and solar heat gain coefficients (IMNICS)	8303.2		
Water heating - setur	Solar, with an atter renewable source supplies a 90% of energy for water heating	1401.2.1*	states for output or eight house parenthis.	O Solar water healing system ejecu- on plans
Windows - sofer Fest gain coefficient (IH&C)	5 0.35 if pregretion feature 12.20 0.40 if regretion facility 550-55 N/In propertion factor 2.0.3. N/A: north windows if PT > 9L20	anti 2.1,	Selds I stiller have gave fastors.  Liver limit of spirally requires double given glairing with a low-emittance securing that is designed to reduce solder foreign.  Projection factor in Stiller gradient of sentring a securind distance from combining to better or develope securing distances from combining to better or develope.  Concluding must defend all select 2.5 on each side of the minimum on the investor with with security as it.	O serpt undoubed on grans O overlang dissensions on plans, il applicable
Skylights - U-factor	1 0.75	8401-2.1*	sayingths must have dust pure glassing.	Displain ordere or plans
tighting	2 75% of lampt or Entures are high efficiety	8404.1	high efficient lamins are defined as:  1. For a smaller discrete fluorescent:  2. Copyant fluorescent:  3. Observational of 3-10s and 5-50s:  4. Observational of 3-10s and 5-50s:  4. Observational observational observations of 3-10s and 3-10s a	☐ Lighting feture boariers on plan ☐ Lighting feture lot-side include Proof present and flutters guiland

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# Section 3 Residential – Tropical Zone





# R401.2.1 Tropical Zone Hawaii Version



### Can use this path if:

- ≤50% air conditioned,
- not heated, and
- elevation < 2,400 feet

#### Requirements cover:

- Water heating
- Glazing
- Lighting
- Roof
- Natural ventilation
- Jalousie air leakage
- Envelope air leakage for AC areas













# R401.2.1 Tropical Zone **Hawaii Version**



R401.2.1 Tropical zone. Residential buildings in the tropical zone at elevations below 2,400 feet (731.5 m) above sea level shall be deemed to comply with this chapter where the following conditions are met:

- 1. Not more than one-half of the dwelling unit is air conditioned
  2. The dwelling unit is not heated.
  3. Solar, wind or other renewable energy source supplies not less than 90 percent of the energy for service water heating.
  4. Glazing in dwelling units shall have a maximum solar heat gain coefficient as specified in Table R402.2.1.

#### Table R402.2.1. Window SHGC Requirements

Projection Factor of overhang from base of average window sill <sup>b</sup>	SHGC
S. 1000 €3630: (7800 701 2	10 July :25 works 40"
.3050	.40
2:50 th went 121	MA STRUGGE

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

- 5. Skylights in dwelling units shall have a maximum U-factor as specified in Table R402.1.2.
  6. Permanently installed lighting is in accordance
- with Section R404.
- 7. The roof/ceiling complies with one of the following

- 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.

If present, attics above the insulation are vented and attics below the insulation are unvented.

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

- Roof surfaces have a minimum slope of 4 inch per foot of run. The finished roof does not have water accumulation areas:
- accumulation areas:

  9. Operable fenestration provides ventilation area equal to not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.

  10. Bedrooms with exterior walls facing two different direction have operable fenestration or exterior walls facing two different directions.

  11. Interior doors to bedrooms are capable of being secured in the open position.

  12. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as bedroom.

  13. Jalousie windows shall have an air infiltration

- 13. Jalousie windows shall have an air infiltration rate of no more than 1.2 cfm per square foot (6.1 L/s/m²).

  14. Walls, floors and ceilings separating air
- waits, floors and cellings 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 [Eff 5/24/10; am and comp MAR 31 2017] (Auth: HRS \$107-29) (Imp: HRS \$\$107-24, 107-25)



# R401.2.1 Tropical Zone Water Heating



Solar, wind or other renewable > 90%



Waiver for instant-on water heater permitted

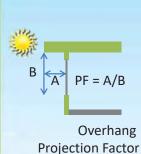
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# **R401.2.1 Tropical Zone Windows**



Maximum solar heat gain coefficient (SHGC)



No requirement	0.40	0.25
Large overhang	Medium overhang	Small overhang
≥ 0.5	0.30 ≤ PF < 0.50	< 0.30

North windows: no requirement if PF > 0.20







## **National Fenestration Rating Council (NFRC) Label**





#### World's Best Window Co.

Millennium 2000 <sup>†</sup>
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: **Vertical Slider** 

#### **ENERGY PERFORMANCE RATINGS**

U-Factor (U.S./I-P) **0.35** 

Solar Heat Gain Coefficient 0.25

#### ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance

Air Leakage (U.S./I-F

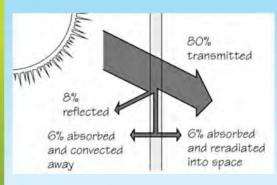
Marufacturer stip Johns that these ratings conform to applicable NFRC procedures for determining who product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer is literature for other product performance information. Nature fits can

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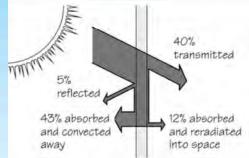
## **Solar Heat Gain Coefficient (SHGC)**

## Clear glass



SHGC = 80% + 6% = 86%

# Tinted glass (heat-absorbing)



SHGC = 40% + 12% = 52%

(An example. A range of performance is available)

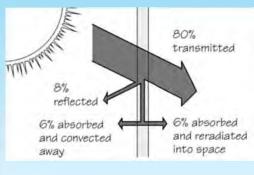
http://windows.lbl.gov/software/NFRC/SimMan/NFRCSim6.3-2013-07-Manual.pdf



## **Solar Heat Gain Coefficient (SHGC)**

## Clear glass

## Reflective glass coating



18% absorbed and convected away into space

SHGC = 80% + 6% = 86%

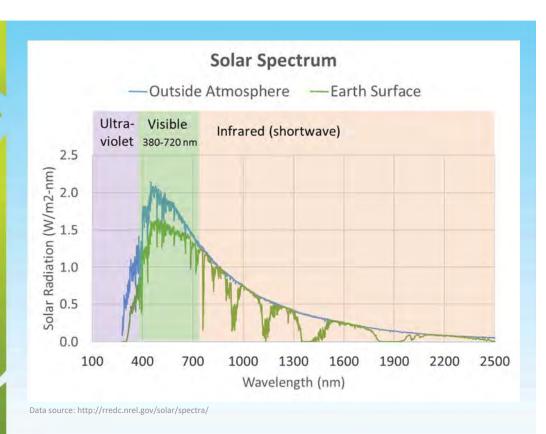
**SHGC = 50% + 6% = 56%** 

(An example. A range of performance is available)

http://windows.lbl.gov/software/NFRC/SimMan/NFRCSim6.3-2013-07-Manual.pdf

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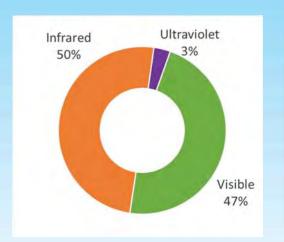




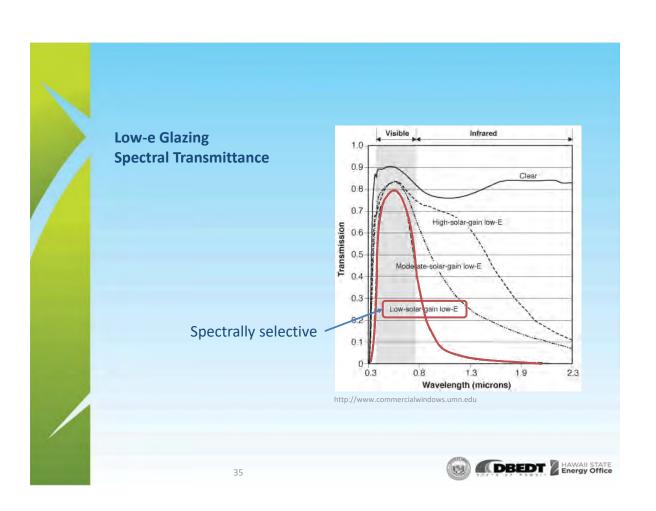
## **Solar Radiation Power**

#### **At Earth Surface**

Ultraviolet 10 Btu/hr-ft²
Visible 149 Btu/hr-ft²
Infrared 158 Btu/hr-ft²
Total 317 Btu/hr-ft²







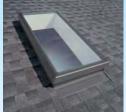
# R401.2.1 Tropical Zone Skylights



U-factor ≤ 0.75

Requires double-pane skylights







www.veluxusa.com

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# R401.2.1 Tropical Zone Lighting (R404.1)



High efficacy ≥ 75% of lamps

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

## High efficacy examples



Compact fluorescent



**Full-size** fluorescent



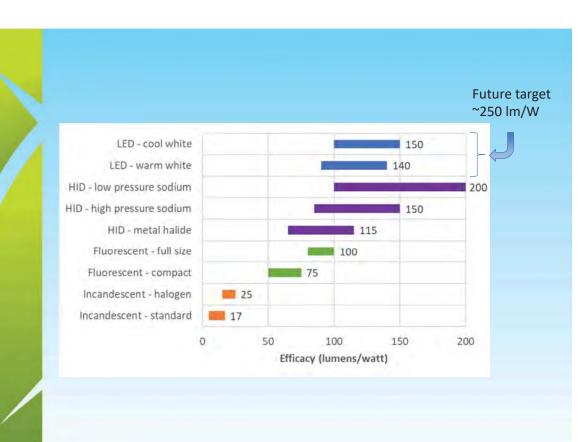
Source: DOE/NREL PIX20307

**LED** 









# R401.2.1 Tropical Zone Roof



- 1. R-19 insulation
- 2. Cool roof + R-13 insulation
- 3. Points option (R407)

#### **Cool roof**





http://coolroofhawaii.com

http://www.whirlwindsteel.com

#### If there is an attic

- Vented if attic above insulation
- Unvented if attic below insulation

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# **R401.2.1 Tropical Zone Natural Ventilation**



- Operable windows
  - Area ≥ 14% of floor area
- Bedrooms
  - Interior doors can be secured open
  - Openings on two different sides if exterior walls face two different directions
- Ceiling fans EK16
  - Bedrooms
  - Largest space that is not a bedroom
- Jalousie windows
  - Air infiltration rate ≤ 1.2 cfm/ft<sup>2</sup>

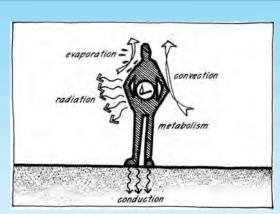




# **R401.2.1 Tropical Zone Summary**



- Efficiency
  - Little or no AC
  - Water heating
  - Lighting
- Comfort
  - Window solar gain
  - Roof heat gain
  - Natural ventilation



Heat generated within body



Heat loss from body

- ↓ Air temperature
- ↓ Ceiling temperature
- ↑ Air movement





# A 1920's Tropical Home





# A Brand New Tropical Home





## Kaupuni Village



Waianae Valley, Oahu 19 affordable homes \$303,000 average construction cost Built in 2011

https://www.nrel.gov/docs/fy12osti/53401.pdf https://www.nrel.gov/docs/fy13osti/58000.pdf











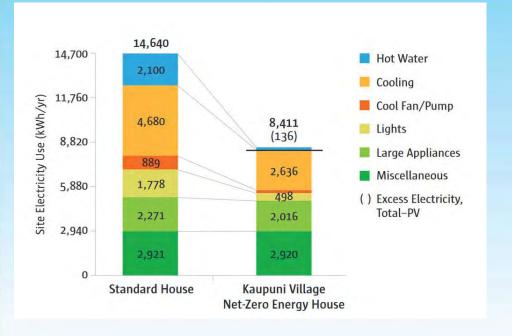
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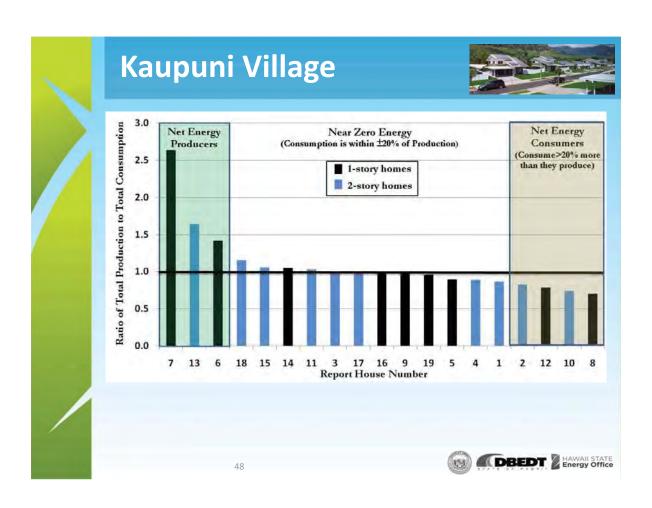


# Kaupuni Village



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## **Tropical Zone Quiz**

- 1. What are the wall insulation requirements?
- 2. Does single-wall construction comply?
- 3. Which is not allowed under the Tropical Zone path?
  - a. Ductless mini-split air conditioner
  - b. Heat pump water heater
  - c. Dark roof
  - d. Unventilated attic
  - e. Jalousie windows
- 4. Design professional certification not required
  - a. True
  - b. False

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# Residential – Envelope Prescriptive Option



# **Residential Envelope**

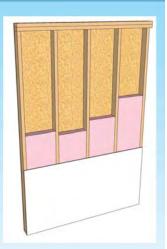
- Wall and roof, three options
  - 1. Table R402.1.2
  - 2. Total UA
  - 3. Points option
- Windows & skylights
  - Table R402.1.2
- Air leakage
  - Installation
  - Testing

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# Table R402.1.2 Opaque Envelope - Prescriptive

	R-value (hr-ft²-°F/Btu)	U-factor (Btu/hr-ft²-°F)
Ceiling	R-30	0.035
Wood frame wall	R-13	0.084
Mass wall	R-3 – exterior R-4 – interior	0.197
Floor	R-13	0.064
Basement wall	0	0.360
Slab on grade	0	NA
Crawl space wall	0	0.477





# Table R402.1.2 Opaque Envelope - Prescriptive

		on R-value -°F/Btu)
Steel frame wall, 16 in. o.c.	R-0 + 9.3 R-13 + 4.2 R-15 + 3.8	R-19 + 2.1 R-21 + 2.8
Steel frame wall, 24 in. o.c.	R-0 + 9.3 R-13 + 3.0 R-15 + 2.4	
Steel truss ceiling	R-38 R-30 + 3 R-26 + 5	
Steel joist ceiling		-38 ming > 2x8

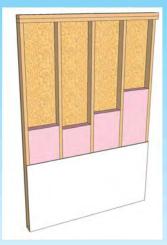


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# Ceilings Some R-30 insulation options 10 in. batt ~10 in. blown-in ~8 in. open-cell spray foam ~5 in. closed-cell spray foam

## **Wood Walls**

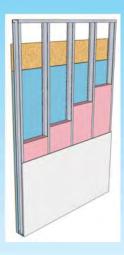


## **Some R-13 insulation options**

- 3.5 in. batt
- 3.5 in. blown-in
- 3.5 in. open-cell spray foam
- ~2 in. closed-cell spray foam



## **Metal Walls**



Framing 16 in. o.c. Framing 24 in. o.c.

R-0 + 9.3 R-0 + 9.3 R-13 + 4.2 R-13 + 3.0 R-15 + 3.8 R-15 + 2.4

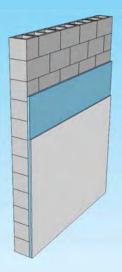
## Rigid foam board thickness

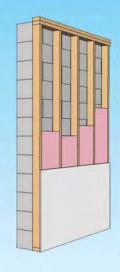
R-value	Extruded Polystyrene (R-5/in.)	Poly- isocyanurate (R-6/in.)
2.4	≥ 0.48 in.	≥ 0.40 in.
3.0	≥ 0.60 in.	≥ 0.50 in.
3.8	≥ 0.76 in.	≥ 0.63 in.
4.2	≥ 0.84 in.	≥ 0.70 in.
9.3	≥ 1.86 in.	≥ 1.55 in.

Or use the points option for compliance









≥ 0.50 in. polyisocyanurate ≥ 0.60 in. polystyrene

R-4 interior ≥ 0.67 in. polyisocyanurate ≥ 0.80 in. polystyrene

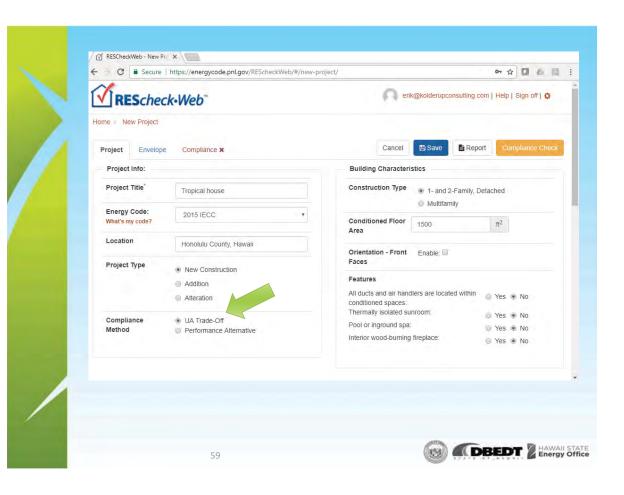
**U-factor** ≤ **0.197** ≥ R-4 in wood furring ≥ R-11 in metal furring

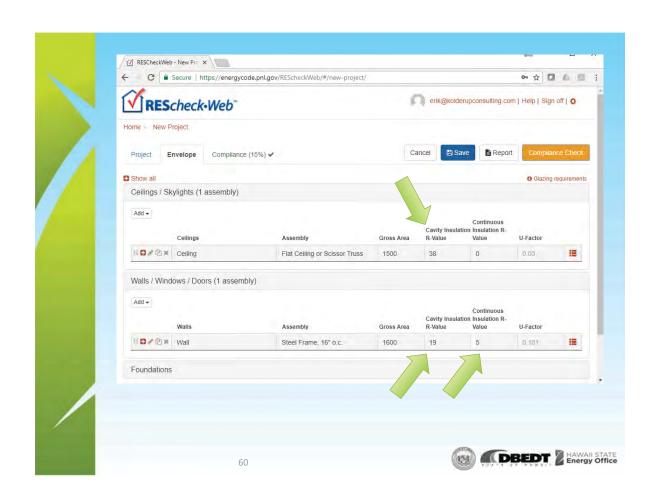


## R402.1.5 **Opaque Envelope – Total UA Option**

- Calculate total U-factor x Area for walls and roof
- Typically use REScheck software
  - Desktop or Web version
  - https://energycode.pnl.gov/REScheckWeb









# Section R407 Hawaii Specific Opaque Envelope – Points Option

- Total points ≥ 0
  - Roof and walls, or
  - Roof alone and wall alone
- Options for credit
  - Insulation
  - Cool roof
  - Radiant barrier
  - Wall reflectance
  - More efficient lighting
  - Efficient appliances
  - Wall shading
  - Ductless AC
  - High efficiency AC
  - No AC
  - Small dwelling
  - Energy Star fans
  - Solar electric

Messure	Standard Home Points	Home Points
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 + 90% high efficacy lighting and Energy Star Appliances	1	2
R-13 Wall Insulation + exterior shading wpf=0.36	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	NA.	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>®</sup>	-1	1
Install 1 kW or greater of solar electric	1	1

#### Reasons to use the Points Option

- 1. Want < R-30 roof insulation
- 2. Have metal-framed walls and don't want to add foam board insulation



# Points Option - <u>Wood</u> Framed Walls

Measure	Standard	Tropical
	Home	Zone
	Points	Points
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 + 90% high efficacy lighting and Energy Star appliances <sup>5</sup>	1	2
R-13 wall Insulation + exterior shading wpf=0.36	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	NA	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

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# **Points Option - Metal Framed Walls**

Measure	Standard Home	Tropical Zone
	Points	Points
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 + 90% high efficacy lighting and Energy Star Appliances <sup>5</sup>	1	2
R-13 wall insulation + exterior shading wpf=0.36	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>	0	1
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	NA	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

## **Points Option - Footnotes**

POINTS OPTION

<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 ≥ 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.

8 Install ceiling fans in all bedrooms and the largest space that is not used as a bedroom.



**POINTS OPTION** 

## **Radiant Barriers**

- Thermal emittance < 0.05 ("low-e")
- Low-e (shiny) surface facing air gap
- Cuts radiant heat transfer
  - Reduce cooling load through roof
  - Cuts radiant heat load on ducts from hot roof deck

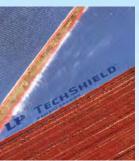








Cooler ceiling



Source: www.lpcorp.com



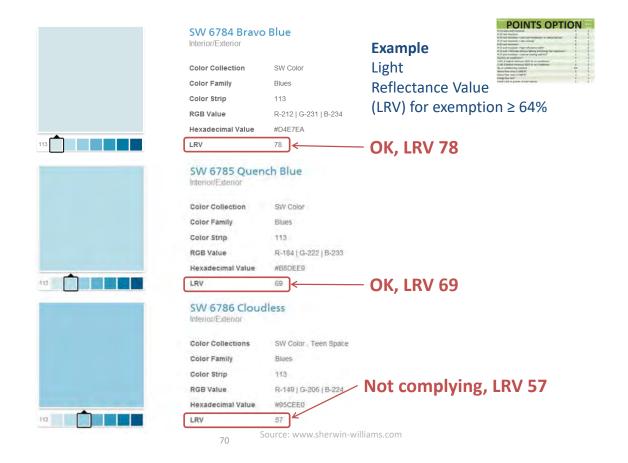


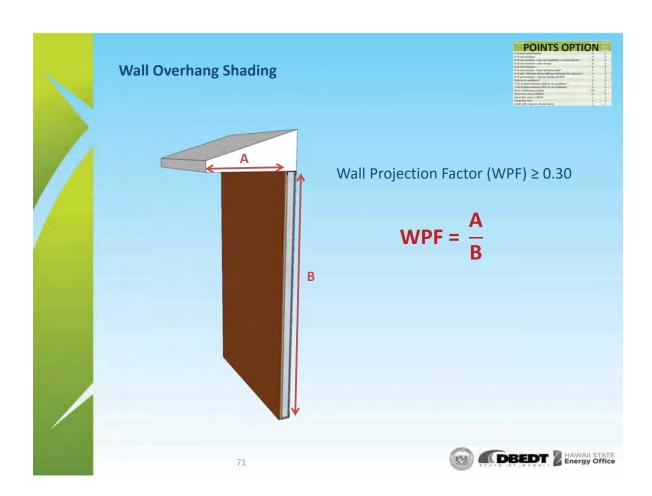














POINTS OPTION	ON	
A A Transport of the Control	1187-	- 0
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\$ 15 may a little legit of home before and from the community	100	- 6
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time? I felt or a recome of many operation.		- 1

AC System Type	Federal Standard	1 point	2 points
Split system	13.0 SEER	13.9 SEER	14.8 SEER
Packaged system	14.0 SEER	15.0 SEER	16.0 SEER

## **Points Option Example**

POINTS OPTION

2 to have been seen as the second of the se

- Single family home
  - 3000 ft<sup>2</sup>
  - Wood-framed construction
  - Air conditioned with splitsystem AC
- Want
  - R-19 insulation in cathedral ceiling (instead of R-30)
  - R-13 wall cavity insulation
- Questions
  - 1. How many points behind?
  - What are the options that can be used for compliance?

#### Two points behind

- R-19 roof
- Area ≥2500 ft<sup>2</sup>

#### **Options**

- 1 point: high reflectance walls
- 1 point: 90% HE lighting + ES appliances
- 1 point: wall shading 1 point: ductless AC 1 point: 13.9 SEER 2 points: 14.8 SEER 1 point: ES ceiling fans
- 1 point: ≥1 kW solar electric



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# Table R402.1.2 & R402.3 Fenestration - Prescriptive

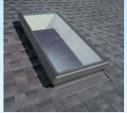
### Solar heat gain coefficient (SHGC) ≤ 0.25 EK22

- Windows and skylights
- Area weighted average allowed

#### **Exceptions**

- Up to 15 ft<sup>2</sup> exempt
- Skylights can have SHGC ≤ 0.30





www.veluxusa.com





## R402.4 **Air Leakage - Installation**



#### Details in Table R402.4.1.1

- Continuous air barrier
- Breaks or joints are sealed
- Recessed lighting
- Fenestration air leakage



## R402.4.1.2 Air Leakage - Testing

**Leakage ≤ 5 air changes per hour** at 0.2 in. w.c. pressure (50 Pa)







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## **Prescriptive Envelope Summary**

- Wall and roof, three options
  - 1. Table R402.1.2
  - 2. Total UA
  - 3. Points option
- Windows & skylights
  - Table R402.1.2
- Air leakage
  - Installation
  - Testing

**Or Tropical Zone option** 



# Residential – Systems







## **R403 AC System Requirements**

### Programmable thermostat



**Duct insulation** 



Duct sealing



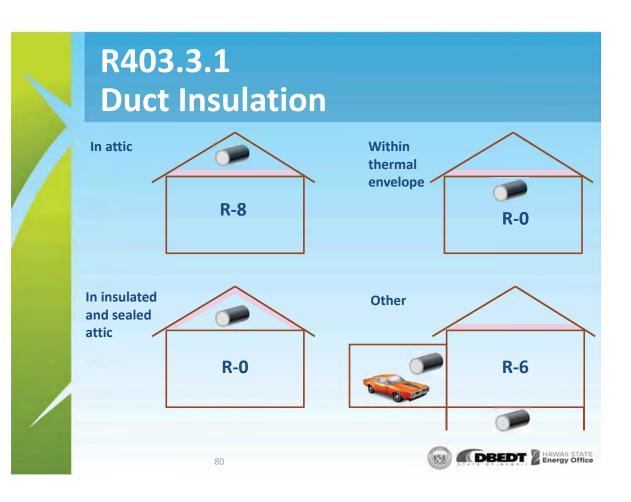
### Duct testing



Source: DOE/NREL PIX04869









## **DUCT WITHIN THERMAL ENVELOPE EXAMPLES**



Source: DOE/NREL PIX03067



Source: DOE/NREL PIX10076





# R403.2.2 Duct Sealing

IRC M1601.4.1 Joints, seams and connections Ducts mechanically fastened and sealed

### **Sealing options**

Tape with UL mark "181 B-FX"



#### Mastic with UL mark "181 B-M"



Source: www.energycodes.gov



## R403.2.2 **Duct Sealing**

IRC M1601.4.1 Joints, seams and connections Ducts mechanically fastened and sealed

### **Mechanical fastening options**

#### Flex duct

Mechanical fasteners with UL mark "181 B-C"





#### Metallic duct

- At least 1 inch overlap
- At least three screws/rivets





## R403.3.3 & R403.3.4 **Duct Testing**

#### Rough-in test





#### **Postconstruction test**



Leakage ≤ 4 cfm/100 ft<sup>2</sup>

Leakage ≤ 3 cfm/100 ft<sup>2</sup> (without air handler)



Leakage ≤ 4 cfm/100 ft<sup>2</sup>

Test **not** required if air handler and all ducts are within conditioned space



## R403.5.4 Hawaii Specific Solar Water Heating

### 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



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# R 403.10 Pool and Spas

- On/off switch
- Time switch
- Cover for heated pool
  - Unless 70% solar or site recovered heat



Source: www.energycodes.gov

### Section 6

## Residential – Electrical & Lighting





# R404.1 Lighting

High efficacy ≥ 75% of lamps

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



## R404.2 Hawaii Specific Ceiling Fans

**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.



an



# R404.2 Hawaii Specific Ceiling Fans/Whole-House Fan



(12)



# R404.2 Hawaii Specific Ceiling Fans/Whole-House Fan



### Section 7

Residential – Additions & Alterations

## **Additions and Alterations**

- Additions
  - 1. New construction requirements for addition alone, or
  - 2. Simulated Performance Alternative for existing + addition
- Alterations
  - New construction requirements for altered components
  - Several exceptions (partial list)
    - · Roof recover
    - · Wall cavity is not exposed
    - · Wall or roof cavity already filled with insulation
    - · Glazing-only replacement
    - · Roof replacement

#### Potential code amendment. Choose two:

- 1. Energy Star compliant roof covering
- 2. Radiant barrier
- 3. Attic ventilation via solar attic fans or ridge vent or gable vent
- 4. Shaded roof (C402.3)

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## **Compliance Certification**

COUNTY OF [COUNTY'S ENERGY CODE NAME]				
To the best of my knowledge, this project's design substantially conforms to the [CODE NAME] (2015 IECC as amended) for <b>building envelope components</b> .				
COMPLIANCE METHOD  Tropical Zone. R401.2.1  Prescriptive. R402  Points Option. R407  Simulated Performance. R405  Energy Rating Index. R406				
INFORMATION IN CONSTRUCTION DOCUMENTS  Roof insulation R-value Roof insulation type and location Roof membrane solar reflectance (if applicable) Wall insulation R-value Wall insulation type and location Window SHGC Air leakage testing requirement				
NOTES				
SIGNATURE:	DATE:			
NAME:				
TITLE:				
LICENSE NO.:				



## Residential – Wrap Up

### 1. Tropical Zone

- ≤50% air conditioned,
- not heated, and
- elevation < 2,400 feet

### 2. Prescriptive

Wall and roof options:

- 1. Prescriptive
- 2. Total UA
- 3. Points option

Windows & skylights

AC systems

Water heating

- 3. Simulated performance alternative
- 4. Energy rating index (ERI)







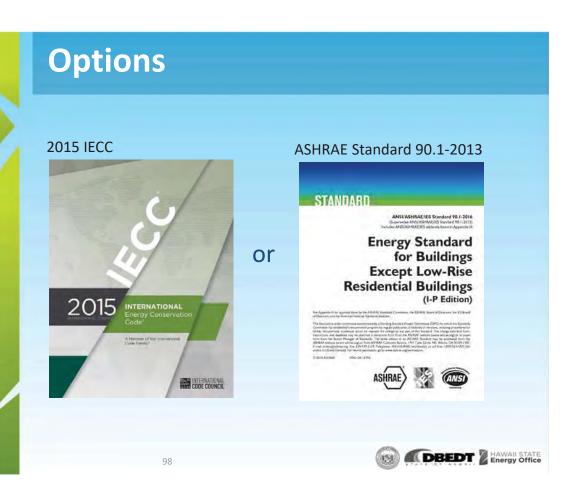


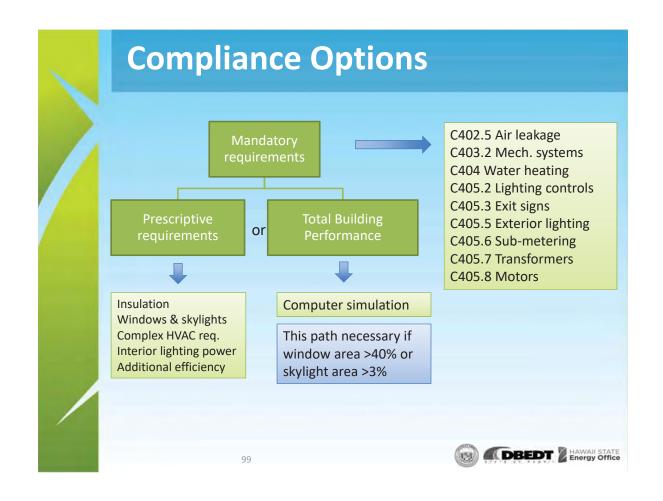


Section 7

Commercial – Overview







## **C406.1 Additional Efficiency Package Options**

Buildings must comply with at least one additional efficiency feature:

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









## **Checklists - Commercial**

- Envelope
- Mechanical system
- Service water heating
- Lighting and electrical
- Additional efficiency
- Additions
- Alterations



## **Highlights**

- Increased roof insulation
- Cool roof for low-slope
- Increased wall insulation
- Mass-wall insulation
- Window U-factor requirement
- Window area limit
- Skylights required for some spaces
- HVAC energy recovery
- **HVAC** system commissioning
- Refrigeration systems
- Lower lighting power allowance
- Lighting system functional testing
- "Additional Efficiency" requirements





# Commercial – Envelope



# Table C402.1.3 Roof and Wall Insulation

	Туре	Min. Insulation		
		Group R	Other	
Roof	Insulation entirely above deck	R-25ci	R-20ci	
	Metal building	R-19 + R-11 LS	R-19 + R-11 LS	
	Attic and other	R-38	R-38	
Walls	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-5ci * R-20	R-13+ R-5ci * R-20	

No requirement:

- Below grade wall
- Floors
- Slab-on-grade floors

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ci = continuous insulation

LS = layer system

\* See Hawaii exceptions





## Roof Insulation Entirely Above Deck

R-25 for group R buildings R-20 for other buildings



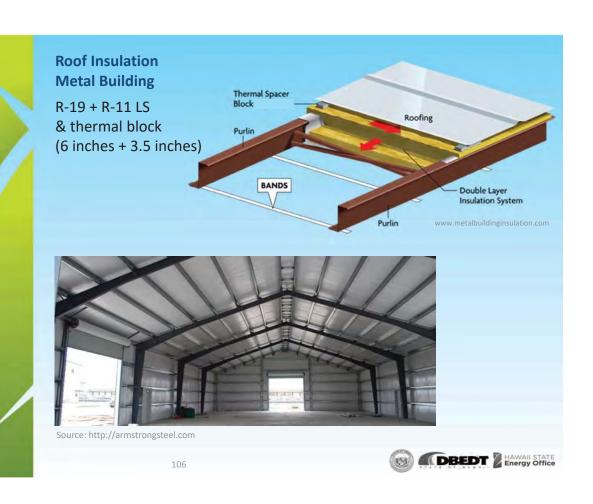


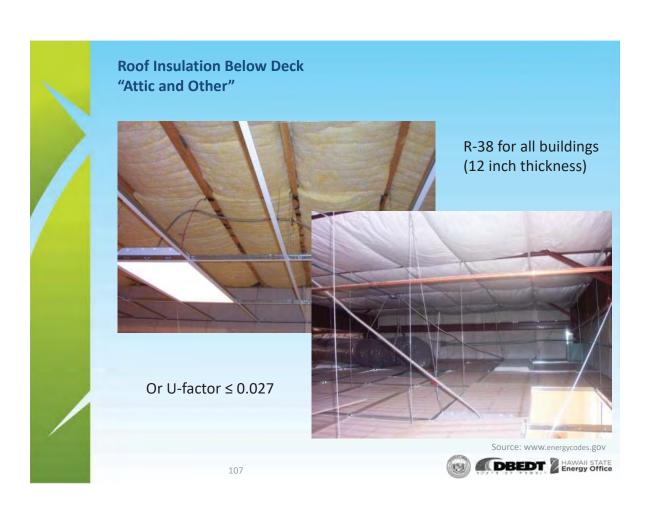
Polyisocyanurate R-6/inch Extruded polystyrene R-5/inch



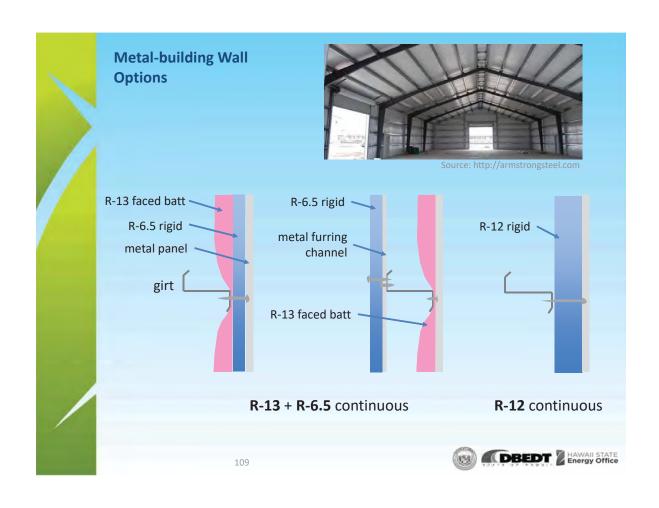
Photos courtesy of PIMA (Polyisocyanurate Insulation Manufacturers Association), via www.energycodes.gov











## C402.2.3 Hawaii Specific Exception for continuous wall insulation

### Continuous insulation for <u>framed</u> walls not required if:

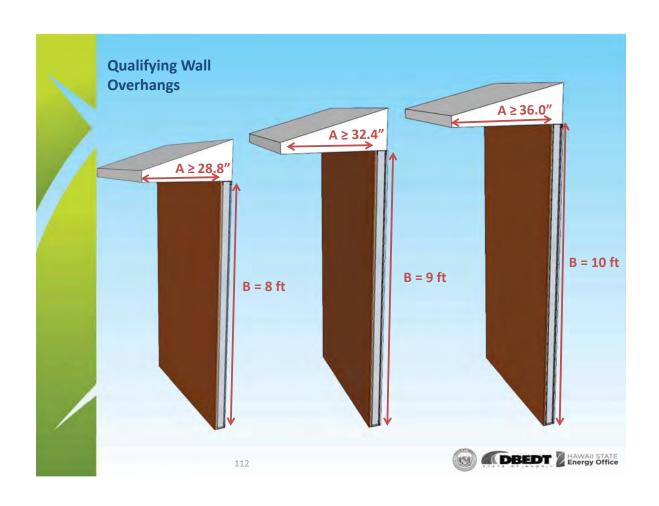
- 1. Walls reflectance  $\geq$  0.64, or
- 2. Walls overhang projection factor ≥ 0.3

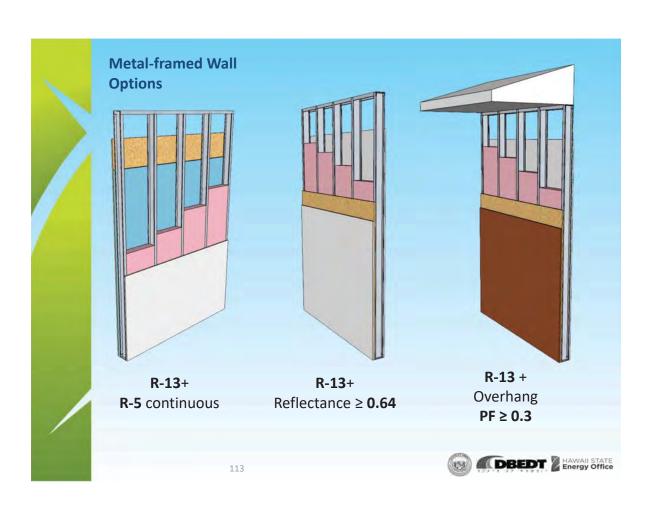
R-13 cavity insulation complies

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## C402.3 Low-sloped Roofs

### **Cool roof required**

- 1. solar reflectance ≥0.55+ thermal emittance ≥ 0.75, or
- 2. solar reflectance index ≥ 64

3-year aged values

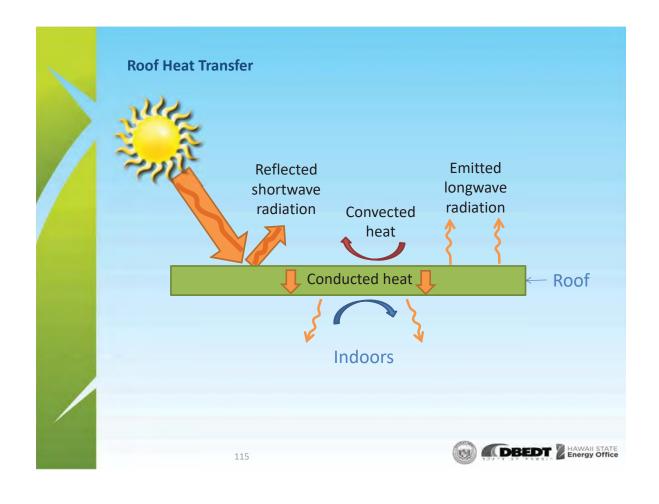
### Typical products

- Single-ply membrane
- Liquid applied



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### **Roof Temperature Examples**

### Sacramento, CA 89°F ambient

**EPDM** single-ply

173°F

Built up roof with aggregate

159°F

Built up roof with capsheet

158°F



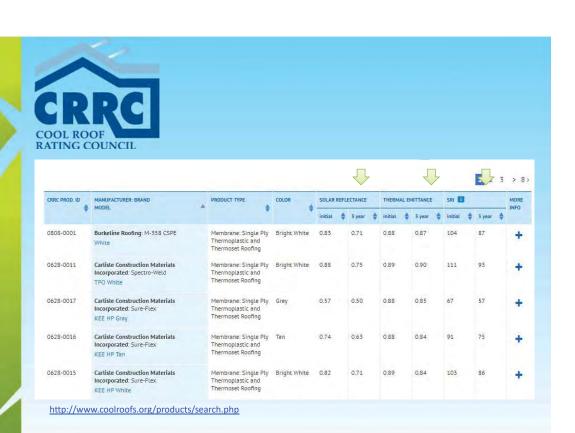






Courtesy Dan Varvais, Applied Polymer Systems





#### **CRRC Product Label Example**



### **Initial** Weathered

Solar Reflectance 0.88 0.68 3 year aged Thermal Emittance 0.87 0.89 3 year aged

Rated Product ID Number 0001 Licensed Seller ID Number 0896

Classification Production Line

Cool Roof Rating Council ratings are determined for a fixed set of conditions, and may not be appropriate for determining seasonal energy performance. The actual effect of solar reflectance and thermal emittance on building performance may vary.

Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.

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## C402.4 Fenestration

### Windows and skylights

- 1. Maximum area
- 2. Maximum U-factor
- 3. Maximum solar heat gain coefficient (SHGC)





## C402.4 Fenestration - Area



### Window area ≤ 30% of gross wall area

Up to 40% with daylighting controls

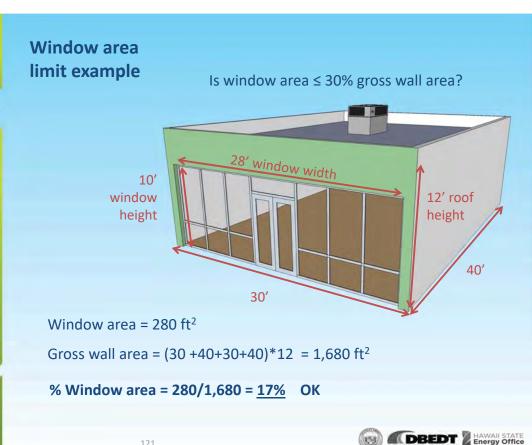
### Skylight area ≤ 3% of gross roof area

Up to 5% with daylighting controls

Otherwise, use <u>Total Building Performance</u> compliance option

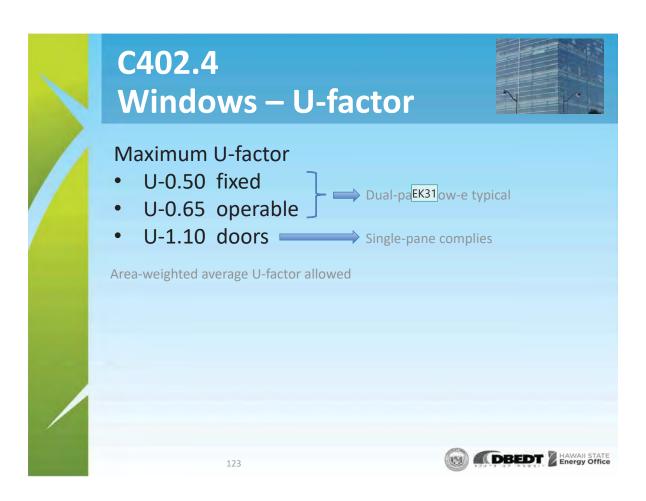








DBEDT HAWAII STATE Energy Office



## C402.4 Skylight – Minimum Area

### **Spaces**

- Under roof
- Area > 2,500 ft<sup>2</sup>
- Ceiling height > 15 ft

Several exceptions apply

### Minimum skylight area

- 1. 3% or roof, or
- 2. 1% effective aperture

- office
- lobby
- atrium
- concourse
- corridor
- storage space
- gymnasium/exercise center
- convention center
- automotive service area
- manufacturing
- nonrefrigerated warehouse
- · retail store
- distribution/sorting area
- · transportation depot
- workshop



## C402.4 Skylight Performance

SHGC  $\leq$  **0.35** (or  $\leq$  0.60 with daylighting controls)

U-factor ≤ **0.75** (or U-0.90 with daylighting controls)

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## C402.5 Envelope Air Leakage

- Continuous air barrier
- · Fenestration air leakage
- Openings to shafts, chutes, stairways and elevator lobbies
- Air intakes, exhaust openings, stairways, and shafts.
- · Loading-dock weatherseals
- Recessed lighting in the thermal envelope



## **Compliance Certification**

CITY AND COUNTY OF HONOLULU
REVISED ORDINANCE CHAPTER 32.
HONOLULU COUNTY CODE 1990. AS AMENDED

TO THE BEST OF MY KNOWLEDGE, THIS PROJECTS DESIGN SUBSTANTIALLY
CONFORMS TO THE 2015 IECC BUILDING ENERGY CONSERVATION CODE FOR THE
COMMERCIAL BUILDING GENERAL COMPLIANCE AND BUILDING ENVELOPE (SECTION C402), INCLUDING:

COMPLIANCE METHOD — INITIAL METHOD THAT APPLIES: INITIALS

COMPLIANCE METHOD — INITIAL METHOD THAT APPLIES: INITIALS

COMPLIANCE METHOD — ON THE COMPLIANCE (INITIAL ALL THAT APPLY): INITIALS

ABOVE DECK CEILING INSULATION R-VALUE

PRESCRIPTIVE BUILDING ENVELOPE COMPLIANCE (INITIAL ALL THAT APPLY): INITIALS

ABOVE DECK CEILING INSULATION (GROUP R)\_ R-20 CONTINUOUS INSULATION (ALL OTHERS)

ACTUAL INSULATION R-VALUE

NOTE; FOR CLIMATE ZONE 1:
R-25 CONTINUOUS INSULATION (GROUP R)\_ R-20 CONTINUOUS INSULATION (ALL OTHERS)

ACTUAL INSULATION R-VALUE

NOTE; FOR CLIMATE ZONE 1:
R-36 (GROUP R)\_ R-36 (ALL OTHERS)

ACTUAL INSULATION R-VALUE

NOTE; FOR CLIMATE ZONE 1:
R-36 (GROUP R)\_ R-30 (ALL OTHERS)

ABOVE GRADE VALUE NOWN ON PLANS/SCHEDULES

OCONTINUOUS INSULATION (GROUP R)\_ R-13 + R-5 CONTINUOUS INSULATION (GROUP R)\_ R-13 + R-6 CONTINUOUS INSULATION (GROUP R)\_ R-13 + R-6 CONTINUOUS INSULATION (GROUP R)\_ R-13 + R-5 CONTINUOUS INSULATION (G

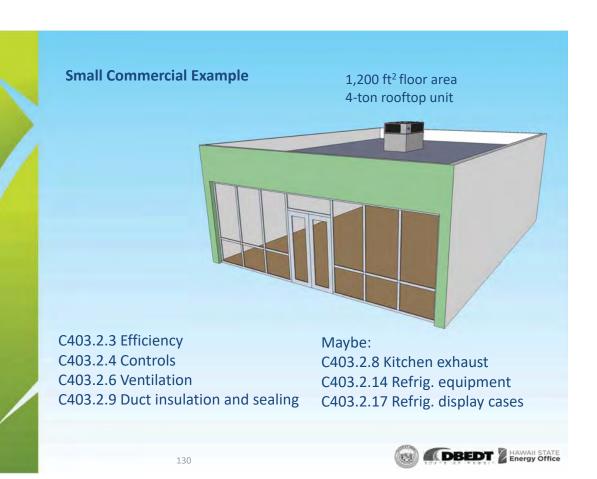
# Section 9 Commercial – Systems

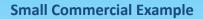


## **Mechanical System** Requirements

- Cooling load calculations
- Cooling and heating equipment efficiency
- Controls
- Ventilation
- Energy recovery
- Kitchen exhaust
- **Duct** insulation
- Pipe insulation
- Commissioning
- Refrigeration equipment efficiency
- Walk-in coolers and freezers
- Refrigerated warehouses
- Refrigerated display cases
- Heat recovery for water heating







C403.2.3 Efficiency

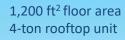




Table C403.2.3 Depends on equipment type & size

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	
				Before 1/1/2016	As of 1/1/2016
Air conditioners, air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System	13.0 SEER	13.0 SEER
			Single Package	13.0 SEER	14.0 SEER <sup>c</sup>





### **Small Commercial Example**

C403.2.4 Controls

### Programmable thermostat

Off-hour setback



1,200 ft<sup>2</sup> floor area 4-ton rooftop unit





### **Small Commercial Example**

C403.2.6 Ventilation

1,200 ft<sup>2</sup> floor area 4-ton rooftop unit



#### Outdoor air ventilation

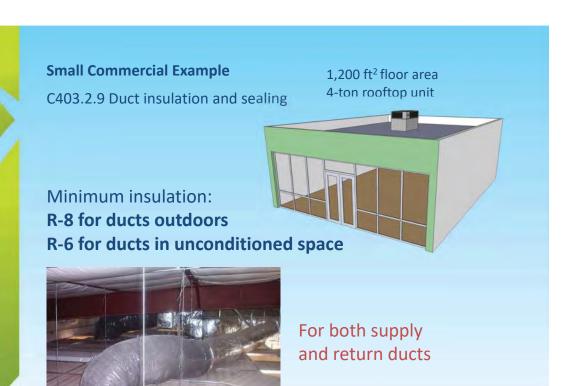
- Per International Mechanical Code
- Equal to ASHRAE Standard 62.1
  - For example:

Source: www.energycodes.gov

0.06 cfm/ft<sup>2</sup> + 5 cfm/person for office space



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# A few more mechanical requirements

Guest room door switches

Demand control ventilation

Parking garage exhaust

**Energy recovery** 

Commissioning

13



## C403.2.4.2.4 Hawaii Specific Door Switches

#### Space types

- Hotel and motel sleeping units
- Guest suites
- Time-share condominiums

#### Control operation

- Disable cooling or reset to ≥90°F
- < 5 minutes of opening</li>







## C403.2.6.1 Demand Controlled Ventilation

### Required for spaces

- > 500 ft<sup>2</sup>, and
- ≥ 25 people/1000 ft² of floor area

### If HVAC system has

- · Automatic outdoor air damper modulating control, or
- > 3,000 cfm outdoor airflow

Theater, auditorium, ballroom, conference room, etc.



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# C403.2.6.2 Enclosed Parking Garages

### Automatic variable-speed exhaust fan control

- Contaminent sensors
- Reduce flow to <50%

#### **Exceptions:**

- < 22,500 cfm
- > 1,125 cfm/hp



# Table C403.2.7 Energy Recovery Ventilation

Energy recovery effectiveness ≥ 50%

If design supply air flow exceeds this limit

Design outdoor airflow	Fan Operates < 8,000 hrs/yr	Fan Operates ≥ 8,000 hrs/yr
≥ 10% and <20%	≥26,000 cfm	≥2,500 cfm
≥ 20% and <30%	≥16,000 cfm	≥2,000 cfm
≥ 30% and <40%	≥5,500 cfm	≥1,000 cfm
≥ 40% and <50%	≥4,500 cfm	≥500 cfm
≥ 50% and <60%	≥3,500 cfm	>0 cfm
≥ 60% and <70%	≥2,000 cfm	>0 cfm
≥ 70% and <80%	≥1,000 cfm	>0 cfm
≥ 80%	>0 cfm	>0 cfm

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EK33 C403.2.11 & C408.2 **Mechanical Systems Commissioning HVAC Commissioning**  Required when • ≥ 480,000 Btu/h cooling capacity, or Typically  $\geq$  20,000 ft<sup>2</sup> • ≥ 600,000 Btu/h heating capacity Requires: Notes on construction documents · Commissioning plan · Systems adjusting and balancing Prior to final mechanical Functional performance testing and plumbing inspections Equipment Controls Preliminary commissioning report Registered design engineer or approved agency Final commissioning report Construction documents and O&M Manuals

### **Compliance Certification**

CITY AND COUNTY OF HONOLULU REVISED ORDINANCE CHAPTER 32, HONOLULU COUNTY CODE 1990, AS AMENDED

TO THE BEST OF MY KNOWLEDGE, THIS PROJECT'S DESIGN SUBSTANTIALLY CONFORMS TO THE 2015 IECC BUILDING ENERGY CONSERVATION CODE FOR COMMERCIAL MECHANICAL SYSTEMS (SECTION C403, C404 and C408), INCLUDING:

MECHANICAL SYSTEM COMPLIANCE (INITIAL ALL THAT APPLY) INITIALS
HAVE EQUIPMENT SIZING & EFFICIENCY
NOTE: MINIMUM EFFICIENCY PER TABLES C403 2 3(1) TO C403 2 3(9)
ACTUAL EQUIPMENT EFFICIENCY. SEER/EER/COP/KW/TON
OR
SEER/EER/COP/KW/TON SHOWN ON EQUIPMENT SCHEDULES

HVAC SYSTEM CONTROLS

NOTE: THERMOSTATIC CONTROLS AS PER SECTION C403.2.4.1,
C403.2.4.1.3, C403.2.4.2, C403.2.4.3, C403.3.1, C403.4

C403.24.1,3 C403.24.2, C403.24.3, C403.3.1, C403.4

REQUIRED DOOR SWITCHES ON OPAQUE AND GLASS DOORS OPENING TO THE OUTDOORS FROM CONDITIONED SPACES. IN HOTEL AND MOTEL SLEEPING UNITS, GUEST SUITES AND TIME-SHARE CONDOMINIUMS

DEMAND CONTROLLED VENTILATION (DCV)

NOTE: DOV SHALL BE PROVIDED FOR SPACES LARGER THAN 500 SQUARE FEET AND OCCUPANT LOAD OF 25 PEOPLE PER 1,000 SQUARE FEET OF FLOOR AREA.

KITCHEN EXPANJES SYSTEM

NOTE: AS PER SECTION C403.2.8

INSULATION

NOTE: DUCT INSULATION AS PER SECTION C403.2.9

PIPE INSULATION AS PER SECTION C403.2.10

MECHANICAL SYSTEM COMMISSIONING
AIR SYSTEM DESIGN FOR FAN MOTORS EXCEEDING 5 HP
NOTE: FAN PERFORMANCE IN ACCORDANCE WITH SECTION
C403.2.12.1 TO C403.2.12.3

REFRIGERATION EQUIPMENT
NOTE: REFRIGERATION EQUIPMENT PERFORMANCE IN
ACCORDANCE WITH SECTION C403.2.14(2) AND C403.2.14(2)
SERVICE WATER HEATING
NOTE: MINIMUM WATER HEATING EQUIPMENT PERFORMANCE PER
TABLE C404.2

SIGNATURE: DATE NAME:

LICENSE NO.:

### Section 10 Commercial – Elec. & Lighting

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### **Electrical Power & Lighting**

- Dwelling unit lighting
- Lighting controls
- Exit signs
- Interior lighting power
- Exterior lighting
- Sub-metering
- Transformers
- Motors
- Elevators and escalators

## **C405.2.1** Occupant Sensor Controls

- · Occupant sensors required
  - Classrooms/lecture/training rooms
  - Conference/meeting/multipurpose
  - Copy/print rooms
  - Lounges
  - Employee lunch and break rooms
  - Private offices
  - Restrooms
  - Storage rooms
  - Janitorial closets
  - Locker rooms
  - Other spaces ≤300 ft² with floor-to-ceiling partitions
  - Warehouses



#### Exceptions

- · Security or emergency areas
- Exit stairways, ramps and passageways





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### C405.2.2 Time-Switch Controls

- Time-switch controls for each area without occupant sensor
- Exceptions
  - Sleeping areas
  - Patient care
  - Safety or security
  - Lighting for continuous operation
  - Shop and laboratory classrooms

Must have light reduction controls



## C405.2.3 Daylight-responsive controls

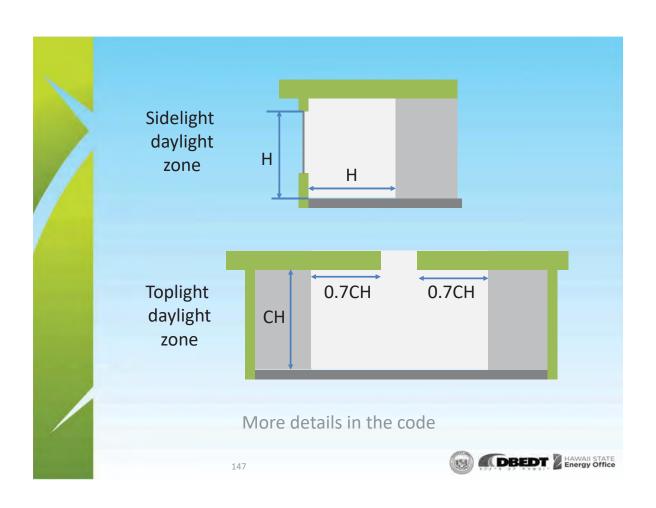
- Required in spaces with >150W of general lighting in:
  - Sidelight daylight zones
  - Toplight daylight zones
- Exceptions
  - Patient care
  - Dwelling units
  - Display and accent lighting
  - Display case lighting
  - First floor sidelight zone in A-2 and M occupancies







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## C405.2.4 Guest Room Master Control

- Applies to
  - Guest rooms and suites
  - Timeshare condos
- Auto shut off
  - Installed lights
  - Switched receptacles
  - < 20 minutes after guest leaves
- Key card system complies





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## C405.4.1 Connected Lighting Power

- Includes
  - Screw-in lamps
    - Labeled max. luminaire power
  - Low-voltage lighting
    - Transformer rated power
  - Line-voltage tracks
    - ≥ 30W/linear ft, or
    - Current-limiting device rating
  - Input power for all other luminaires



## Table C405.4.2(1) Interior Lighting Power Allowance

#### **Building Area Method**

TABLE C405.4.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft²)	
Automotive facility	0.80	
Convention center	1.01	
Courthouse	1.01	
Dining: bar lounge/leisure	1.01	
Dining: cafeteria/fast food	0.9	
Dining: family	0.95	
Dormitory	0.57	
Exercise center	0.84	
Fire station	0.67	
Gymnasium	0.94	
Health care clinic	0.90	
Hospital	1.05	
Hotel/Motel	0.87	
Library	1.19	
Manufacturing facility	1.17	

Motion picture theater	0.76
Multifamily	0.51
Museum	1.02
Office	0.82
Parking garage	0.21
Penitentiary	0.81
Performing arts theater	1.39
Police station	0.87
Post office	0.87
Religious building	1.0
Retail	1.26
School/university	0.87
Sports arena	0.91
Town hall	0.89
Transportation	0.70
Warehouse	0.66
Workshop	1.19

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## Table C405.4.2(2) Interior Lighting Power Allowance

Space-by-Space Method (partial)

### TABLE C405.4.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES <sup>a</sup>	LPD (watts/sq.ft)	
Atrium		
Less than 40 feet in height	0.03 per foot in total height	
Greater than 40 feet in height	0.40 + 0.02 per foo in total height	
Audience seating area		
In an auditorium	0.63	
In a convention center	0.82	
In a gymnasium	0.65	
In a motion picture theater	1.14	
In a penitentiary	0.28	
In a performing arts theater	2.43	
In a religious building	1.53	
In a sports arena	0.43	
Otherwise	0.43	
Banking activity area	1.01	
Breakroom (See Lounge/Breakroom)		
Classroom/lecture hall/training room		
In a penitentiary	1.34	
Otherwise	1.24	

#### TABLE C405.4.2(2) INTERIOR LIGHTING POWER ALLOWANCES:

COMMON SPACE TYPES <sup>a</sup>	LPD (watts/sq.ft)
Atrium	
Less than 40 feet in height	0.03 per foot in total height
Greater than 40 feet in height	0.40 + 0.02 per foot in total height
Audience seating area	
In an auditorium	0.63
In a convention center	0.82
In a gymnasium	0.65
In a motion picture theater	1.14
In a penitentiary	0.28
In a performing arts theater	2.43
In a religious building	1.53
In a sports arena	0.43
Otherwise	0.43
Banking activity area	1.01
Breakroom (See Lounge/Breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	1.34
Otherwise	1.24
Conference/meeting/multipurpose room	1.23
Copy/print room	0.72
Corridor	
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	0.92
In a hospital	0.79
In a manufacturing facility	0.41
Otherwise	0.66
Courtroom	1.72
Computer room	1.71
Dining area	
In a penitentiary	0.96
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	19
In bar/lounge or leisure dining	1.07
In cafeteria or fast food dining	0.65
In family dining	0.89
Otherwise	0.65
Electrical/mechanical room	0.95
Emergency vehicle garage	0.56

#### TABLE C405.4.2(2)—continued INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES*	LPD (watts/sq.ft
Food preparation area	1.21
Guest room	0.47
Laboratory	
In or as a classroom	1.43
Otherwise	1.81
Laundry/washing area	0.6
Loading dock, interior	0.47
Lobby	
In a facility for the visually impaired (and not used primarily by the staff) <sup>b</sup>	1.8
For an elevator	0.64
In a hotel	1.06
In a motion picture theater	0.59
In a performing arts theater	2.0
Otherwise	0.9
Locker room	0.75
Lounge/breakroom	
In a healthcare facility	0.92
Otherwise	0.73
Office	
Enclosed	1.11
Open plan	0.98
Parking area, interior	0.19
Pharmacy area	1.68
Restroom	
In a facility for the visually impaired (and not used primarily by the staff	1.21
Otherwise	0.98
Sales area	1.59
Seating area, general	0.54
Stairway (See space containing stairway)	
Stairwell	0.69
Storage room	0.63
Vehicular maintenance area	0.67
Workshop	1.59
BUILDING TYPE SPECIFIC SPACE TYPES	LPD (watts/sq.ft)
Facility for the visually impaired <sup>b</sup>	
In a chapel (and not used primarily by the staff)	2.21
In a recreation room (and not used primarily by the staff)	2.41
Automotive (See Velucular Maintenance Area	bove)
Convention Center—exhibit space	1,45
Dormitory—living quarters	0.38
Fire Station—sleeping quarters	0.22
Gymnasium/fitness center	
In an exercise area	0.72
In a playing area	1.2

BUILDING TYPE SPECIFIC SPACE TYPES*	LPD (watts/sq.ft
healthcare facility	
In an exam/treatment room	1.66
In an imaging room	1,51
In a medical supply room	0.74
In a nursery	0.88
In a nurse's station	0.71
In an operating room	2,48
In a patient room	0.62
In a physical therapy room	0.91
In a recovery room	1.15
Library	
In a reading area	1.06
In the stacks	1.71
Manufacturing facility	
In a detailed manufacturing area	1.29
In an equipment room	0.74
In an extra high bay area (greater than 50' floor-to-ceiling height)	1.05
In a high bay area (25-50' floor-to-ceiling height)	1.23
In a low bay area (less than 25' floor-to- ceiling height)	1.19
Museum	
In a general exhibition area	1.05
In a restoration room	1.02
Performing arts theater—dressing room	0.61
Post Office—Sorting Area	0.94
Religious buildings	
In a fellowship hall	0.64
In a worship/pulpit/choir area	1.53
Retail facilities	
In a dressing/fitting room	0.71
In a mall concourse	1.1
Sports arena—playing area	
For a Class I facility	3.68
For a Class II facility	2.4
For a Class III facility	1.8
For a Class IV facility	1,2
Transportation facility	
In a baggage/carousel area	0.53
In an airport concourse	0.36
At a terminal ticket counter	0.8
Warehouse—storage area	
For medium to bulky, palletized items	0.58
For smaller, hand-carried items	0.95

- a. In cases where both a common space type and a building area specif
- b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

#### **Small Commercial Example**

What is the allowed interior lighting power?

#### Floor area 1,200 ft<sup>2</sup> Office occupancy

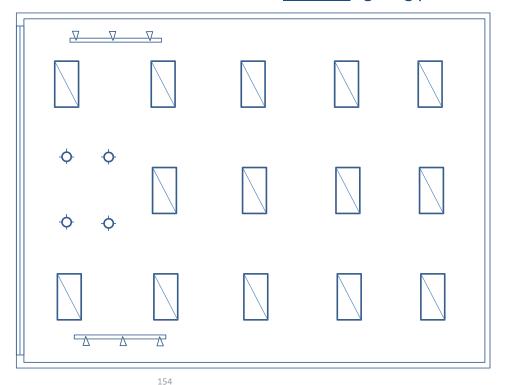


**Table C405.4.2 Building Area Method Allowance** Office = 0.82 W/ft<sup>2</sup>

 $0.82 \text{ W/ft}^2 \times 1,200 \text{ ft}^2 = 984 \text{ watts allowed}$ 

#### **Small Commercial Example**

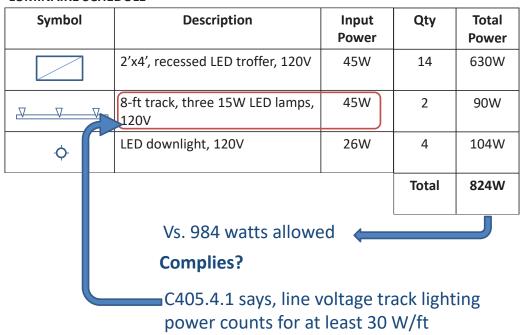
#### What is the <u>installed</u> lighting power?



#### Small Commercial Example

#### What is the <u>installed</u> lighting power?

#### **LUMINAIRE SCHEDULE**



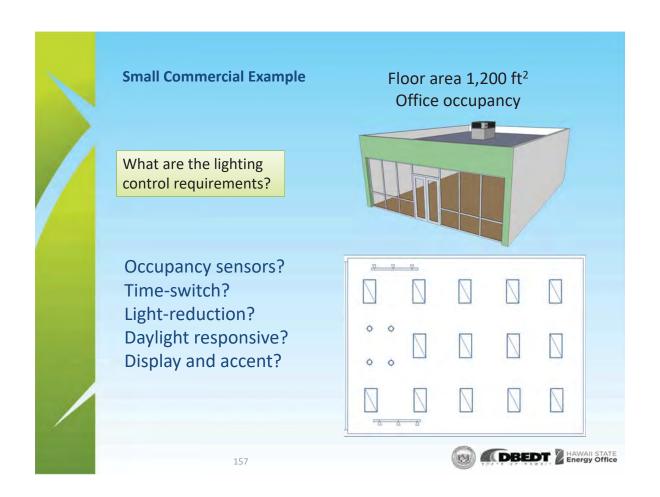
#### **Small Commercial Example**

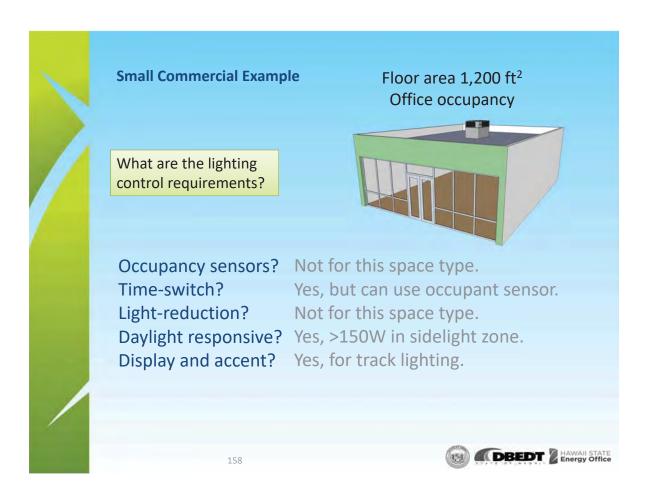
#### What is the <u>installed</u> lighting power?

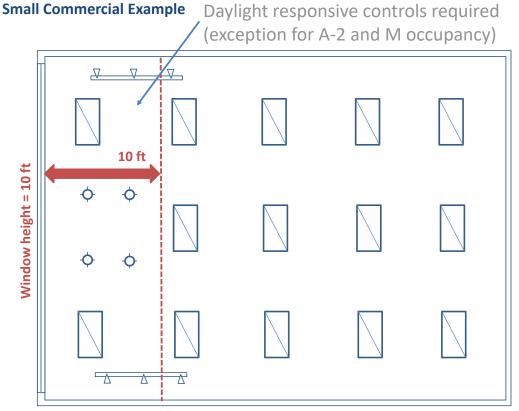
#### **LUMINAIRE SCHEDULE**

Symbol		Description Input Power		Qty	Total Power
		2'x4', recessed LED troffer, 120V 45W		14	630W
□ □ □	V	8-ft track, three 15W LED lamps, 120V	4 <del>5W</del> 240W	2	<del>90W</del> 480W
<b>\$</b>		LED downlight, 120V	26W	4	104W
					<del>824W</del> 1214W
	Vs. 984 watts allowed				
	Complies?				
C405.4.1 says, line voltage track lighting power counts for at least 30 W/ft					

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## C405.5 Exterior Lighting

Exterior lighting zones

- 1. Base site allowance
- 2. Tradable surfaces
  Sum allowance for all surfaces
- 3. Nontradable surfaces

  Each surface comply separately

Some exceptions

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 metropoli- tan areas as designated by the local land use planning authority		

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# C405.5 Exterior Lighting

1. Base site allowance

Zone 1	500 W
Zone 2	600 W
Zone 3	750 W
Zone 4	1300 W

#### 2. Tradable surfaces

		LIGHTING ZONES					
		Zone 1	Zone 2	Zone 3	Zone 4		
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W		
	Uncovered Parking Areas						
	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>		
	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		
Tradable Surfaces	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>3</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>		
(Lighting power densities for uncovered	Building Entrances and Exits						
parking areas, building grounds, building entrances and exits, canopies and overhangs	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					
and outdoor sales areas are tradable.)	Entry canopies	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>		
	Sales Canopies						
	Free-standing and attached	0.6 W/ft <sup>2</sup>	0.6 W/ft <sup>2</sup>	0.8 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>		
	Outdoor Sales						
	Open areas (including vehicle sales lots)	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.5 W/ft <sup>2</sup>	0.7 W/ft <sup>2</sup>		
	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		

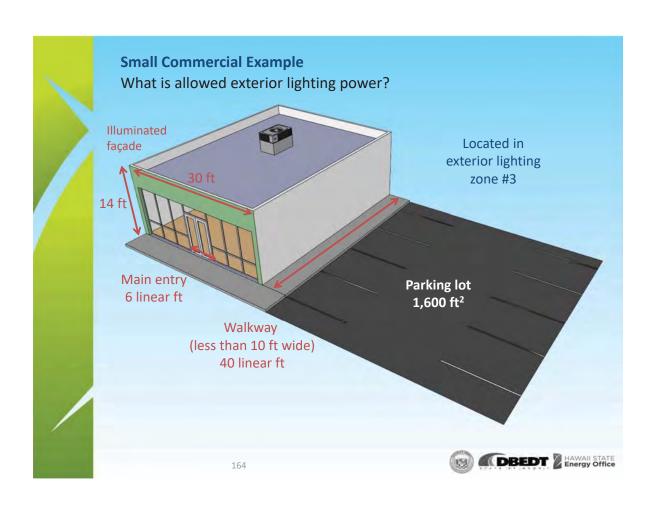
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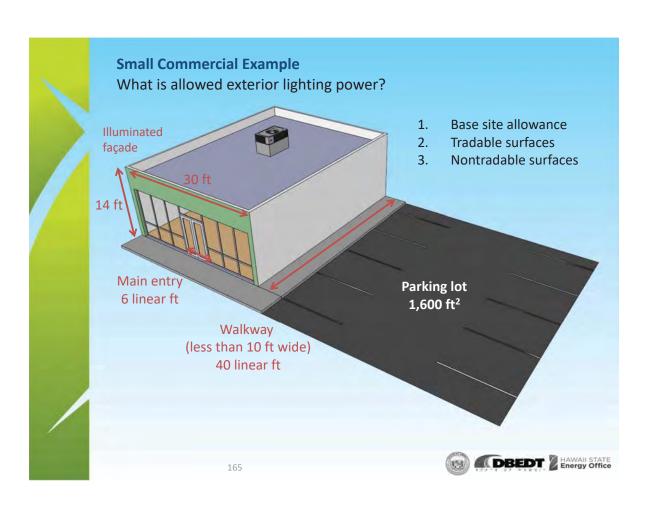


#### 3. Nontradable surfaces

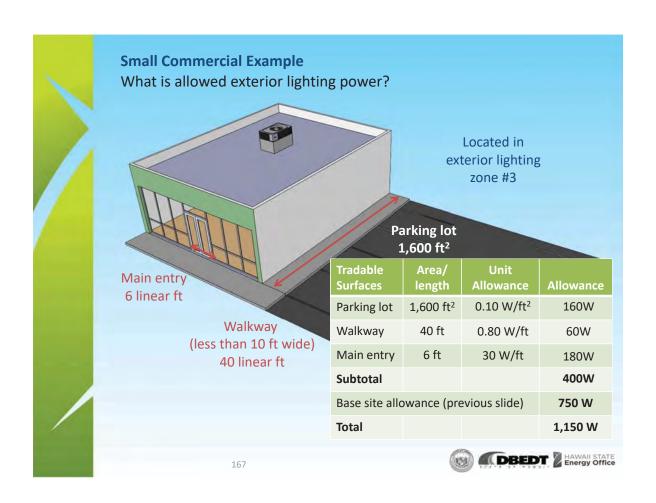
		LIGHTING ZONES			
		Zone 1	Zone 2	Zone 3	Zone 4
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.075 W/ft² of gross above-grade wall area	0.113 W/ft² of gross above-grade wall area	0.15 W/ft² of gross above-grade wall area
	Automated teller machines (ATM) 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/ft² of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft² of covered and uncovered area	0.5 W/ft² of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through			
	Parking near 24-hour retail entrances	800 W per main entry			













### C408.3 Lighting System Functional Testing

- Applies to:
  - Occupancy sensor controls
  - Time-switch controls
  - Daylight responsive controls
- Calibrated, adjusted, programmed and in proper working condition per the design and manufacturer's instructions
  - Prior to passing final inspection
  - Registered design professional provides evidence

### C405.10 Hawaii Specific **Sub-Metering**

#### Metering for new buildings with tenants

- Entire building, and
- Each tenant occupying ≥1,000 ft<sup>2</sup>

Tenants shall have access to data collected for their space





### **Compliance Certification**

CITY AND COUNTY OF HONOLULU REVISED ORDINANCE CHAPTER 32 HONOLULU COUNTY CODE 1990, AS AMENDED

TO THE BEST OF MY KNOWLEDGE, THIS PROJECT'S DESIGN SUBSTANTIALLY CONFORMS TO THE 2015 IECC BUILDING ENERGY CONSERVATION CODE COMMERCIAL ELECTRICAL SYSTEMS (SECTION C405), INCLUDING:

ELECTRICAL SYSTEM COMPLIANCE (INITIAL ALL THAT APPLY): INITIALS LIGHTING CONTROLS

NOTE: LIGHTING CONTROLS AS PER SECTION C405.2.1, C405.2.2. C405.2.3, C405.2.4 AND C405.2.5 INTERIOR LIGHTING POWER

NOTE: BUILDING AREA METHOD PER TABLE C405.4.2(1)

OR
SPACE-BY-SPACE METHOD PER TABLE C405.4.2(2)

EXTERIOR LIGHTING POWER
NOTE: AS PER TABLE C405.5.2(1) AND C405.5.2(2)

SEPARATE ELECTRICAL METER FOR EACH DWELLING UNIT IN GROUP R-2 BUILDING
ELECTRICAL TRANSFORMERS
NOTE: MINIMUM EFFICIENCY PER TABLE C405.7

NOTE: MINIMUM EFFICIENCY PER TABLE C405.7
ELECTRICAL MOTORS

NOTE: MINIMUM EFFICIENCY PER TABLE C405.8(1) TO C405.8(4)
SUB-METERING

NOTE: IN NEW BUILDINGS WITH TENANTS, METERING SHALL BE COLLECTED FOR THE ENTIRE BUILDING AND INDIVIDUALLY FOR EACH TENANT OCCUPYING 1,000 SQUARE FEET OR MORE.

SIGNATURE NAME TITLE: LICENSE NO.

## Please fill out the evaluation forms

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### For more information

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#### 2015 IECC available:

http://iccsafe.org/publications

#### State Energy Code Website:

 http://energy.hawaii.gov/hawaii-energy-buildingcode/2015-iecc-update

