# City of Scottsdale
# Energy Conservation Code

## Commercial Energy Code Provisions

## 2021 International Energy Conservation Code

rev. February 24, 2025

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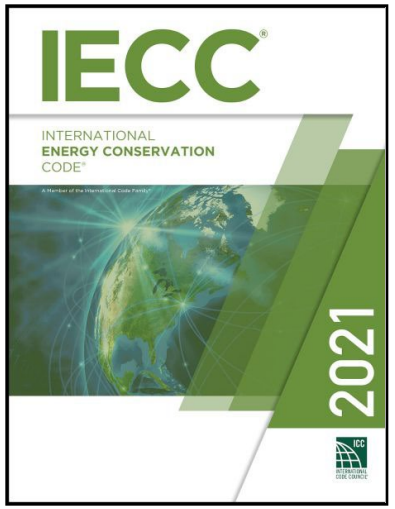
Office of Environmental Initiatives
Planning and Development
Community and Economic Development
City of Scottsdale

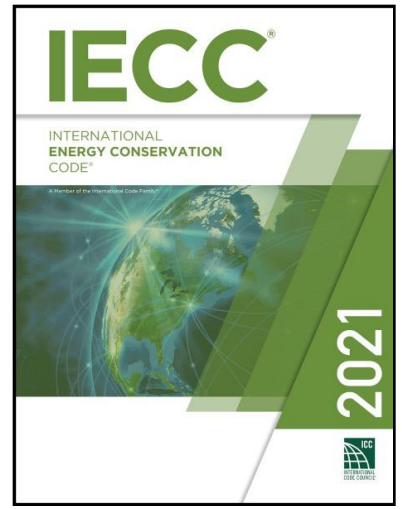
# IECC Efficiency Components




- **Building Thermal Envelope**
  - Walls, roofs, fenestration (R-value, U-factor, SHGC)
  - Air leakage control
- **Mechanical Systems**
  - HVAC system sizing, efficiency, and controls
  - Ventilation systems, fan power efficiency and controls
- **Service Water Heating**
  - Equipment efficiencies and hot water delivery
- **Electrical Power and Lighting Systems**
  - Lighting power density and controls
  - Automatic receptacle control
  - EV charging infrastructure

# IECC Commercial Provisions

- Chapter 1 Scope and Administrative
- Chapter 2 Definitions
- Chapter 3 General Requirements
- Chapter 4 Commercial Energy Efficiency
- Chapter 5 Existing Buildings
- Chapter 6 Referenced Standards



# International Energy Conservation Code

## Scope

- "*Commercial buildings*", building site, associated systems and equipment.
- "*Commercial buildings*" include multifamily buildings (R-2) more than 3 stories.
- For this code, "*residential building*" includes 1- and 2-family dwellings and multiple single-family dwellings (townhouses) and Group R-2, R-3 and R-4 buildings 3 stories or less.

*CI01.2*

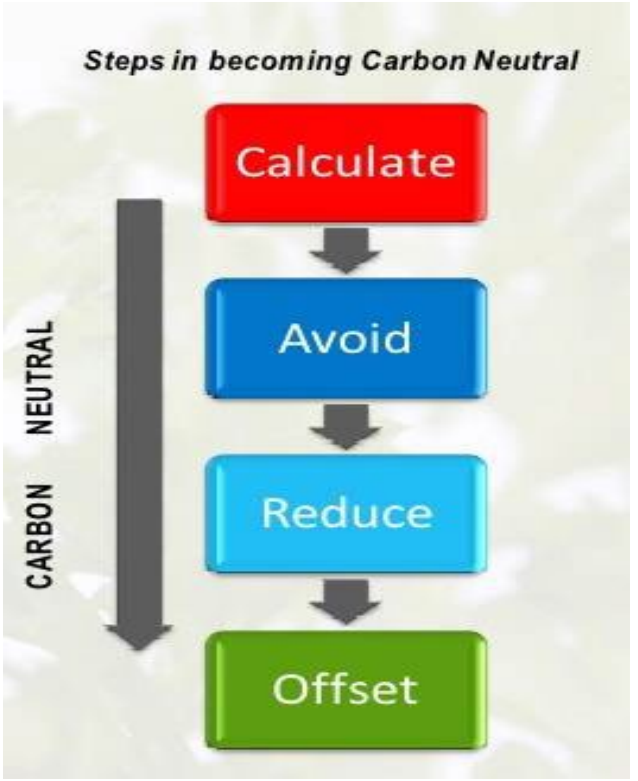
# International Energy Conservation Code

## Intent

- Regulate the design and construction of buildings for the use and conservation of energy over the life of each building
- Addresses the design of all building systems that affect the comfort of the occupants and their use of the building, including:
  - Wall, roof and floor insulation
  - Fenestration
  - Cooling and heating systems
  - Service hot water systems
  - Lighting systems and controls
  - Elevators and escalators

# Health, safety & public welfare benefits

- Reduced site energy, source energy and emissions
- Reduced transmission and distribution losses
- Reduced utility load and need to build new power generation plants and infrastructure
- Leverage for on-site renewable energy
- Carbon neutrality


Carbon Neutrality

# Mixed Residential and Commercial Buildings

Where a building includes both residential and commercial, each portion shall be separately considered and meet the applicable provisions of the IECC-Residential and IECC-Commercial

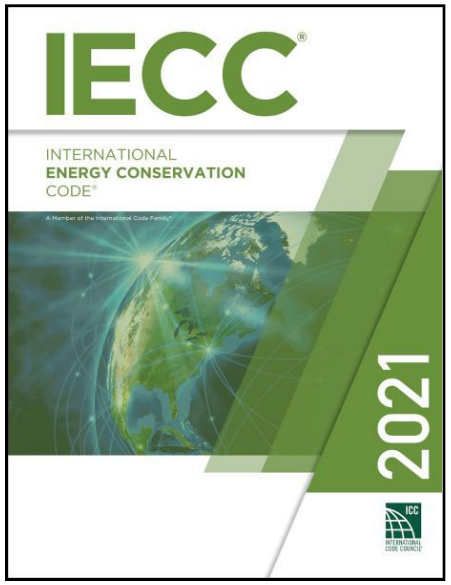
*C101.4.1*

# Information on construction documents

- Energy compliance path
- Insulation materials and their R-Values
- Fenestration U-factors and SHGC
- Area-weighted U-factors and SHGC calculations
- Mechanical system design criteria, equipment types, sizes and efficiencies
- Equipment and system controls
- Duct sealing, duct and pipe insulation and location
- Lighting fixture schedule with wattage and controls
- Location of daylight zones on floor plans
- Air barrier and air sealing details

# IECC for Multifamily and Commercial

- **Top 10 2021 Energy Code Changes**
  1. Thermal envelope/air leakage (not TI)
  2. Cool roofs for low slope roofs (not TI)
  3. Demand control ventilation and energy recovery
  4. Automatic HVAC controls in hotel guestrooms
  5. Lighting controls and power allowance
  6. Automatic receptacle control in offices (not TI)
  7. EV capable charging infrastructure (not TI)
  8. Rooftop solar-ready zones (not TI)
  9. Additional efficiency requirement options (not TI)
  10. Commissioning of mechanical and lighting systems




“not TI” means not applicable for tenant improvement and remodeling projects.

# IECC Commercial Provisions

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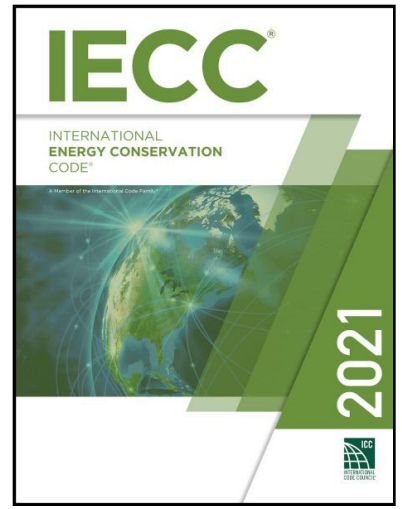
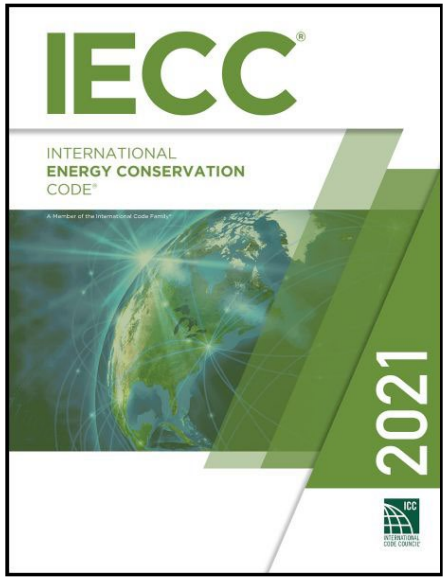


# Chapter 4 – Energy Efficiency Requirements

- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Choose Compliance Path

**1**

## 2021 IECC Mandatory & Prescriptive

- C402 – **Envelope**
  - Tables or UA trade-off
  - Air leakage
- C403 – **Mechanical**
- C404 – **SWH**
- C405 – **Lighting**
- C406 - **Additional Efficiency Requirements**
  - HVAC upgrade
  - Lighting upgrade
  - Enhanced light controls
  - On-site renewable
  - Water heating upgrade

OR

**2**

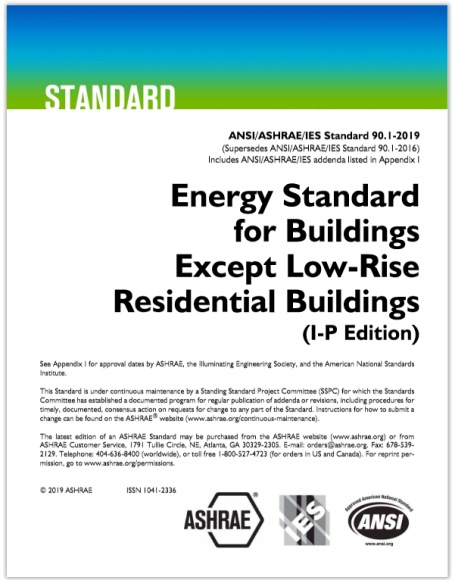
## 2021 IECC Mandatory & Performance

- C407 – **Total Building Performance**
- C402.5 – **Air leakage**
- C403.2 – **Mechanical**
- C404 – **SWH**
- C405 – **Lighting Controls**
- Building energy cost to be ≤ 80% of reference

OR

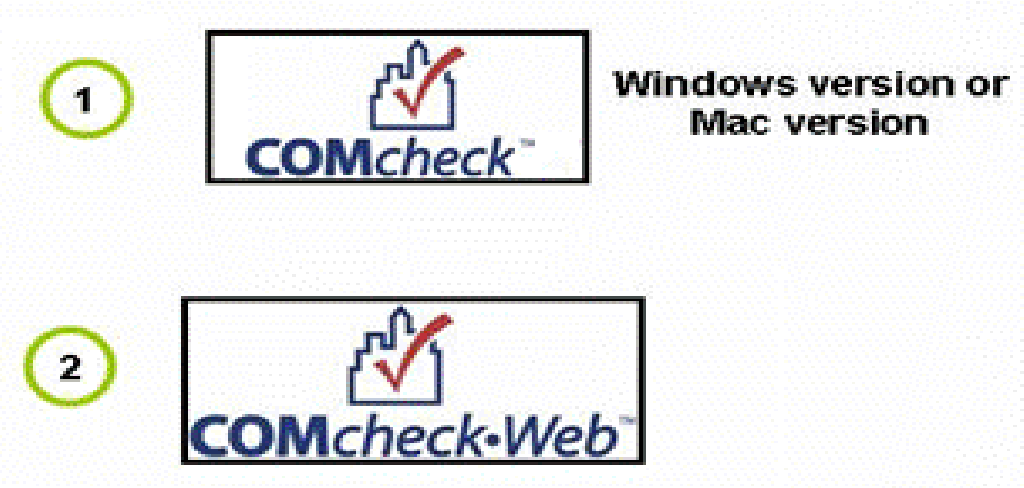
**3**

## 90.1-2019 Mandatory & Performance



# Prescriptive Compliance Path
## Thermal Envelope Component Trade-Off

- COMcheck can show compliance through the trade-off, mandatory and prescriptive approach
  - Thermal envelope
    - Trade-off thermal components
  - Mechanical systems
    - Mandatory/Prescriptive
  - Service Water Heating
    - Mandatory/Prescriptive
  - Lighting
    - Lighting power allowance




**www.energycodes.gov**

# Chapter 4 – Energy Efficiency Requirements

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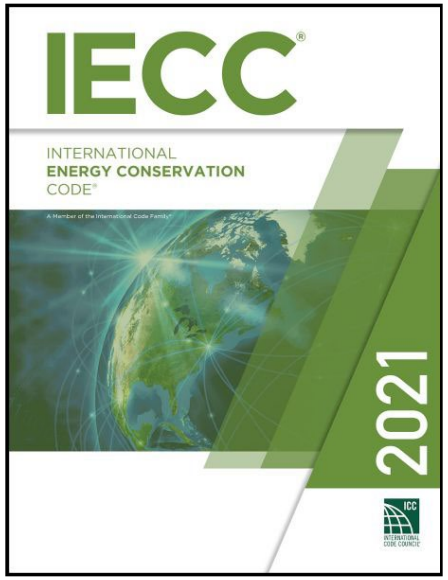
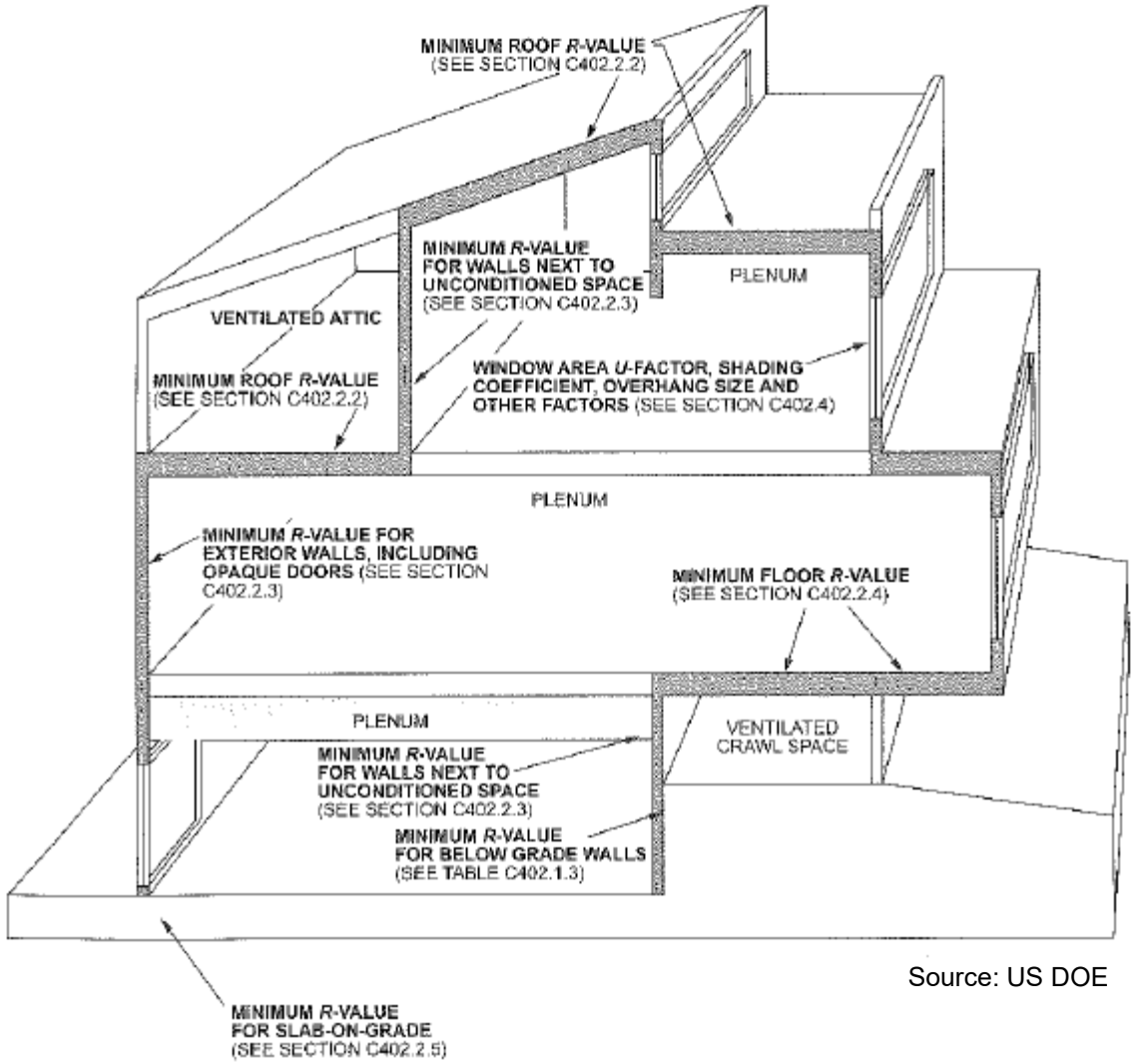


# Building thermal envelope requirements

- Roof/ceiling assemblies
- Wall assemblies
- Below grade walls
- Floor assemblies over unconditioned space
- Slab edge
- Vertical fenestration and skylights




Source: US DOE

# Design decisions have long-term consequences for energy efficiency

- Tight thermal envelope and efficient windows coupled with an efficient lighting system will significantly reduce summer heat gain.

# The building envelope is the most significant component that outlasts all other building systems

Imagine the energy savings if these buildings were insulated to today's standards.

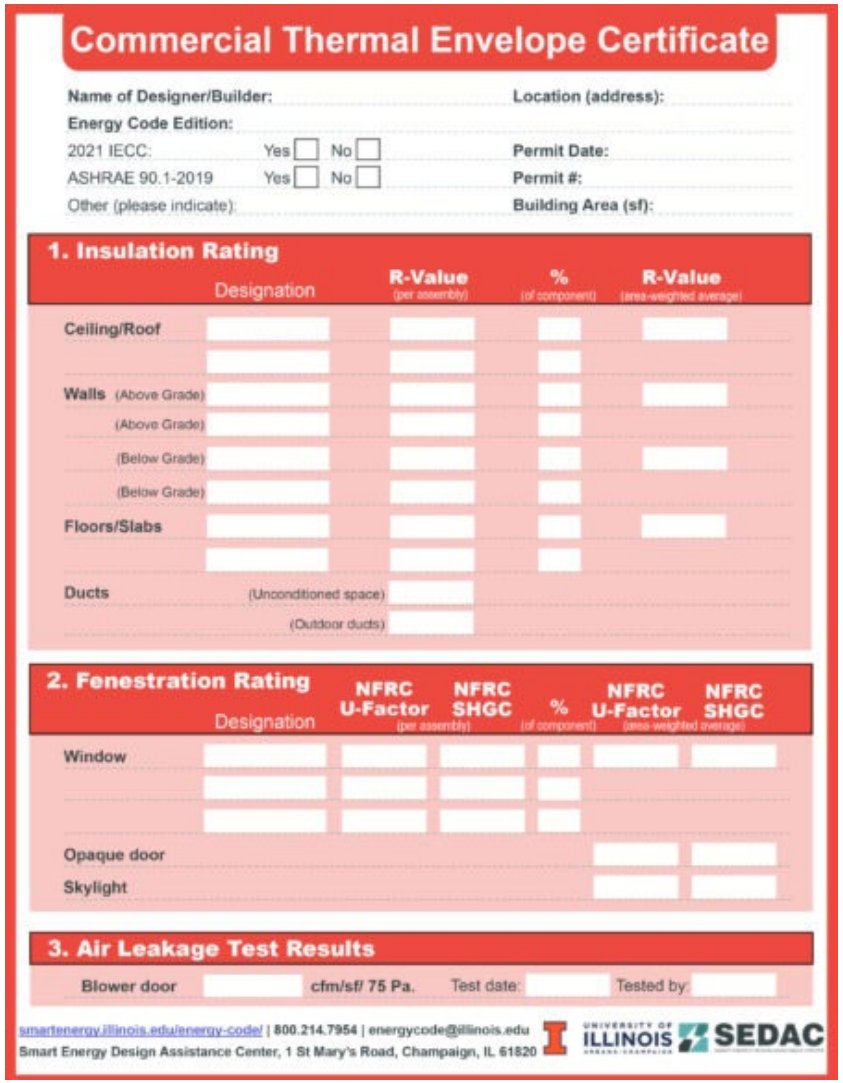
**Flatiron Building**
New York City - 1902
**Stone - 123 years**

**Seagram Building**
New York City -1958
**Glass & Steel - 67 years**

**Federal Courthouse**
Phoenix -2000
**Glass & Steel - 25 years**

# Thermal Envelope Certificate – C401.3

- A permanent thermal certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or other *approved* location:
  1. *R*-values of insulation in or on ceilings, roofs and walls.
  2. *U*-factors and *solar heat gain coefficient*.
  3. Results from any building envelope air leakage testing.



Commercial Thermal Envelope Certificate

Name of Designer/Builder: Location (address):

Energy Code Edition:

2021 IECC: Yes ☐ No ☐ Permit Date:

ASHRAE 90.1-2019 Yes ☐ No ☐ Permit #:

Other (please indicate): Building Area (sf):

1. Insulation Rating

| Designation | R-Value (per assembly) | % (of component) | R-Value (area-weighted average) |
|---|---|---|---|
| Ceiling/Roof | | | |
| Walls (Above Grade) | | | |
| (Above Grade) | | | |
| (Below Grade) | | | |
| (Below Grade) | | | |
| Floors/Slabs | | | |
| Ducts (Unconditioned space) | | | |
| (Outdoor ducts) | | | |

2. Fenestration Rating

| Designation | NFRC U-Factor (per assembly) | NFRC SHGC (per assembly) | % (of component) | NFRC U-Factor (area-weighted average) | NFRC SHGC (area-weighted average) |
|---|---|---|---|---|---|
| Window | | | | | |
| Opaque door | | | | | |
| Skylight | | | | | |

3. Air Leakage Test Results

Blower door cfm/sf/ 75 Pa. Test date: Tested by:

smartenergy.illinois.edu/energy-code/ | 800.214.7954 | energycode@illinois.edu

Smart Energy Design Assistance Center, 1 St Mary's Road, Champaign, IL 61820

UNIVERSITY OF ILLINOIS SEDAC

# Plan Review Correction Stamp

**IECC C401.3 Thermal envelope certificate.** Add note: "A permanent thermal certificate shall be completed by the builder or other responsible party and posted on a wall in the space where the space conditioning equipment is located, a utility room or other *approved* location:

1. *R*-values of insulation in or on ceilings, roofs, and walls.
2. *U*-factors and *solar heat gain coefficient*.
3. Results from any building envelope air leakage testing."

# Building envelope: Low energy buildings Exceptions

- Peak design rate of energy usage less than 3.4 Btu/h-ft$^2$ or 1 watt/ft$^2$ for space conditioning
- Buildings that do not contain conditioned space
- Greenhouse structures

Lonestar Custom Barns

# Building thermal envelope

## Tables separated by occupancy type

- Group R occupancies use “Group R” high rise column
- Non-Group R occupancies use “all other” column

TABLE 502.1.2
BUILDING ENVELOPE REQUIREMENTS OPAQUE ELEMENT, MAXIMUM *U*-FACTORS

| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R |
| **Roofs** | | | | | | | | | | | | | | | | |
| Insulation entirely above deck | U-0.063 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.039 | U-0.039 | U-0.039 | U-0.039 |
| Metal buildings | U-0.065 | U-0.065 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.049 | U-0.049 | U-0.049 | U-0.049 | U-0.035 | U-0.035 |
| Attic and other | U-0.034 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 |
| **Walls, Above Grade** | | | | | | | | | | | | | | | | |
| Mass | U-0.58 | U-0.151 | U-0.151 | U-0.123 | U-0.123 | U-0.104 | U-0.104 | U-0.090 | U-0.090 | U-0.080 | U-0.080 | U-0.071 | U-0.071 | U-0.071 | U-0.071 | U-0.052 |
| Metal building | U-0.093 | U-0.093 | U-0.093 | U-0.093 | U-0.084 | U-0.084 | U-0.084 | U-0.084 | U-0.069 | U-0.069 | U-0.069 | U-0.069 | U-0.057 | U-0.057 | U-0.057 | U-0.057 |
| Metal framed | U-0.124 | U-0.124 | U-0.124 | U-0.064 | U-0.084 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.057 | U-0.064 | U-0.052 | U-0.064 | U-0.037 |
| Wood framed and other | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.064 | U-0.064 | U-0.051 | U-0.051 | U-0.051 | U-0.051 | U-0.051 | U-0.036 | U-0.036 |

*Tables C402.1.3 & C402.1.4*

# Building thermal envelope

## Prescriptive: R-value table

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R |
| **Roofs** | | | | | | | | | | | | | | | | |
| Insulation entirely above deck | R-15ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-20ci | R-25ci | R-25ci | R-25ci | R-25ci |
| Metal buildings (with R-5 thermal blocks[a, b]) | R-19 | R-19 | R-13 + R-13 | R-13 + R-13 | R-13 + R-13 | R-19 | R-13 + R-13 | R-19 | R-13 + R-13 | R-19 | R-13 + R-19 | R-19 | R-13 + R-19 | R-19 + R-10 | R-11 + R-19 | R-19 + R-10 |
| Attic and other | R-30 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-38 | R-49 | R-49 |
| **Walls, Above Grade** | | | | | | | | | | | | | | | | |
| Mass | NR | R-5.7ci[f] | R-5.7ci[f] | R-7.6ci | R-7.6ci | R-9.5ci | R-9.5ci | R-11.4ci | R-11.4ci | R-13.3ci | R-13.3ci | R-15.2ci | R-15.2ci | R-15.2ci | R-25ci | R-25ci |
| Metal building[b] | R-16 | R-16 | R-16 | R-16 | R-19 | R-19 | R-19 | R-19 | R-13 + R-5.6ci | R-13 + R-5.6ci | R-13 + R-5.6ci | R-13 + R-5.6ci | R-19 + R-5.6ci | R-19 + R-5.6ci | R-19 + R-5.6ci | R-19 + R-5.6ci |
| Metal framed | R-13 | R-13 | R-13 | R-13+ 7.5ci | R-13 + R-3.8ci | R-13 + R-7.5ci | R-13 + R-7.5 | R-13 + R-7.5ci | R-13 + R-7.5 ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-15.6ci | R-13 + R-7.5 ci | R-13 + R-18.8ci |
| Wood framed and other | R-13 | R-13 | R-13 | R-13 | R-13 | R-13 | R-13 | R-13+ R-3.8ci | R-13 + R-3.8ci | R-13 + R-3.8ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13+ R-7.5ci | R-13 +7.5ci | R-13 + R-15.6ci | R-13 + 15.6ci |
| **Walls, Below Grade** | | | | | | | | | | | | | | | | |
| Below grade wall[f] | NR | NR | NR | NR | NR | NR | NR | R-7.5ci | R-7.5ci | R-7.5ci | R-7.5ci | R-7.5ci | R-7.5ci | R-10ci | R-7.5ci | R-12.5ci |
| **Floors** | | | | | | | | | | | | | | | | |
| Mass | NR | NR | R-6.3ci | R-8.3ci | R-6.3ci | R-8.3ci | R-10ci | R-10.4ci | R-10ci | R-12.5ci | R-12.5ci | R-14.6ci | R-15ci | R-16.7ci | R-15ci | R-16.7ci |
| Joist/Framing (steel/wood) | NR | NR | R-19 | R-30 | R-19 | R-30 | R-30 | R-30 | R-30 | R-30 | R-30 | R-30[e] | R-30 | R-30[e] | R-30[e] | R-30[e] |
| **Slab-on-Grade Floors** | | | | | | | | | | | | | | | | |
| Unheated slabs | NR | NR | NR | NR | NR | NR | NR | R-10 for 24 in. below | NR | R-10 for 24 in. below | R-10 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-20 for 24 in. below |
| Heated slabs | R-7.5 for 12 in. below | R-7.5 for 12 in. below | R-7.5 for 12 in. below | R-7.5 for 12 in. below | R-10 for 24 in. below | R-10 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-15 for 24 in. below | R-20 for 48 in. below | R-20 for 24 in. below | R-20 for 48 in. below | R-20 for 48 in. below | R-20 for 48 in. below |
| Opaque doors | | | | | | | | | | | | | | | | |
| Swinging | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.70 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 |
| Roll-up or sliding | U-1.45 | U-1.45 | U-1.45 | U-1.45 | U-1.45 | U-1.45 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 | U-0.50 |

*Table C402.1.3 (R-Value)*

# Building thermal envelope
## Prescriptive: U-factor, C-factor, F-factor Table

TABLE 502.1.2
BUILDING ENVELOPE REQUIREMENTS OPAQUE ELEMENT, MAXIMUM *U*-FACTORS

| CLIMATE ZONE | 1 | | 2 | | 3 | | 4 EXCEPT MARINE | | 5 AND MARINE 4 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R | All other | Group R |
| **Roofs** | | | | | | | | | | | | | | | | |
| Insulation entirely above deck | U-0.063 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.048 | U-0.039 | U-0.039 | U-0.039 | U-0.039 |
| Metal buildings | U-0.065 | U-0.065 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.055 | U-0.049 | U-0.049 | U-0.049 | U-0.049 | U-0.035 | U-0.035 |
| Attic and other | U-0.034 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 | U-0.027 |
| **Walls, Above Grade** | | | | | | | | | | | | | | | | |
| Mass | U-0.58 | U-0.151 | U-0.151 | U-0.123 | U-0.123 | U-0.104 | U-0.104 | U-0.090 | U-0.090 | U-0.080 | U-0.080 | U-0.071 | U-0.071 | U-0.071 | U-0.071 | U-0.052 |
| Metal building | U-0.093 | U-0.093 | U-0.093 | U-0.093 | U-0.084 | U-0.084 | U-0.084 | U-0.084 | U-0.069 | U-0.069 | U-0.069 | U-0.069 | U-0.057 | U-0.057 | U-0.057 | U-0.057 |
| Metal framed | U-0.124 | U-0.124 | U-0.124 | U-0.064 | U-0.084 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.064 | U-0.057 | U-0.064 | U-0.052 | U-0.064 | U-0.037 |
| Wood framed and other | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.089 | U-0.064 | U-0.064 | U-0.051 | U-0.051 | U-0.051 | U-0.051 | U-0.051 | U-0.036 | U-0.036 |
| **Walls, Below Grade** | | | | | | | | | | | | | | | | |
| Below-grade wall[a] | C-1.140 | C-1.140 | C-1.140 | C-1.140 | C-1.140 | C-1.140 | C-1.140 | C-0.119 | C-0.119 | C-0.119 | C-0.119 | C-0.119 | C-0.119 | C-0.092 | C-0.119 | C-0.075 |
| **Floors** | | | | | | | | | | | | | | | | |
| Mass | U-0.322 | U-0.322 | U-0.107 | U-0.087 | U-0.107 | U-0.087 | U-0.087 | U-0.074 | U-0.074 | U-0.064 | U-0.064 | U-0.057 | U-0.064 | U-0.051 | U-0.057 | U-0.051 |
| Joist/Framing | U-0.282 | U-0.282 | U-0.052 | U-0.052 | — | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 | U-0.033 |
| **Slab-on-Grade Floors** | | | | | | | | | | | | | | | | |
| Unheated slabs | F-0.730 | F-0.730 | F-0.730 | F-0.730 | F-0.730 | F-0.730 | F-0.730 | F-0.540 | F-0.730 | F-0.540 | F-0.540 | F-0.520 | F-0.520 | F-0.520 | F-0.520 | F-0.510 |
| Heated slabs | F-1.020 | F-1.020 | F-1.020 | F-1.020 | F-0.900 | F-0.900 | F-0.860 | F-0.860 | F-0.860 | F-0.860 | F-0.860 | F-0.688 | F-0.830 | F-0.688 | F-0.688 | F-0.688 |

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

*Table C402.1.4 (U-Factor)*

# Building thermal envelope
## Prescriptive: Roof R-value and U-factor

**Roof R-values and U-factor requirements are based on assembly type and insulation placement**

- ✓ Insulation entirely above deck
- ✓ Attic space between joists
- ✓ Metal building
- ✓ Metal framing cavities
- ✓ Wood framing cavities
- ✓ Mass
- ✓ Heated or unheated slabs

*C402.1.3 (R-Value) and C402.1.4 (U-Factor)*

# Building thermal envelope
## R-value: Roof insulation

### Table C402.1.3 - Roofs

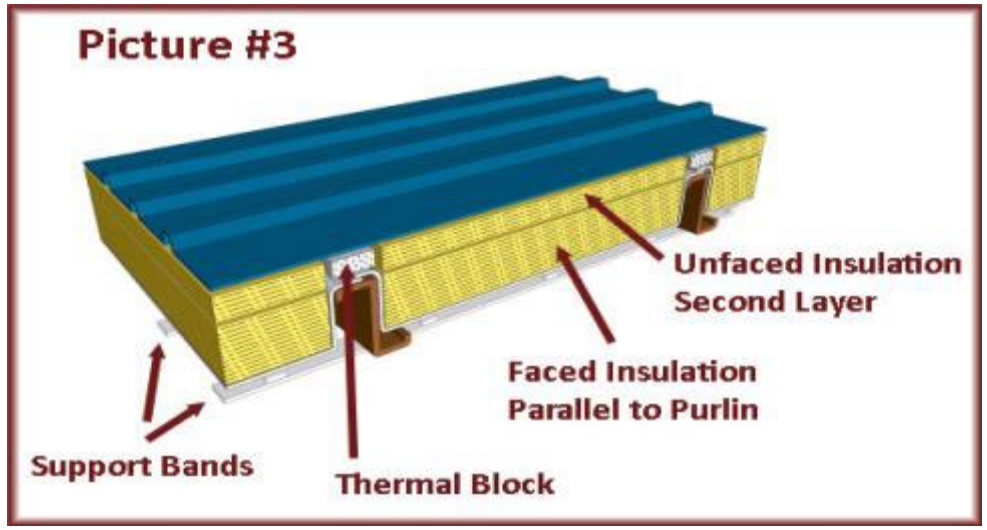
| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other | R | Other | R | Other | R | Other | R | Other | R | Other | R |
| **Insulation entirely above deck** | R-20ci | R-20ci | **R-25ci** | **R-25ci** | R-20ci | R-20ci | R-25ci | R-25ci | R-25ci | R-25ci | R-30ci | R-30ci |
| **Metal buildings[ab] (with thermal spacer block)** | R-19 + R-11 LS | R-19 + R-11 LS | **R-19 + R-11 LS** | **R-19 + R-11 LS** | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-19 + R-11 LS | R-25 + R-11 LS | R-25 + R-11 LS |
| **Attic and other** | R-38 | R-38 | **R-38** | **R-38** | R-38 | R-38 | R-38 | R-38 | R-38 | R-48 | R-49 | R-49 |

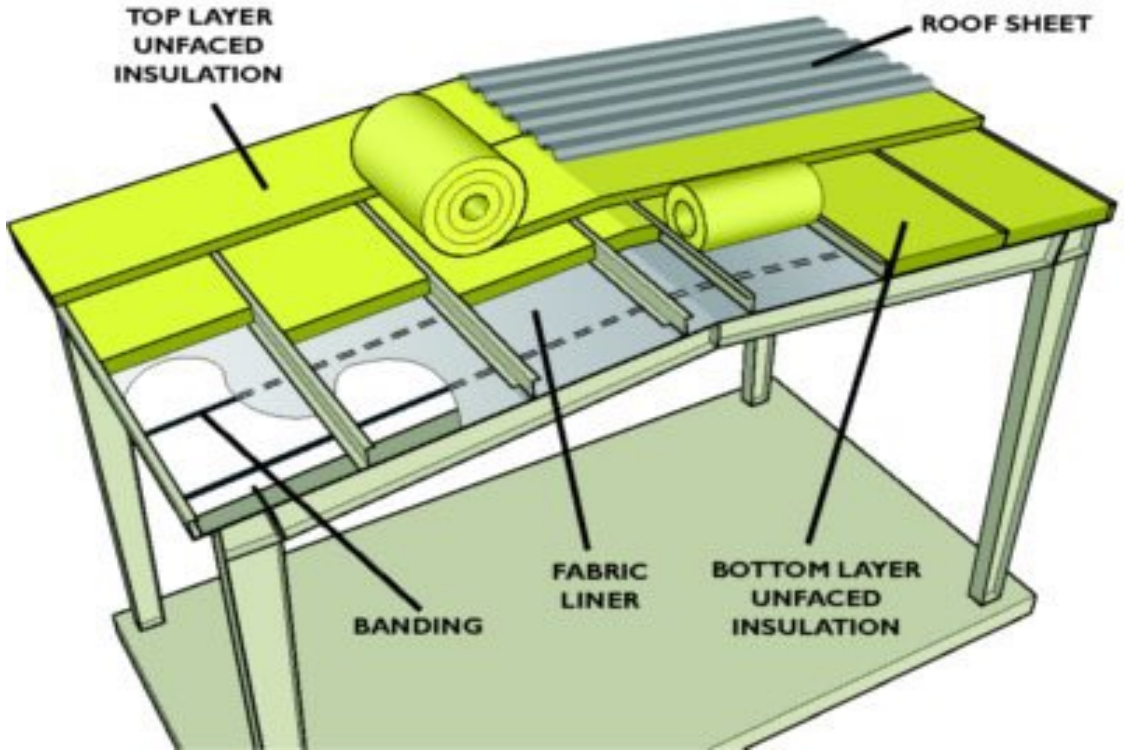
ci = Continuous Insulation LS = Liner System

*Table C402.1.3*

# Building thermal envelope
## R-value: Roof insulation

- Metal buildings require thermal blocks and liner system



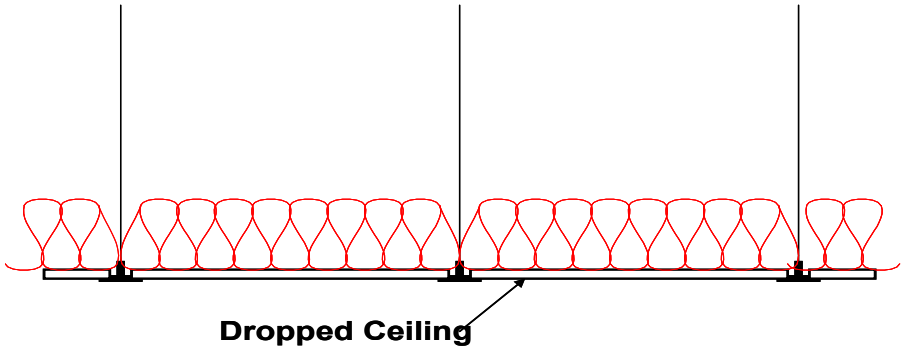




Liner System – continuous vapor barrier membrane installed below the purlins with unfaced insulation placed on top of the liner membrane between the purlins

*Table C402.1.3*

# Building thermal envelope
## R-value: Roof insulation

- <u>Insulation placed on suspended ceiling with removable ceiling tiles</u>
  - ✓ Will not count for code compliance
  - ✓ Will not comply with Section 402.5.1, continuous air barrier




*C402.2.2*

# Building thermal envelope
## R-value: Framed wall insulation

### Table C402.1.3 - Walls, Above Grade

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other | R | Other | R | Other | R | Other | R | Other | R | Other | R |
| **Mass** | R-5.7ci | R-5.7ci | **R-5.7ci** | **R-7.6ci** | R-7.6ci | R-9.5ci | R-9.5ci | R-11.4ci | R-11.4ci | R-13.3ci | R-13.3ci | R-15.2ci |
| **Metal building** | R-13 + R-6.5ci | R-13 + R-6.5ci | **R-13 + R-6.5ci** | **R-13 + R-13ci** | R-13 + R-6.5ci | R-13 + R-13ci | R-13 + R-13ci | R-13 + R-13ci | R-13 + R-13ci | R-13 + 13ci | R-13 + 13ci | R-13 + 13ci |
| **Metal Framed** | R-13 + R-5ci | R-13 + R-5ci | **R-13 + R-5ci** | **R-13 + R-7.5ci** | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci | R-13 + R-7.5ci |
| **Wood Framed & Other** | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | **R-13 + R-3.8ci or R-20** | **R-13 + R-3.8ci or R-20** | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 | R-13 + R-3.8ci or R-20 + R-3.8ci | R-13 + R-3.8ci or R-20 + R-3.8ci | R-13 + R-3.8ci or R-20 + R-3.8ci |

*Table C402.1.3*

# Building thermal envelope
## Wood and metal framed walls


- **Continuous insulation (ci)** not broken up by framing members e.g., rigid board insulation
- **Cavity insulation** or cavity plus <u>continuous insulation (ci)</u>

*Table C402.1.3*

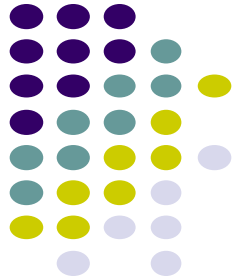
# Building thermal envelope
## Opaque doors

### Table C402.1.4 - Opaque Doors

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | | 5 And Marine 4 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other | R | Other | R | Other | R | Other | R | Other | R | Other | R |
| **Non-Sliding** | U- 0.31 | U- 0.31 | **U-0.31** | **U-0.31** | R- 0.31 | U-0.31 | U-0.31 | R- 0.31 | R- 0.31 | R- 0.31 | R- 0.31 | R- 0.31 |
| **Swinging** | U-0.37 | U-0.37 | **U-0.37** | **U-0.37** | U-0.37 | U-0.37 | U-0.37 | U-0.37 | U-0.37 | U-0.37 | U-0.37 | U-0.37 |

*Table C402.1.4*

# Plan Review Correction Stamp



Provide U-factor and SHGC values for exterior glazing.

Provide insulation values for exterior walls and roof.

# Cool/Light Reflective Coated Roofs

## Low Slope roofs (less than 2 in 12 slope) – C402.3

- Minimum solar reflectance index (SRI) of 64 over conditioned and non-conditioned spaces
- Required under both prescriptive and performance compliance paths

| Table C402.3<br>Minimum Roof Reflectance and Emittance Options |
|---|
| 1. Three-year aged solar reflectance of 0.55 and three-year aged thermal emittance of 0.75<br>2. Three-year-aged solar reflectance index of 64 |

# Plan Review Correction Stamp

Low-slope roof surfaces (less than 2 in 12 slope) are required to have a solar reflectance index (SRI) value of 64 or higher.

# Prescriptive Compliance Path

## Maximum Vertical Fenestration

- Percentage of vertical fenestration area to gross above-grade wall area
  - 30% max. of above grade wall area
  - 40% max. with daylight responsive controls in climate zones 0 to 6:
    - Not less than 50% of floor area shall be within a daylight zone for buildings two stories or less
    - Not less than 25% of floor area shall be within a daylight zone for for buildings three or more stories

*C402.4.1 and C402.4.1.1 – Prescriptive (Max Area)*

# Building thermal envelope

## Prescriptive: Maximum skylight area

Percentage of skylight to gross roof area

- ✓ Allowed up to 3% of roof area
- ✓ Allowed up to 5% with daylight responsive controls installed in daylight zones under skylights

*C402.4.1 and 402.4.1.2 – Prescriptive*

# Building thermal envelope

## Prescriptive: Skylight requirement

Minimum skylight fenestration area required

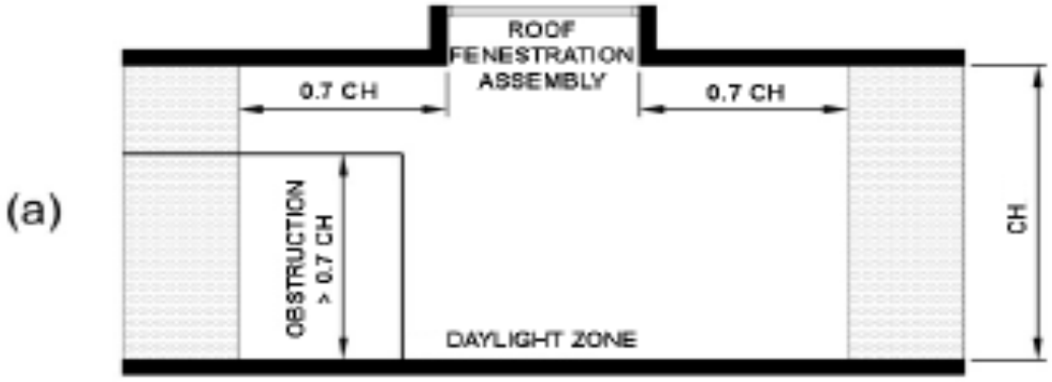
- Enclosed spaces greater than 2,500 sq. ft. under a roof with ceiling heights greater than 15 feet
- Office, lobby, atrium, concourse, corridor, storage, gymnasium, exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail
- Total daylight zone under skylights shall be not less than half the floor area

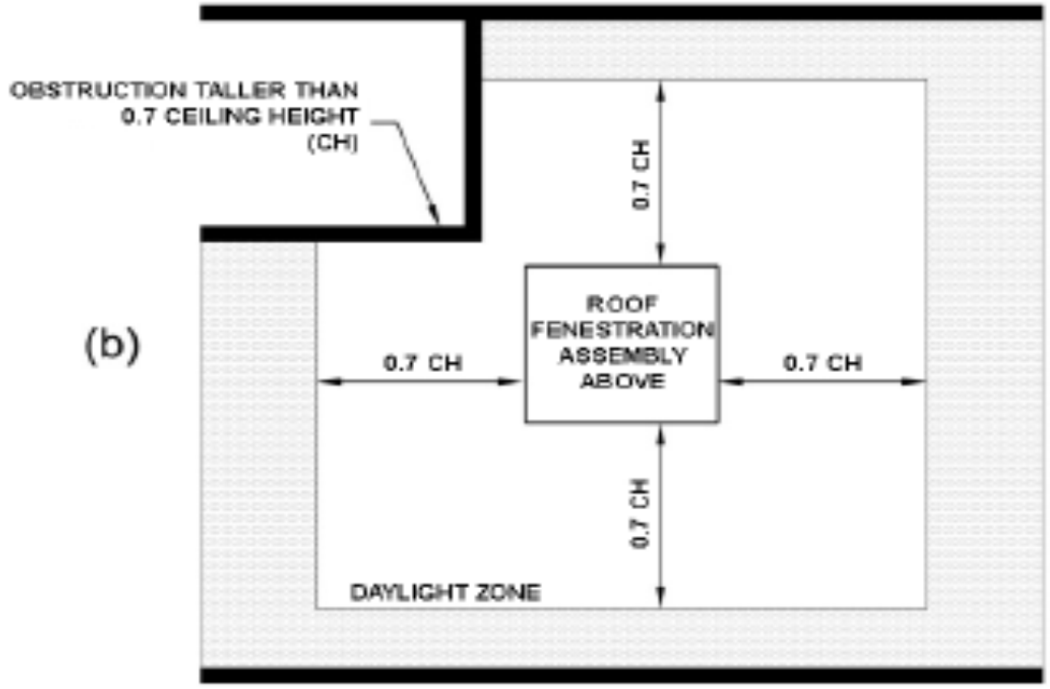
**Exceptions**: 1. Climate Zones 6-8
2. Spaces where lighting power densities are less than 0.5 W/ft$^2$

*C402.4.2 – Prescriptive*

# Building thermal envelope
## Daylight zone under skylights

- Area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension plus either:
  - 0.7 times ceiling height, or the distance to a ceiling height partition




(a) Section view
(b) Plan view of daylight zone under a roof fenestration assembly

# Building thermal envelope
## Prescriptive: Fenestration

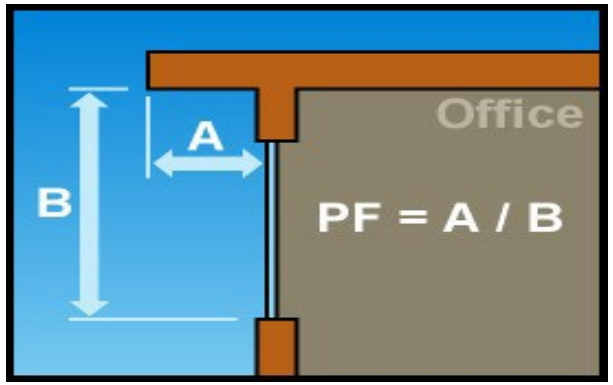
### Table C402.4 - Building Envelope Fenestration Requirements

| Climate Zone | 1 | | 2 | | 3 | | 4 Except Marine | |
|---|---|---|---|---|---|---|---|---|
| **Vertical Fenestration** | | | | | | | | |
| **U-Factor** | | | | | | | | |
| **Fixed fenestration** | 0.50 | | 0.45 | | 0.42 | | 0.36 | |
| **Operable fenestration** | 0.62 | | 0.60 | | 0.54 | | 0.45 | |
| **Entrance doors** | 0.83 | | 0.77 | | 0.68 | | 0.63 | |
| **SHGC** | | | | | | | | |
| | **Fixed** | **Operable** | **Fixed** | **Operable** | **Fixed** | **Operable** | **Fixed** | **Operable** |
| **PF < 0.2** | 0.23 | 0.21 | 0.25 | 0.23 | 0.25 | 0.23 | 0.36 | 0.33 |
| **0.2 ≤ PF < 0.5** | 0.28 | 0.25 | 0.30 | 0.28 | 0.30 | 0.28 | 0.43 | 0.40 |
| **PF ≥ 0.5** | 0.37 | 0.34 | 0.40 | 0.37 | 0.40 | 0.37 | 0.58 | 0.53 |
| **Skylights** | | | | | | | | |
| **U-Factor** | 0.70 | | 0.65 | | 0.55 | | 0.50 | |
| **SHGC** | 0.30 | | 0.30 | | 0.30 | | 0.40 | |

# Building thermal envelope
## Fenestration SHGC Adjustment

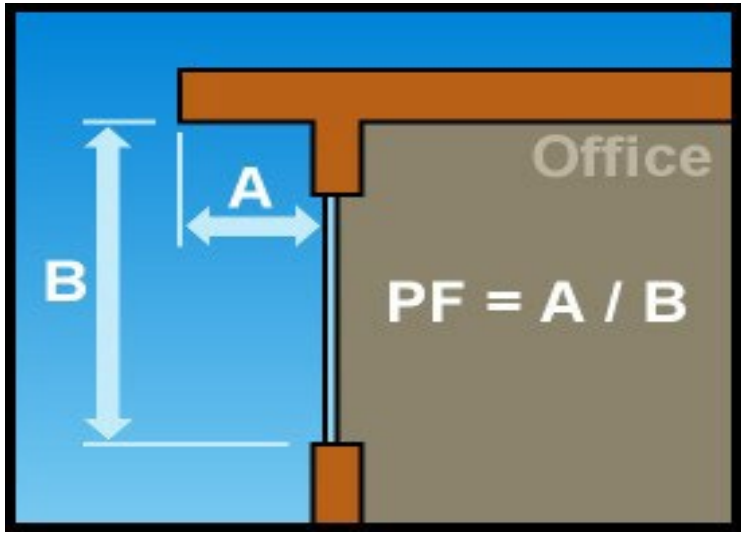
Table C402.4 SHGC - Overhangs allow for a higher SHGC

| Climate Zone | 0 and 1 | | 2 | | 3 | | 4 Except Marine | |
|---|---|---|---|---|---|---|---|---|
| **Vertical Fenestration** | | | | | | | | |
| **SHGC** | | | | | | | | |
| | **Fixed** | **Operable** | **Fixed** | **Operable** | **Fixed** | **Operable** | **Fixed** | **Operable** |
| **PF < 0.2** | 0.23 | 0.21 | 0.25 | 0.23 | 0.25 | 0.23 | 0.36 | 0.33 |
| **0.2 ≤ PF < 0.5** | 0.28 | 0.25 | 0.30 | 0.28 | 0.30 | 0.28 | 0.43 | 0.40 |
| **PF ≥ 0.5** | 0.37 | 0.34 | 0.40 | 0.37 | 0.40 | 0.37 | 0.58 | 0.53 |




# Example

- A new building has fixed fenestration in CZ 2
- What is the max. U-factor value? 0.45
- What is the max. SHGC value based the following overhang dimensions? 0.37




A = 4 feet
B = 8 feet

PF = 4/8 = 0.5

Overhangs allow for a higher SHGC

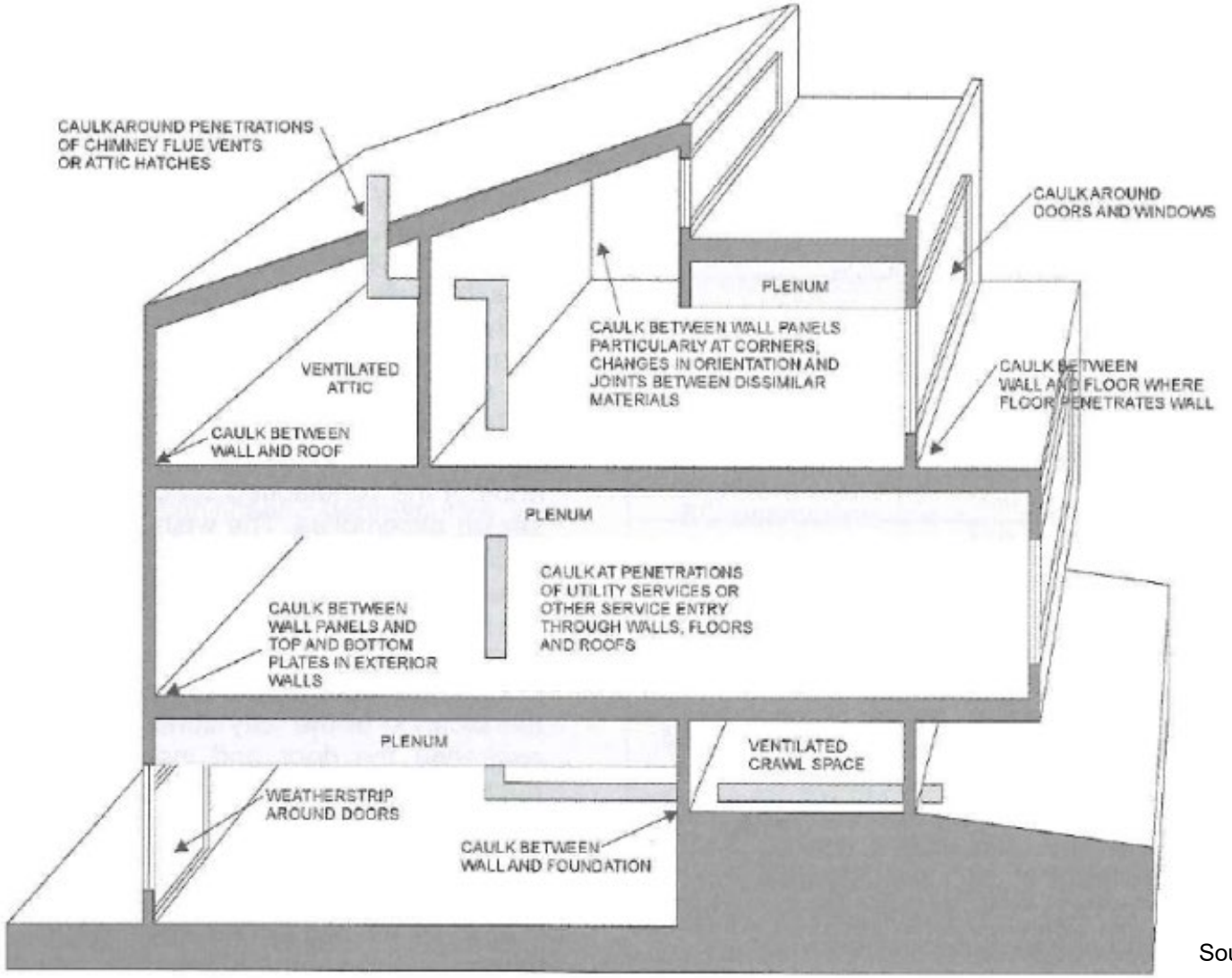
# Air Leakage - Thermal Envelope – C402.5

- **Air Barrier Compliance**
  - Required for climate zone 2B (IgCC)
  - Air barrier materials and assemblies
  - Inspection of continuous air barrier installation
  - Final inspection report by a registered design professional or approved agency

- or -

- **Air Leakage Testing of Thermal Envelope**
  - Measured air leakage shall not exceed 0.40 cfm/ft$^2$ of the building thermal envelope area.

# Requirements for sealing the building envelope

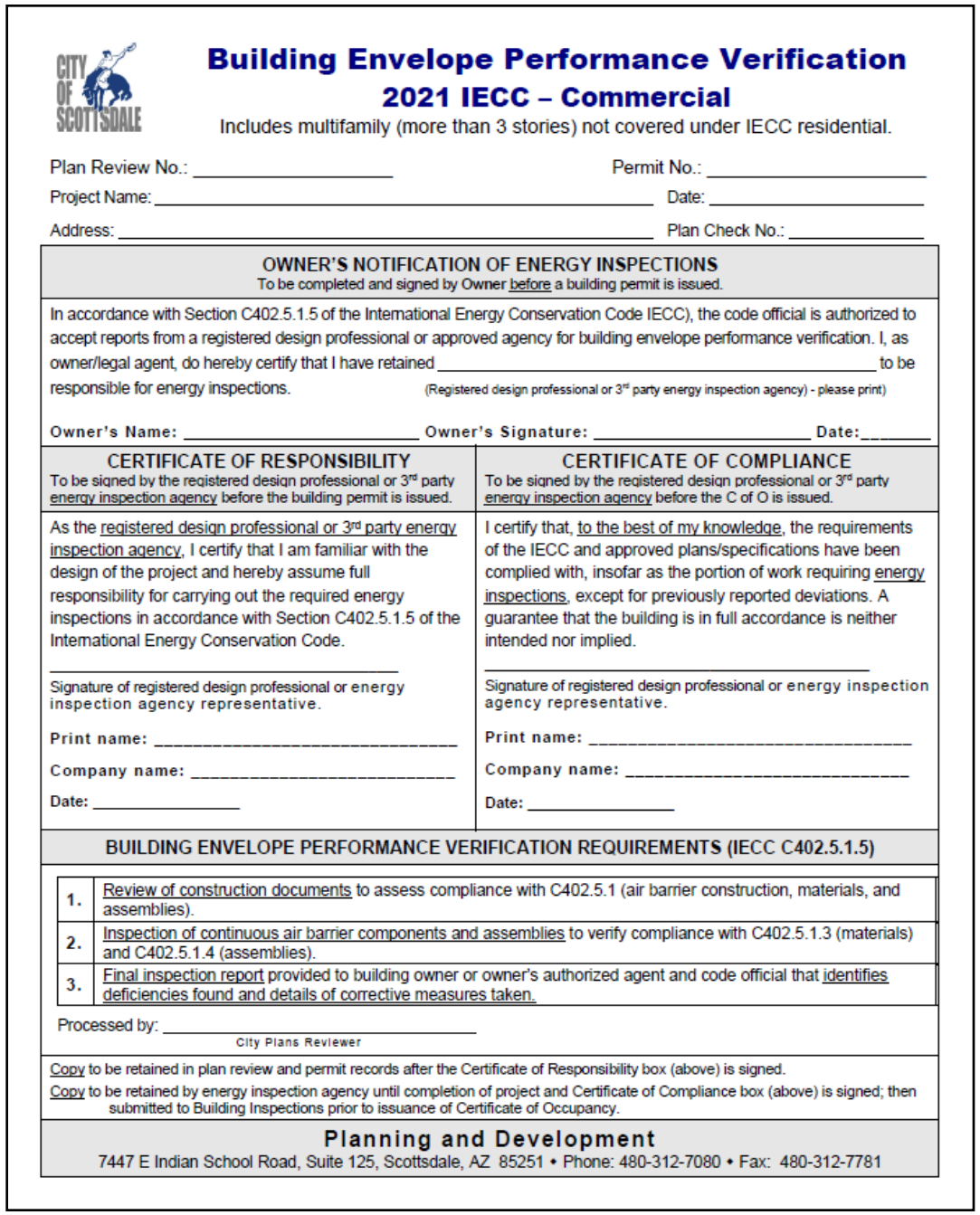



Source: US DOE

# Building thermal envelope
## Mandatory: Air leakage

- Fenestration
- Rooms containing fuel-burning appliances
- Doors and access openings to shafts, chutes, stairways, and elevator lobbies
- Air intakes and exhaust openings
- Loading dock weather seals
- Recessed lighting
- Operable openings interlocking

*402.5.4 through 402.5.11*



**Building Envelope Performance Verification**
**2021 IECC – Commercial**
Includes multifamily (more than 3 stories) not covered under IECC residential.

Plan Review No.: _____ Permit No.: _____
Project Name: _____ Date: _____
Address: _____ Plan Check No.: _____

**OWNER'S NOTIFICATION OF ENERGY INSPECTIONS**
To be completed and signed by Owner before a building permit is issued.

In accordance with Section C402.5.1.5 of the International Energy Conservation Code IECC), the code official is authorized to accept reports from a registered design professional or approved agency for building envelope performance verification. I, as owner/legal agent, do hereby certify that I have retained _____ to be responsible for energy inspections. (Registered design professional or 3rd party energy inspection agency) - please print)

**Owner's Name:** _____ **Owner's Signature:** _____ **Date:** _____

| CERTIFICATE OF RESPONSIBILITY | CERTIFICATE OF COMPLIANCE |
|---|---|
| To be signed by the registered design professional or 3rd party energy inspection agency before the building permit is issued. | To be signed by the registered design professional or 3rd party energy inspection agency before the C of O is issued. |
| As the registered design professional or 3rd party energy inspection agency, I certify that I am familiar with the design of the project and hereby assume full responsibility for carrying out the required energy inspections in accordance with Section C402.5.1.5 of the International Energy Conservation Code. | I certify that, to the best of my knowledge, the requirements of the IECC and approved plans/specifications have been complied with, insofar as the portion of work requiring energy inspections, except for previously reported deviations. A guarantee that the building is in full accordance is neither intended nor implied. |
| _____ Signature of registered design professional or energy inspection agency representative. | _____ Signature of registered design professional or energy inspection agency representative. |
| **Print name:** _____ | **Print name:** _____ |
| **Company name:** _____ | **Company name:** _____ |
| **Date:** _____ | **Date:** _____ |

**BUILDING ENVELOPE PERFORMANCE VERIFICATION REQUIREMENTS (IECC C402.5.1.5)**

| | |
|---|---|
| 1. | Review of construction documents to assess compliance with C402.5.1 (air barrier construction, materials, and assemblies). |
| 2. | Inspection of continuous air barrier components and assemblies to verify compliance with C402.5.1.3 (materials) and C402.5.1.4 (assemblies). |
| 3. | Final inspection report provided to building owner or owner's authorized agent and code official that identifies deficiencies found and details of corrective measures taken. |

Processed by: _____
City Plans Reviewer

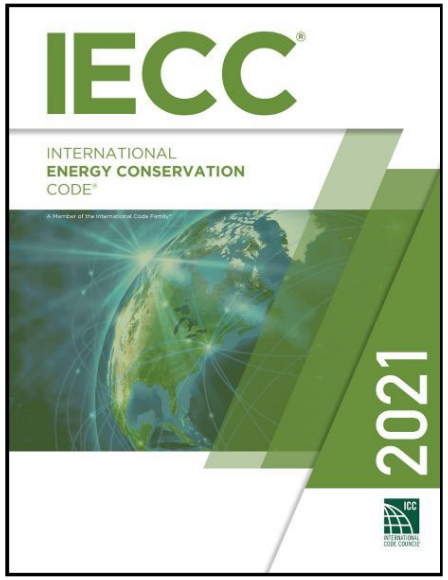
Copy to be retained in plan review and permit records after the Certificate of Responsibility box (above) is signed.
Copy to be retained by energy inspection agency until completion of project and Certificate of Compliance box (above) is signed; then submitted to Building Inspections prior to issuance of Certificate of Occupancy.

**Planning and Development**
7447 E Indian School Road, Suite 125, Scottsdale, AZ 85251 • Phone: 480-312-7080 • Fax: 480-312-7781

# Building Envelope Performance Verification
## IECC C402.5.1.5

# Chapter 4 – Energy Efficiency Requirements

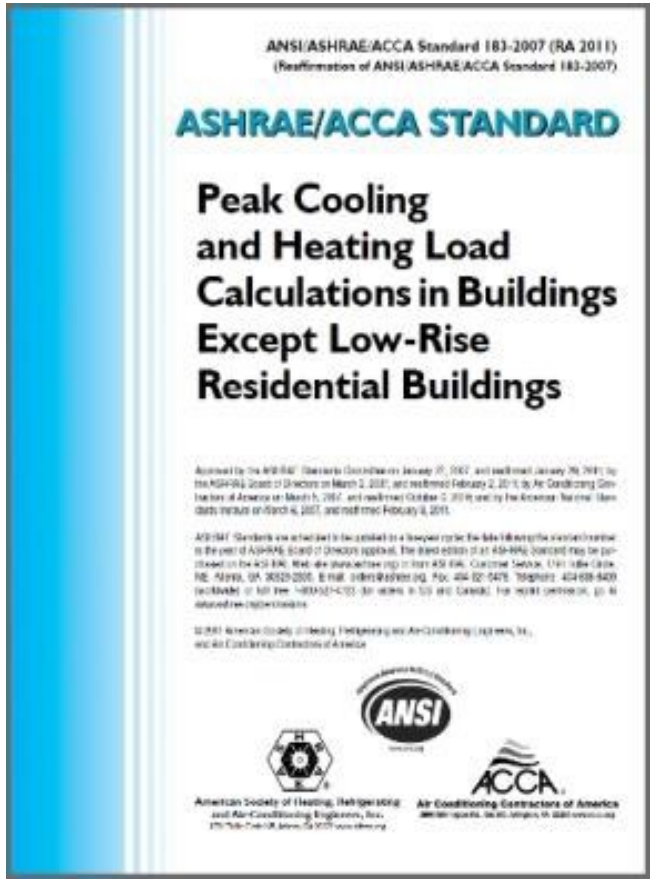
- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Calculation of Heating and Cooling Loads

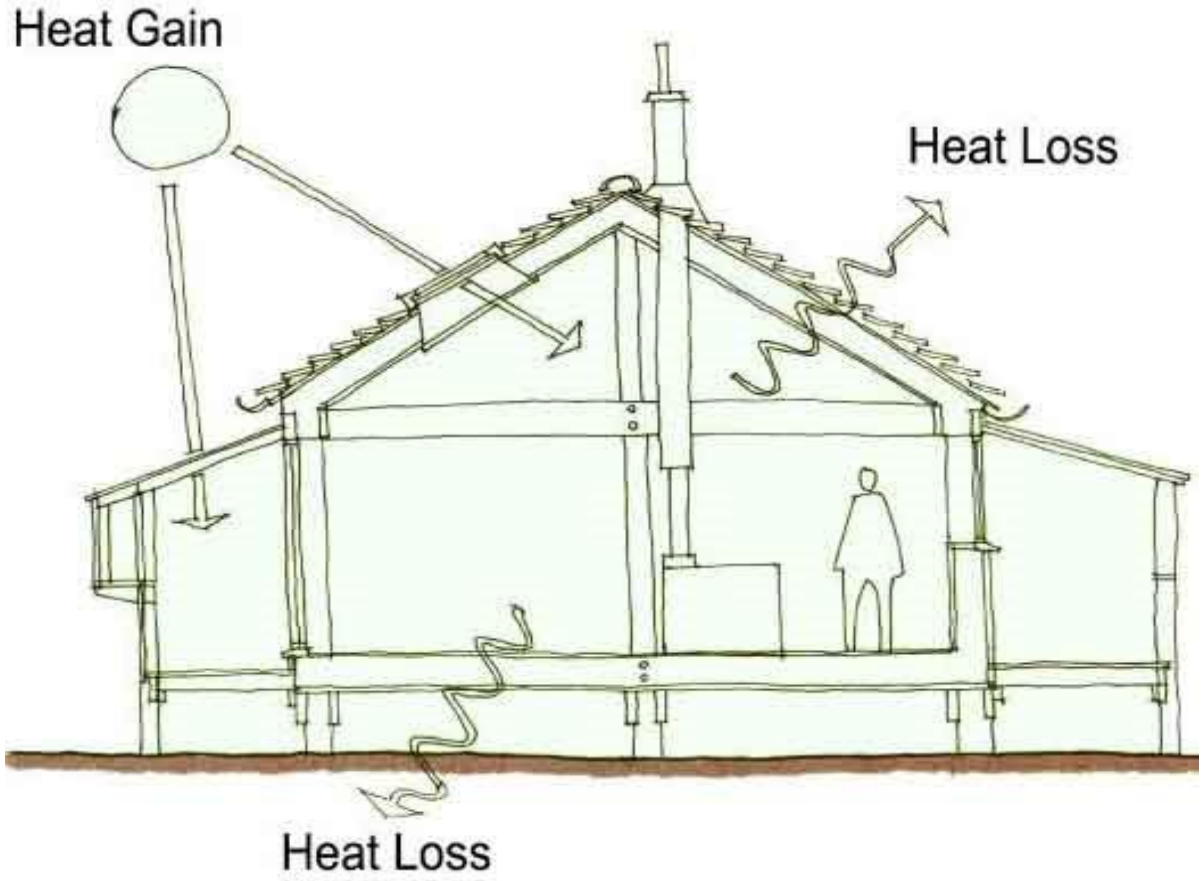
## ASHRAE/ACCA Standard 183

- Exterior design conditions
  - Specified by ASHRAE
- Interior design conditions
  - Specified by section C302
    - ≤ 72°F for heating load
    - ≥ 75°F for cooling load
  - HVAC manufacturer programs
    - Trane TRACE (Trane Air Conditioning Economics)
    - Carrier HAP (Hourly Analysis Program)




*C403.1.1 Mandatory*

# Heating and Cooling Loads

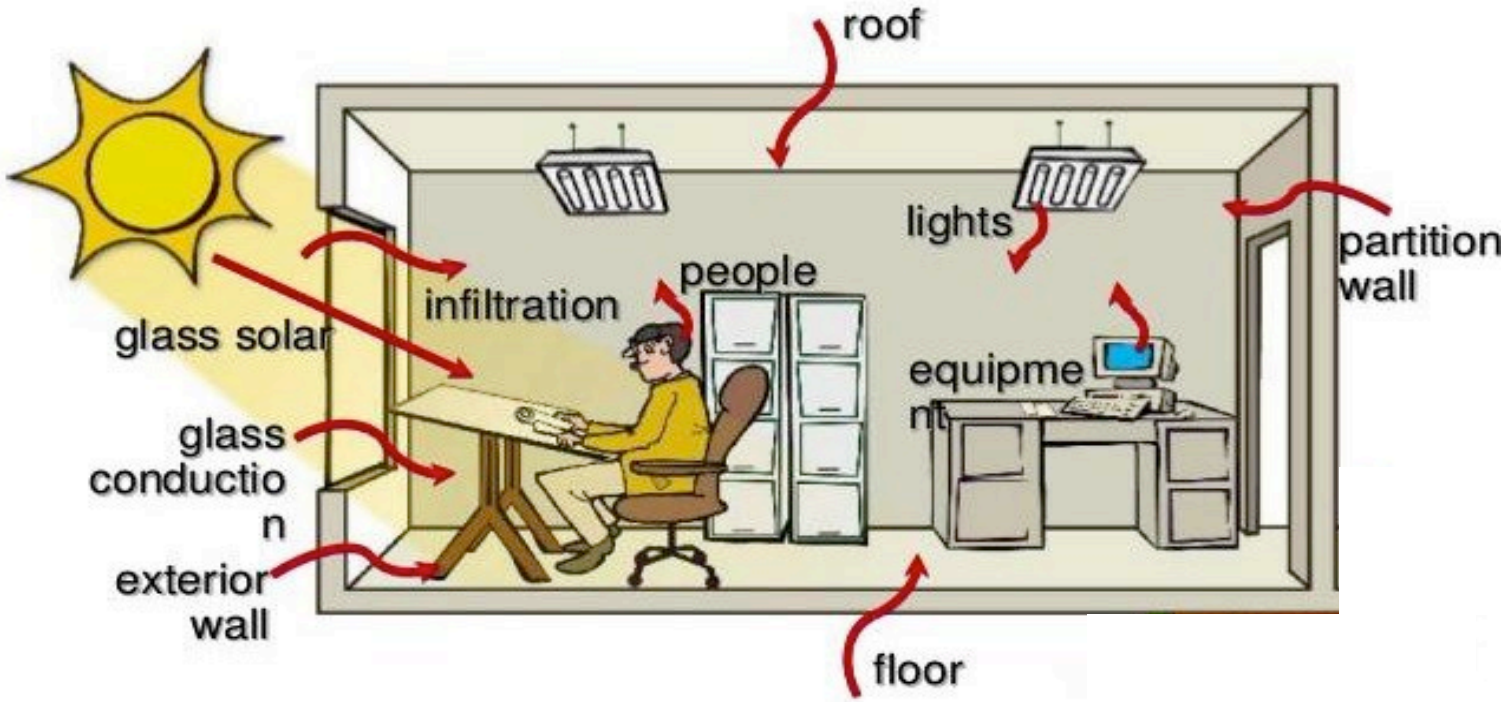



**Ventilation** shall be provided in accordance with Chapter 4 of International Mechanical Code (IMC)

- **Heat Gains**
  - Solar thru windows/walls
  - Summer transfer/infiltration
  - Internal
    - Electric Use, Lighting
    - Body Heat
- **Heat Loss**
  - Air Leaks (Infiltration)
  - Transfer (conduction & radiant) through
    - Walls
    - Roofs
    - Floor
    - Windows
- **Difference made up by**
  - Heater or Air Conditioner

# Equipment and system size

- HVAC capacity shall not exceed calculated loads
- Select the system which serves the greater load between heating or cooling



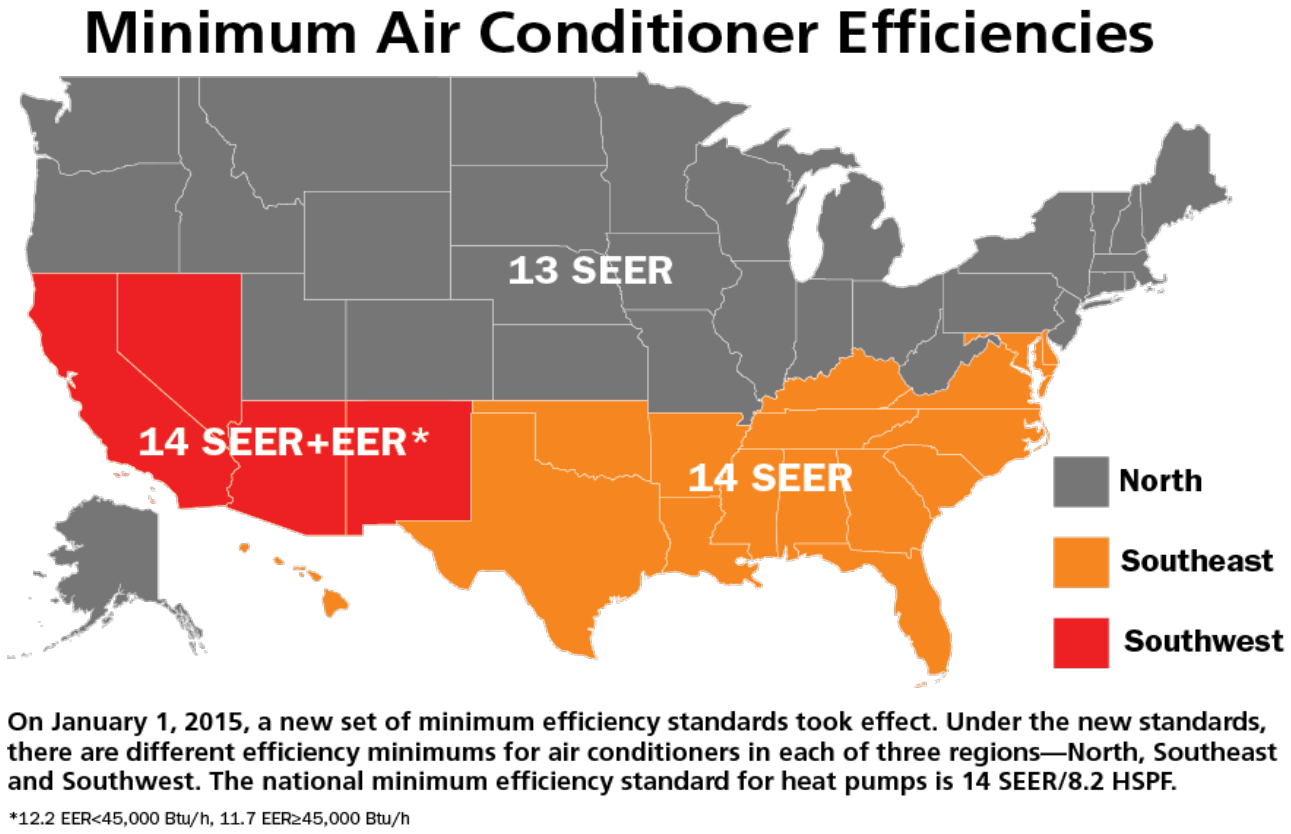

*C403.2 Mandatory*

# HVAC equipment performance requirements

- All equipment must meet minimum efficiency requirements of tables
  - National Appliance Energy Conservation Act (NAECA)

SEER
=
Seasonal Energy Efficiency Rate

**Energy Efficiency Ratio**




On January 1, 2015, a new set of minimum efficiency standards took effect. Under the new standards, there are different efficiency minimums for air conditioners in each of three regions—North, Southeast and Southwest. The national minimum efficiency standard for heat pumps is 14 SEER/8.2 HSPF.

*12.2 EER<45,000 Btu/h, 11.7 EER≥45,000 Btu/h

*C403.3.2 Mandatory Minimum Efficiency*

# Equipment efficiency – Unitary AC units, condensing units, heat pumps

- Tables C403.3.2(1) thru C403.3.2(16)
- Tables for each system type
- Efficiency ratings
  - **Cooling**: SEER vs. EER vs. IEER vs. COP
  - **Heat pump heating**: HSPF vs. COP
  - **Furnace**: AFUE vs. $E_t$

**IEER** – Integrated energy efficiency ratio
**COP** – Coefficient of performance
**HSPF** – Heating seasonal performance factor
**AFUE** – Annual fuel utilization efficiency
**$E_t$** – Thermal efficiency

TABLE C403.3.2(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS[c, d]

| EQUIPMENT TYPE | SIZE CATEGORY | HEADING SECTION TYPE | SUBCATEGORY OR RATING CONDITION | MINIMUM EFFICIENCY | TEST PROCEDURE[a] |
|---|---|---|---|---|---|
| Air conditioners, air cooled | < 65,000 Btu/h[b] | All | Split system, three phase and applications outside US single phase[b] | 13.0 SEER before 1/1/2023<br>13.4 SEER2 after 1/1/2023 | AHRI 210/240—2017 before 1/1/2023<br>AHRI 210/240—2023 after 1/1/2023 |
| | | | Single-package, three phase and applications outside US single phase[b] | 14.0 SEER before 1/1/2023<br>13.4 SEER2 after 1/1/2023 | |
| Space constrained, air cooled | ≤ 30,000 Btu/h[b] | All | Split system, three phase and applications outside US single phase[b] | 12.0 SEER before 1/1/2023<br>11.7 SEER2 after 1/1/2023 | AHRI 210/240—2017 before 1/1/2023<br>AHRI 210/240—2023 after 1/1/2023 |
| | | | Single package, three phase and applications outside US single phase[b] | 12.0 SEER before 1/1/2023<br>11.7 SEER2 after 1/1/2023 | |
| Small duct, high velocity, air cooled | < 65,000 Btu/h[b] | All | Split system, three phase and applications outside US single phase[b] | 12.0 SEER before 1/1/2023<br>12.1 SEER2 after 1/1/2023 | AHRI 210/240—2017 before 1/1/2023<br>AHRI 210/240—2023 after 1/1/2023 |

# Equipment efficiency – Boilers and chillers

- Tables C403.3.2(1) thru C403.3.2(16)
- **Boiler efficiency**
- **Chiller efficiency**
  - **Full Load** and **IPLV** (Integrated Part Load Value)
- **Heat rejection efficiency**

TABLE C403.2.3(5)
MINIMUM EFFICIENCY REQUIREMENTS: GAS- AND OIL-FIRED BOILERS

| EQUIPMENT TYPE[a] | SUBCATEGORY OR RATING CONDITION | SIZE CATEGORY (INPUT) | MINIMUM EFFICIENCY[d, e] | TEST PROCEDURE |
|---|---|---|---|---|
| Boilers, hot water | Gas-fired | < 300,000 Btu/h | 80% AFUE | 10 CFR Part 430 |
| | | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[b] | 80% $E_t$ | 10 CFR Part 431 |
| | | > 2,500,000 Btu/h[a] | 82% $E_c$ | |
| | Oil-fired[c] | < 300,000 Btu/h | 80% AFUE | 10 CFR Part 430 |
| | | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[b] | 82% $E_t$ | 10 CFR Part 431 |
| | | > 2,500,000 Btu/h[a] | 84% $E_c$ | |
| | Gas-fired | < 300,000 Btu/h | 75% AFUE | 10 CFR Part 430 |
| | Gas-fired- all, except natural draft | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[b] | 79% $E_t$ | 10 CFR Part 431 |
| | | > 2,500,000 Btu/h[a] | 79% $E_t$ | |

TABLE C403.2.3(7)
WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS[a, b, d]

| EQUIPMENT TYPE | SIZE CATEGORY | UNITS | BEFORE 1/1/2015 | | AS OF 1/1/2015 | | TEST PROCEDURE[e] |
|---|---|---|---|---|---|---|---|
| | | | Path A | Path B | Path A | Path B | |
| Air-cooled chillers | < 159 Tons | EER (Btu/W) | ≥ 9.562 FL | NA[c] | ≥ 10.100 FL | ≥ 9.700 FL | AHRI 550/590 |
| | | | ≥ 12.500 IPLV | | ≥ 13.700 IPLV | ≥ 15,800 IPLV | |
| | ≥ 150 Tons | | ≥ 9.562 FL | NA[c] | ≥ 10.100 FL | ≥ 9.700 FL | |
| | | | ≥ 12.500 IPLV | | ≥ 14.000 IPLV | ≥ 16.100 IPLV | |
| Air cooled without condenser, electrically operated | All capacities | EER (Btu/W) | Air-cooled chillers without condenser shall be rated with matching condensers and complying with air-cooled chiller efficiency requirements. | | | | |
| Water cooled, electrically operated positive displacement | < 75 Tons | kW/ton | ≤ 0.780 FL | ≤ 0.800 FL | ≤ 0.750 FL | ≤ 0.780 FL | |
| | | | ≤ 0.630 IPLV | ≤ 0.600 IPLV | ≤ 0.600 IPLV | ≤ 0.500 IPLV | |
| | ≥ 75 tons and < 150 tons | | ≤ 0.775 FL | ≤ 0.790 FL | ≤ 0.720 FL | ≤ 0.750 FL | |
| | | | ≤ 0.615 IPLV | ≤ 0.586 IPLV | ≤ 0.560 IPLV | ≤ 0.490 IPLV | |
| | ≥ 150 tons and < 300 tons | | ≤ 0.680 FL | ≤ 0.718 FL | ≤ 0.660 FL | ≤ 0.680 FL | |
| | | | ≤ 0.580 IPLV | ≤ 0.540 IPLV | ≤ 0.540 IPLV | ≤ 0.440 IPLV | |
| | ≥ 300 tons and < 600 tons | | ≤ 0.620 FL | ≤ 0.639 FL | ≤ 0.610 FL | ≤ 0.625 FL | |
| | | | ≤ 0.540 IPLV | ≤ 0.490 IPLV | ≤ 0.520 IPLV | ≤ 0.410 IPLV | |
| | ≥ 600 tons | | ≤ 0.620 FL | ≤ 0.639 FL | ≤ 0.560 FL | ≤ 0.585 FL | |
| | | | ≤ 0.540 IPLV | ≤ 0.490 IPLV | ≤ 0.500 IPLV | ≤ 0.380 IPLV | |

Air-cooled chiller

Source: http://www.trane.com/commercial/north-america/us/en/products-systems/equipment/chillers/air-cooled-chillers.html

# HVAC system controls

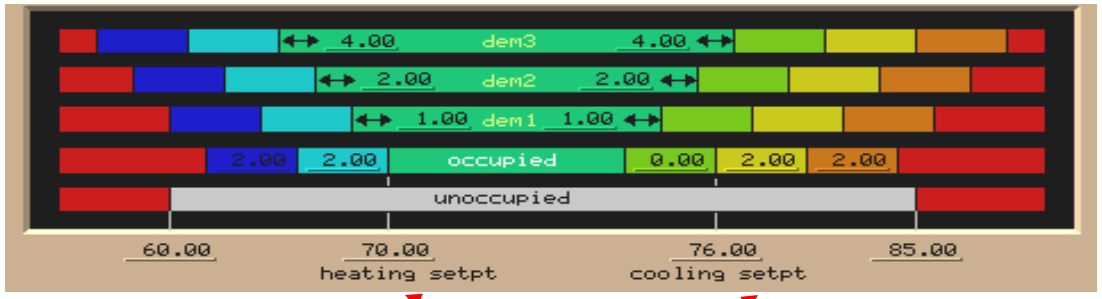
- Supply of heating and cooling to each zone shall be controlled by individual thermostatic controls
- Thermostats shall provide a temperature range or deadband of at least a 5° F within which the supply of heating and cooling to the zone is shut off or reduced to a minimum


*C403.2.4.1 - Mandatory*

# Full 5 degree temperature deadband

- If heating is set at 70°F, then cooling should be ≥ 75°F
- Why?
  - **Simple systems** can fight each other in open office areas
  - **VAV systems** have excessive reheat if settings are too tight
- ENERGY STAR recommended factory default setpoints of:
  - Heating  70°F
  - Cooling  78°F

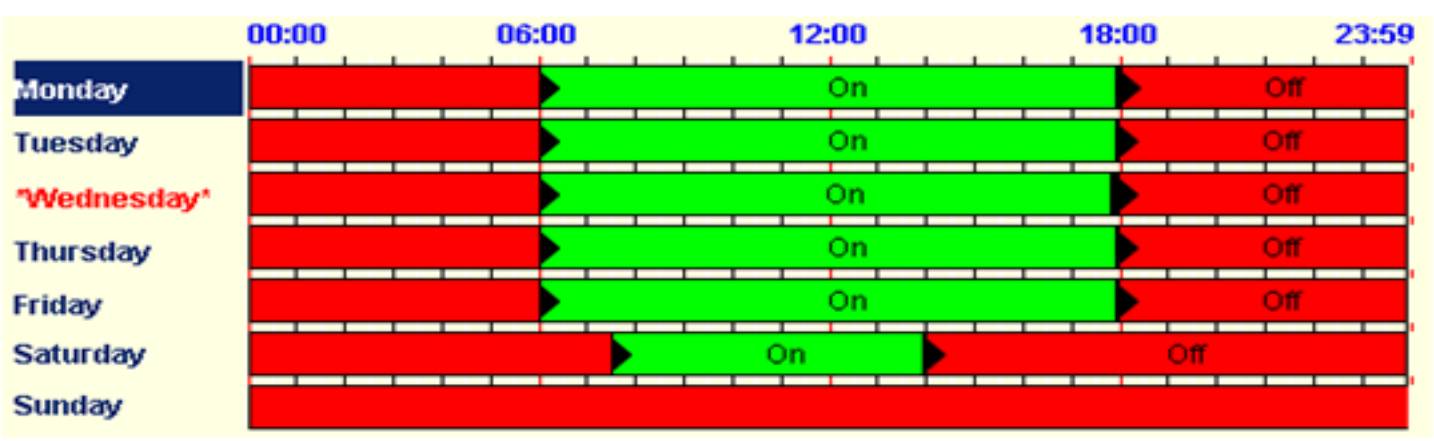

Source: http://oscac.com/what-you-need-to-know-about-programmable-thermostat/




Source: www.AutomatedLogic.com

# Temperature setback scheduling

- **Thermostatic setback capabilities**
  - Down to 55°F during winter
  - Up to 85°F during the summer
- **Automatic setback, shutdown, start-up**
  - Capable of seven different daily schedules per week
  - Manual override for two hours or occupancy sensor
  - Capable of adjusting daily start time to bring each space to desired occupied temperature prior to scheduled occupancy

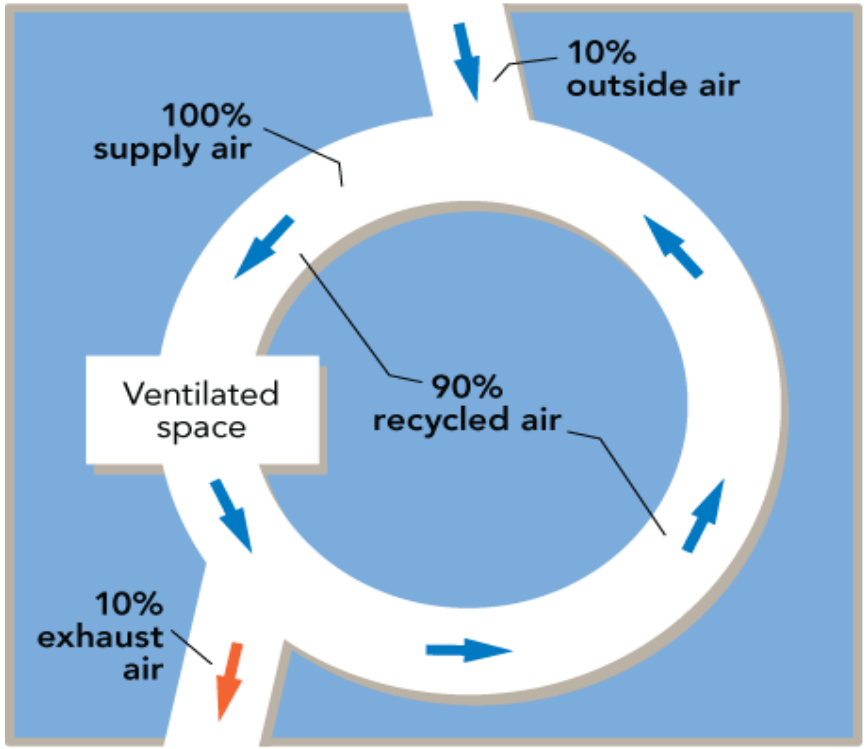

Source: http://docplayer.net/5893734-Chapter-5-introduction-to-building-automation-system-bas.html

Energy Myth:
Setback does not save energy because it takes so long to warm up in the morning
*Not true:*
*Savings can be 5%-20% of HVAC energy Use*

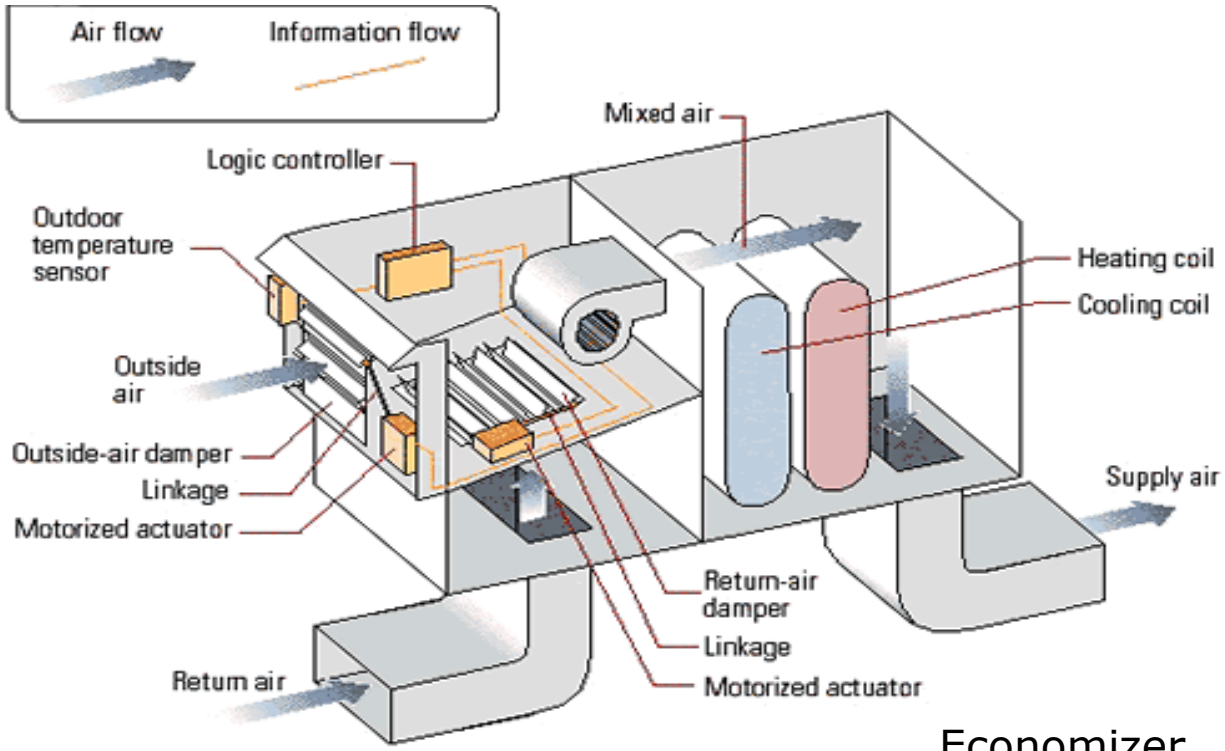
*C403.2.4.2.1, 403.2.4.2.2, C403.2.4.2.3 - Mandatory*

# Economizers provide "free cooling"

- Economizer function: Flush out building heat with cool outside air
- Meet minimum outside ventilation requirement



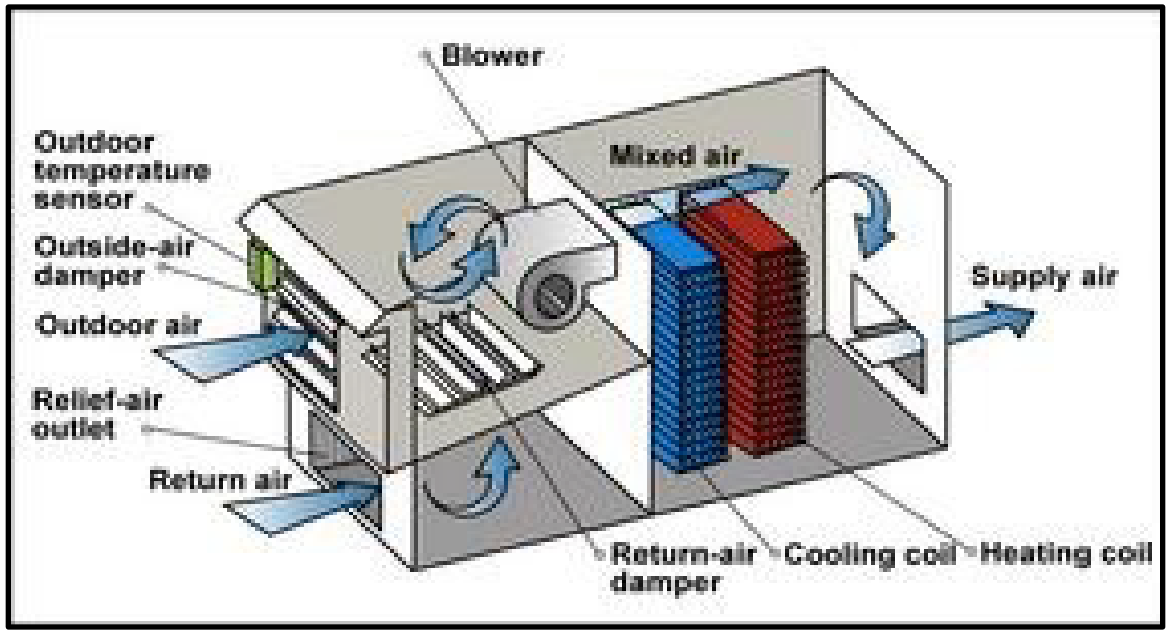

Ventilation Air




Economizer

# Economizers

- Economizer requirements are based on climate zone
- Capable of providing 100-percent outdoor air even if additional mechanical cooling is required
- Temperature sensors for outside air, supply air and return air
- Must provide a means to relieve excess outdoor air



# Economizers

**C403.5 Economizers.** An air or water economizer shall be provided for the following cooling systems.

- Individual fan systems with a cooling capacity greater than or equal to 54,000 Btu/h in buildings having other thana Group R occupancy.
- Individual fan systems with a cooling capacity greater than or equal to 270,000 Btu/h in buildings having a Group R occupancy.

Exceptions:

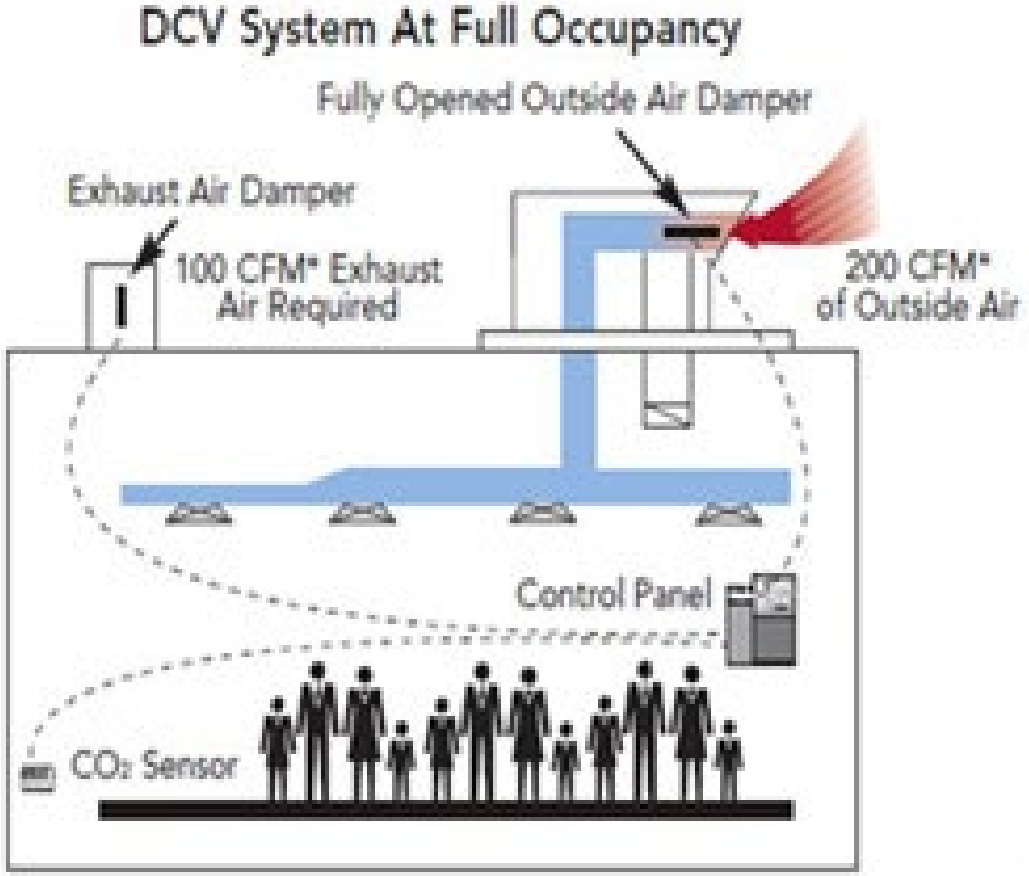
- Systems expected to operate less than 20 hours per week
- Systems serving supermarkets with open refrigerated casework

TABLE C403.5(2)
EQUIPMENT EFFICIENCY PERFORMANCE EXCEPTION FOR ECONOMIZERS

| CLIMATE ZONES | COOLING EQUIPMENT PERFORMANCE IMPROVEMENT (EER OR IPLV) |
|---|---|
| 2A, 2B | 10% efficiency improvement |
| 3A, 3B | 15% efficiency improvement |
| 4A, 4B | 20% efficiency improvement |

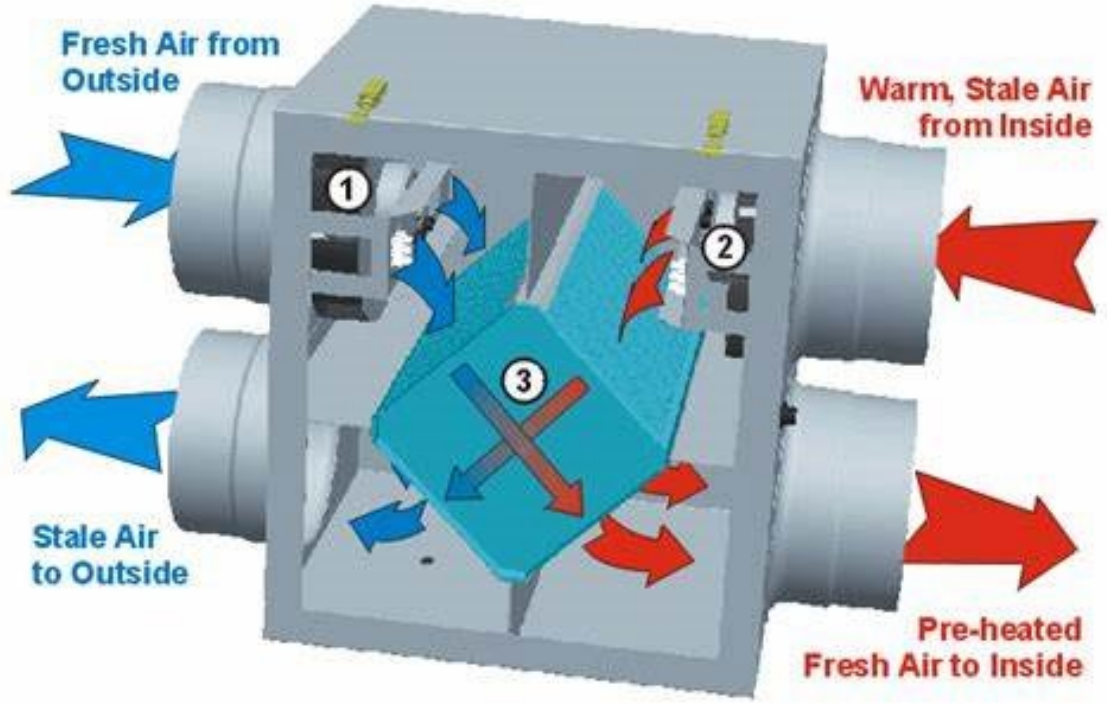
# Demand Control Ventilation – C403.7.1

- Required for spaces larger than 500 sf and with an average occupant load of 15 people or greater per 1,000 sf of floor area
  - Exceptions include -
    - Systems with an energy recovery per C403.7.4.2
    - Education laboratories, barber, beauty and nail salons, bowling alley seating areas



# Energy Recovery Systems – C403.7.4

- Non-transient dwelling units
  - Exceptions:
    - Dwelling units not more than 500 sq. ft. of conditioned floor area
- Spaces other than non-transient dwelling units
  - Required where supply airflow rate of fan system exceeds values specified in Tables C403.7.4.2(1) and (2)
  - Exceptions:
    - Systems expected to operate less than 20 hours per week
    - Commercial kitchen hoods



# Automatic HVAC System Controls in Hotel Guestrooms – C403.7.6

- Group R-1 buildings containing more than 50 guestrooms
  - Temperature setpoint control on each HVAC system that are capable of and configured with three modes of temperature control
    - Rented but unoccupied
    - Unrented and unoccupied
    - Occupied
  - Ventilation controls
    - Automatically turn off ventilation and exhaust fans within 30 minutes of occupants leaving the guestroom

Networked guestroom control system

# Duct and plenum insulation and sealing

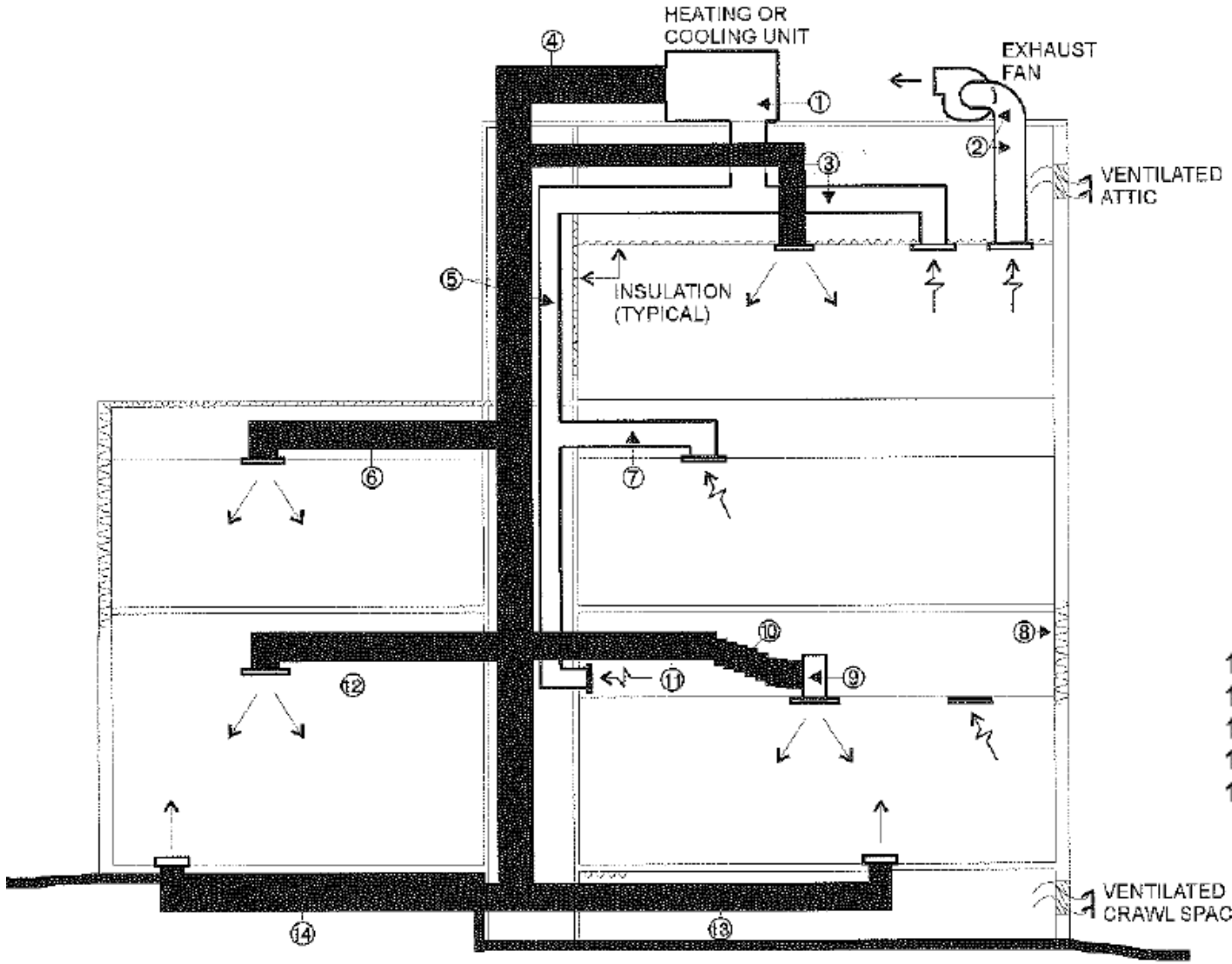
- **Insulation required for supply and return ducts and plenums**
  - ✓ Located in building in unconditioned space – min. R-6
  - ✓ Located outside building – min. R-8 (CZ1-4) and R-12 (CZ5-8)

**Exceptions:**

1. When located within equipment
2. When design temperature difference between interior and exterior of the duct or plenum is not greater than 15º F

*C403.12.1 - Mandatory*

# Duct insulation




KEY

1. INSULATION OF UNIT CASING
2. EXHAUST
3. SUPPLY & RETURN IN VENTED ATTIC
4. SUPPLY & RETURN IN EXTERIOR OF BUILDING
5. SUPPLY & RETURN IN SHAFT
6. SUPPLY & RETURN IN UNVENTED ATTIC
7. RETURN IN INDIRECTLY CONDITIONED CEILING SPACE
8. EXTERIOR WALL OF RETURN PLENUM
9. SUPPLY OUTLET IN PLENUM
10. SUPPLY RUNOUT IN RETURN PLENUM
11. SUPPLY IN RETURN PLENUM
12. SUPPLY & RETURN IN CONDITIONED SPACE
13. SUPPLY & RETURN IN VENTED CRAWL SPACE
14. BURIED SUPPLY

Source: US DOE

# Piping insulation

- All piping serving heating or cooling system must be insulated in accordance with Table 403.12.3

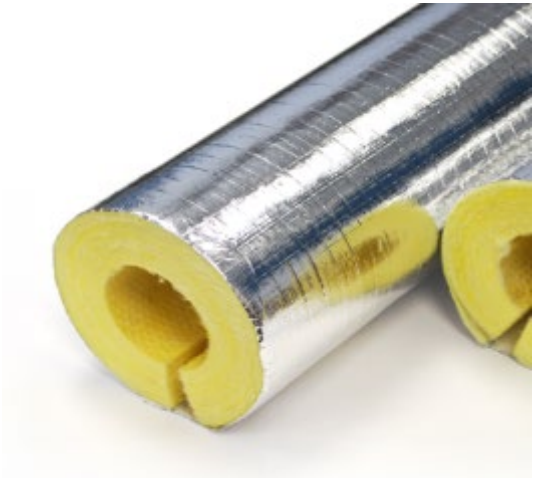


TABLE C403.12.3
MINIMUM PIPE INSULATION THICKNESS (in inches)[a, c]

| FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F) | INSULATION CONDUCTIVITY | | NOMINAL PIPE OR TUBE SIZE (inches) | | | | |
|---|---|---|---|---|---|---|---|
| | Conductivity Btu × in./(h × ft² × °F)[b] | Mean Rating Temperature, °F | < 1 | 1 to < 1 1/2 | 1 1/2 to < 4 | 4 to < 8 | > 8 |
| > 350 | 0.32–0.34 | 250 | 4.5 | 5.0 | 5.0 | 5.0 | 5.0 |
| 251–350 | 0.29–0.32 | 200 | 3.0 | 4.0 | 4.5 | 4.5 | 4.5 |
| 201–250 | 0.27–0.30 | 150 | 2.5 | 2.5 | 2.5 | 3.0 | 3.0 |
| 141–200 | 0.25–0.29 | 125 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 105–140 | 0.21–0.28 | 100 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |
| 40–60 | 0.21–0.27 | 75 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| < 40 | 0.20–0.26 | 50 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 |

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a. For piping smaller than 1 1/2 inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in Note b) but not to a thickness less than 1 inch.

# Piping insulation

**Exceptions to pipe insulation:**

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a procedure referenced by code
2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 & 840
3. Piping that conveys fluids that have a design operating temperature range between 60° F and 105° F
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power
5. Strainers, control valves, and balancing valves associated with piping 1 inch or less in diameter
6. Direct buried piping that conveys fluids at or below 60° F

*C403.2.10 - Mandatory*

# Fan efficiency

- Fans shall have a fan efficiency grade (FEG) of not less than 67.
- The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

**Exceptions**:

- Fans of 5 HP or less
- Fans that are a part of or included in an equipment package
- Powered wall and roof ventilators

ebmpapst

*C403.8.3 - Mandatory*

# Heating outside a building

- Systems installed to provide heat outside a building must be radiant systems

  - ✓ Must be controlled by an occupancy sensing device or timer switch
  - ✓ System must automatically be de-energized when no occupants are present

*C403.13.1 - Mandatory*

# Energy compliance software
## Provides Design Flexibility

- COMcheck can show compliance through the trade-off, mandatory and prescriptive approach.
  - **Thermal envelope**
    - Trade-off
  - **Mechanical systems**
    - Mandatory/Prescriptive
  - **Service Water Heating**
    - Mandatory/Prescriptive
  - **Lighting**
    - Mandatory/Prescriptive

1 COMcheck™ Windows version or Mac version

2 COMcheck-Web™

**www.energycodes.gov**

**COMcheck Software Version 4.1.5.5**

# Mechanical Compliance Certificate

## Project Information

| | |
|---|---|
| Energy Code: | 2021 IECC |
| Project Title: | Soho Salon |
| Location: | Scottsdale, Arizona |
| Climate Zone: | 2b |
| Project Type: | Alteration |

1

Construction Site:
16580 N. 92nd Street, Ste. 101
Scottsdale, AZ 85260

Owner/Agent:

Designer/Contractor:
Jorge Suchilt
NP Mechanical, Inc.
17215 N. 72nd Drive, Ste. D-145
Glendale, AZ 85308
602-249-6311
jorge@npmechanical.com

## Mechanical Systems List

| Quantity | System Type & Description |
|---|---|
| 1 | HVAC System 1 (Single Zone):<br>Split System Heat Pump<br>Heating Mode: Capacity = 24 kBtu/h,<br>Proposed Efficiency = 8.50 HSPF, Required Efficiency = 8.20 HSPF<br>Cooling Mode: Capacity = 31 kBtu/h,<br>Proposed Efficiency = 14.50 SEER, Required Efficiency: 14.00 SEER<br>Fan System: FAN SYSTEM 1 -- Compliance (Motor nameplate HP method) : Passes<br><br>Fans:<br>FAN 1 Supply, Constant Volume, 1200 CFM, 0.5 motor nameplate hp, 0.0 fan efficiency grade |
| 1 | HVAC System 2 (Single Zone):<br>Split System Heat Pump<br>Heating Mode: Capacity = 35 kBtu/h,<br>Proposed Efficiency = 8.20 HSPF, Required Efficiency = 8.20 HSPF<br>Cooling Mode: Capacity = 41 kBtu/h,<br>Proposed Efficiency = 14.00 SEER, Required Efficiency: 14.00 SEER<br>Fan System: FAN SYSTEM 2 -- Compliance (Motor nameplate HP method) : Passes<br><br>Fans:<br>FAN 2 Supply, Constant Volume, 1600 CFM, 0.8 motor nameplate hp, 0.0 fan efficiency grade |
| 1 | Water Heater 1:<br>Electric Storage Water Heater, Capacity: 80 gallons w/ Circulation Pump<br>Proposed Efficiency: 0.34 SL, %/h (if > 12 kW), Required Efficiency: 0.64 SL, %/h (if > 12 kW) |

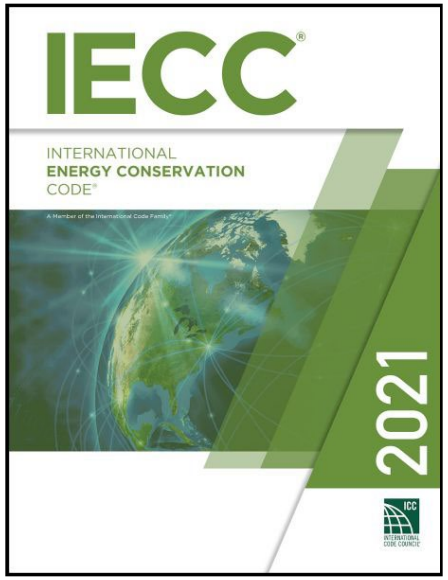
## Mechanical Compliance Statement

*Compliance Statement:* The proposed mechanical alteration project represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2021 IECC requirements in COM*check* Version 4.1.5.5 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

| JORGE SUCHILT – DESIGNER | Jorge Suchilt | 9-26-24 |
|---|---|---|
| Name - Title | Signature | Date |

# Chapter 4 – Energy Efficiency Requirements

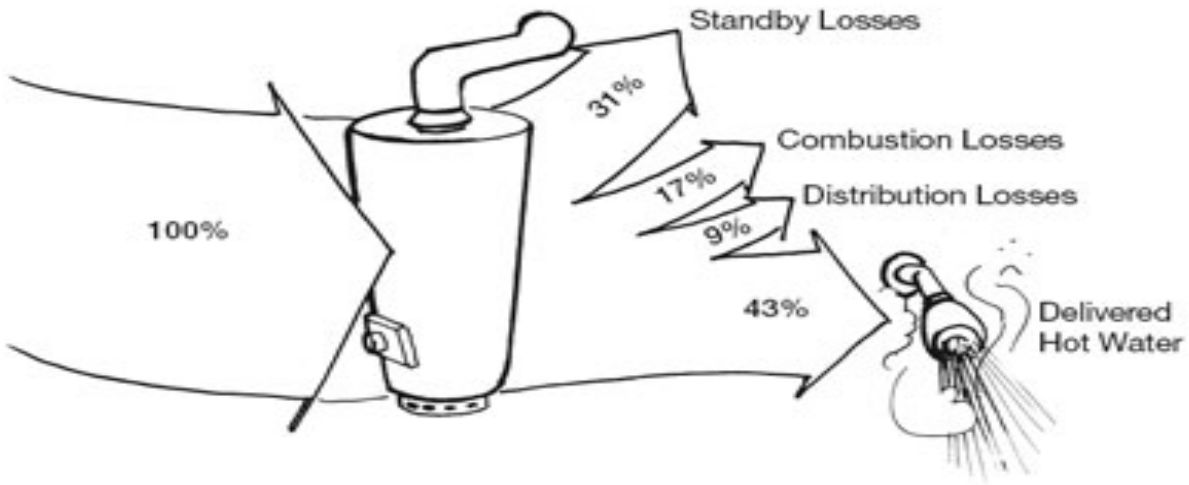
- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Service water heating
## Equipment efficiency

### Table C404.2

Minimum Performance Efficiency of Water-Heating Equipment




American Council for an Energy-Efficient Economy

| EQUIPMENT TYPE | SIZE CATEGORY (input) | SUBCATEGORY OR RATING CONDITION | PERFORMANCE REQUIREDa, b | TEST PROCEDURE |
|---|---|---|---|---|
| **Water heaters, electric** | £ 12 kWd | Resistance | 0.97 - 0.00 132V, EF | DOE 10 CFR Part 430 |
| | > 12 kW | Resistance | (0.3 + 27/Vm), %/h | ANSI Z21.10.3 |
| | £ 24 amps and £ 250 volts | Heat pump | 0.93 - 0.00 132V, EF | DOE 10 CFR Part 430 |
| **Storage water heaters, gas** | £ 75,000 Btu/h | ³ 20 gal | 0.67 - 0.0019V, EF | DOE 10 CFR Part 430 |
| | > 75,000 Btu/h and £ 155,000 Btu/h | < 4,000 Btu/h/gal | | ANSI Z21.10.3 |
| | > 155,000 Btu/h | < 4,000 Btu/h/gal | | |
| **Instantaneous water heaters, gas** | > 50,000 Btu/h and < 200,000 Btu/hc | ³ 4,000 (Btu/h)/gal and < 2 gal | 0.62 - 0.00 19V, EF | DOE 10 CFR Part 430 |
| | ³ 200,000 Btu/h | ³ 4,000 Btu/h/gal and < 10 gal | 80% Et | ANSI Z21.10.3 |
| | ³ 200,000 Btu/h | ³ 4,000 Btu/h/gal and ³ 10 gal | | |
| **Storage water heaters, oil** | £ 105,000 Btu/h | ³ 20 gal | 0.59 - 0.0019V, EF | DOE 10 CFR Part 430 |
| | ³ 105,000 Btu/h | < 4,000 Btu/h/gal | | ANSI Z21.10.3 |
| **Instantaneous water heaters, oil** | £ 210,000 Btu/h | ³ 4,000 Btu/h/gal and < 2 gal | 0.59 - 0.0019V, EF | DOE 10 CFR Part 430 |
| | > 210,000 Btu/h | ³ 4,000 Btu/h/gal and < 10 gal | 80% Et | ANSI Z21.10.3 |
| | > 210,000 Btu/h | ³ 4,000 Btu/h/gal and ³ 10 gal | | |
| **Hot water supply boilers, gas and oil** | ³ 300,000 Btu/h and < 12,500,000 Btu/h | ³ 4,000 Btu/h/gal and < 10 gal | 80% Et | ANSI Z21.10.3 |
| **Hot water supply boilers, gas** | ³ 300,000 Btu/h and < 12,500,000 Btu/h | ³ 4,000 Btu/h/gal and ³ 10 gal | | |
| **Hot water supply boilers, oil** | > 300,000 Btu/h and < 12,500,000 Btu/h | > 4,000 Btu/h/gal and > 10 gal | | |
| **Pool heaters, gas and oil** | All | — | 82% Et | ASHRAE 146 |
| **Heat pump pool heaters** | All | — | 4.0 COP | AHRI 1160 |
| **Unfired storage tanks** | All | — | Minimum insulation requirement R-12.5 (h · ft2 · ° F)/Btu | (none) |

*C404 Mandatory, Table C404.2*

# Service water heating
## Pipe insulation

**C404.4** – Piping from a water heater to the termination of the water fixture supply pipe shall be insulated per Table C403.12.3.

TABLE C403.12.3
MINIMUM PIPE INSULATION THICKNESS (in inches)[a, c]

| FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F) | INSULATION CONDUCTIVITY | | NOMINAL PIPE OR TUBE SIZE (inches) | | | | |
|---|---|---|---|---|---|---|---|
| | Conductivity Btu × in./(h × ft$^2$ × °F)[b] | Mean Rating Temperature, °F | < 1 | 1 to < 1$^1/_2$ | 1$^1/_2$ to < 4 | 4 to < 8 | > 8 |
| > 350 | 0.32–0.34 | 250 | 4.5 | 5.0 | 5.0 | 5.0 | 5.0 |
| 251–350 | 0.29–0.32 | 200 | 3.0 | 4.0 | 4.5 | 4.5 | 4.5 |
| 201–250 | 0.27–0.30 | 150 | 2.5 | 2.5 | 2.5 | 3.0 | 3.0 |
| 141–200 | 0.25–0.29 | 125 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 105–140 | 0.21–0.28 | 100 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |
| 40–60 | 0.21–0.27 | 75 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| < 40 | 0.20–0.26 | 50 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 |

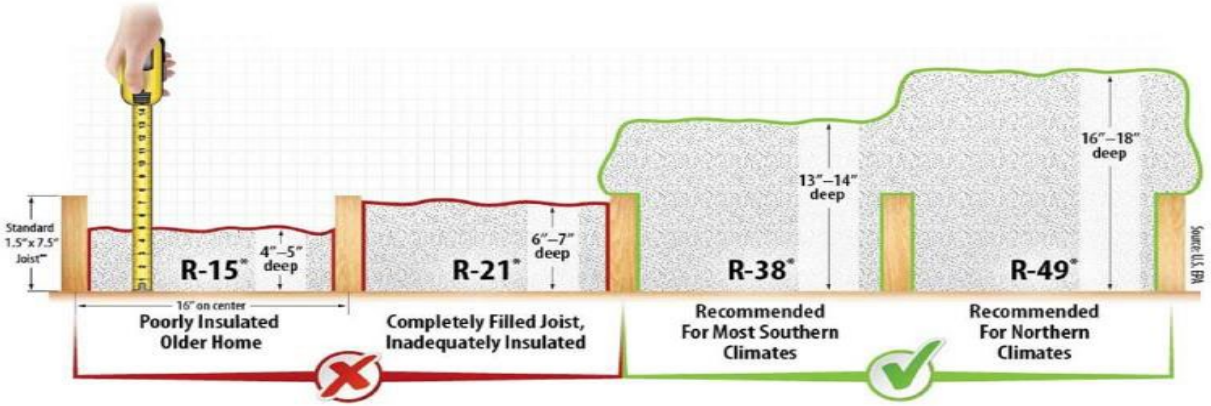
For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a. For piping smaller than 1$^1/_2$ inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in Note b) but not to a thickness less than 1 inch.

# Service water heating
## Pipe insulation

- **Exceptions:**
  - ✓ Piping at locations where vertical support of piping is installed
  - ✓ Tubing from connection at termination of supply piping to plumbing fixture
  - ✓ Cold-water piping used as a return for a demand recirculation hot water system
  - ✓ Piping surrounded by building insulation with a thermal resistance of not less than R-3

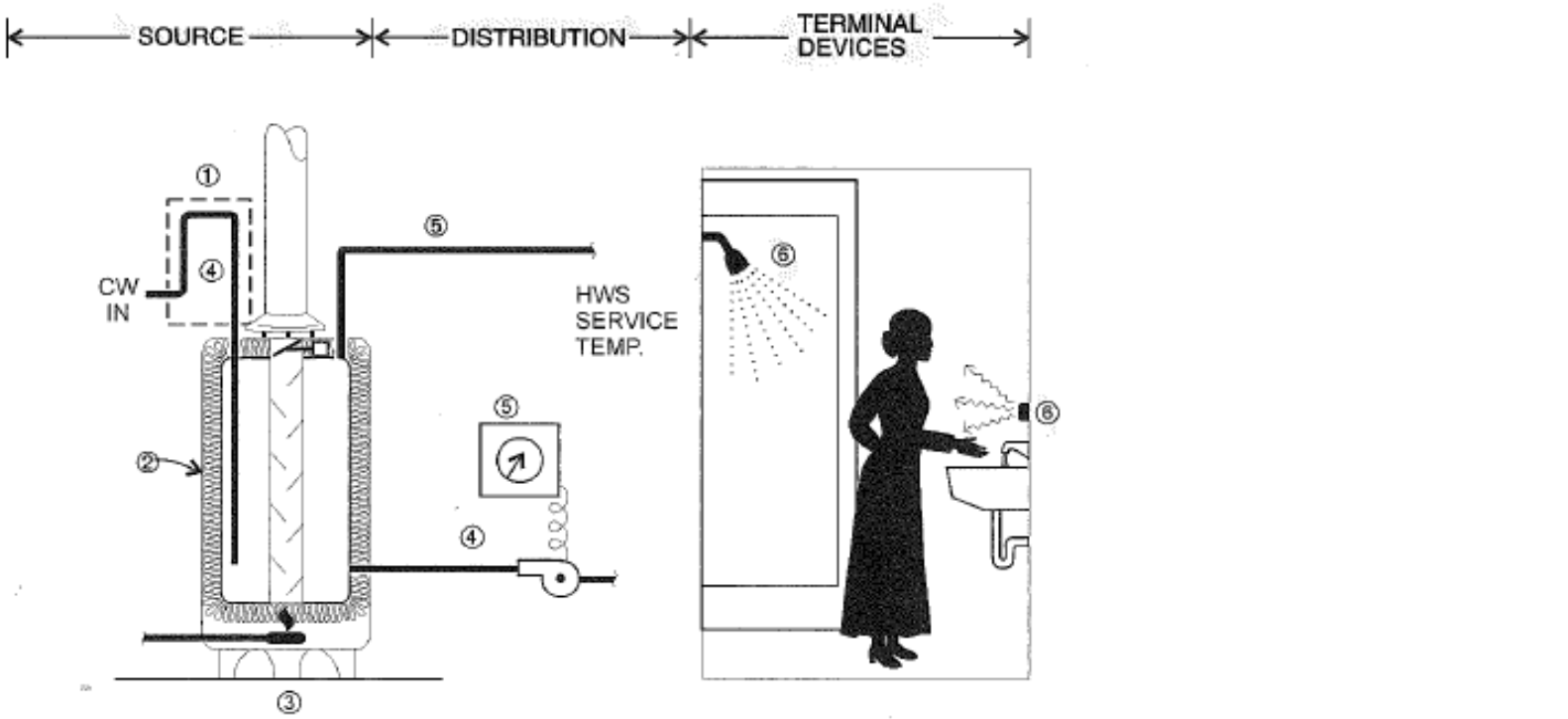
Mar Falardeauc/CC BY-NC 2.0




Owens Corning

# Service water heating distribution

**IPC Section 607.2.** The *developed length* of hot or tempered water piping, from the source of hot to the fixtures the require hot or tempered water, **shall not exceed 50 feet**.




① HEAT TRAPS TO REDUCE STANDBY LOSSES

② INSULATED TANKS TO REDUCE STANDBY LOSSES

③ HIGH EFFICIENCY SOURCES

④ PIPE INSULATION TO REDUCE DISTRIBUTION AND STANDBY LOSSES

⑤ CIRCULATION LOOP TEMPERATURE CONTROLS TO REDUCE DISTRIBUTION LOSSES

⑥ FLOW LIMITING DEVICES SUCH AS LOW FLOW SHOWER HEADS AND OCCUPANT SENSORS TO REDUCE WASTE ARE ENCOURAGED BUT NOT REQUIRED BY THE IECC ( FOR FURTHER DISCUSSION OF WATER CONSERVATION MEASURES

Source: US DOE

# Service water heating
## Maximum pipe volume or length

**Table C404.5.1 – Max. Pipe Volume or Lengths between nearest source & fixture**

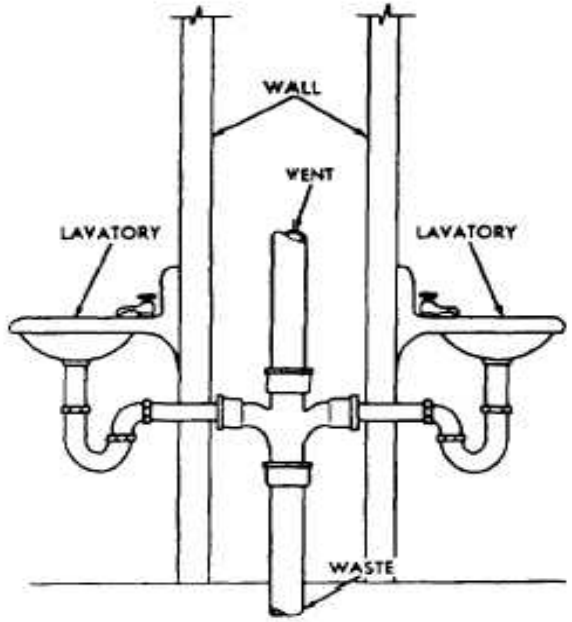
| NOMINAL PIPE SIZE (inches) | VOLUME (liquid ounces/foot length) | MAXIMUM PIPING LENGTH (feet) | |
|---|---|---|---|
| | | Public lavatory faucets | Other fixtures & appliances |
| 1/4 | 0.33 | 6 | 50 |
| 5/16 | 0.5 | 4 | 50 |
| 3/8 | 0.75 | 3 | 50 |
| 1/2 | 1.5 | 2 | 43 |
| 5/8 | 2 | 1 | 32 |
| 3/4 | 3 | 0.5 | 21 |
| 7/8 | 4 | 0.5 | 16 |
| 1 | 5 | 0.5 | 13 |
| 11/4 | 8 | 0.5 | 8 |
| 11/2 | 11 | 0.5 | 6 |
| 2 or larger | 18 | 0.5 | 4 |

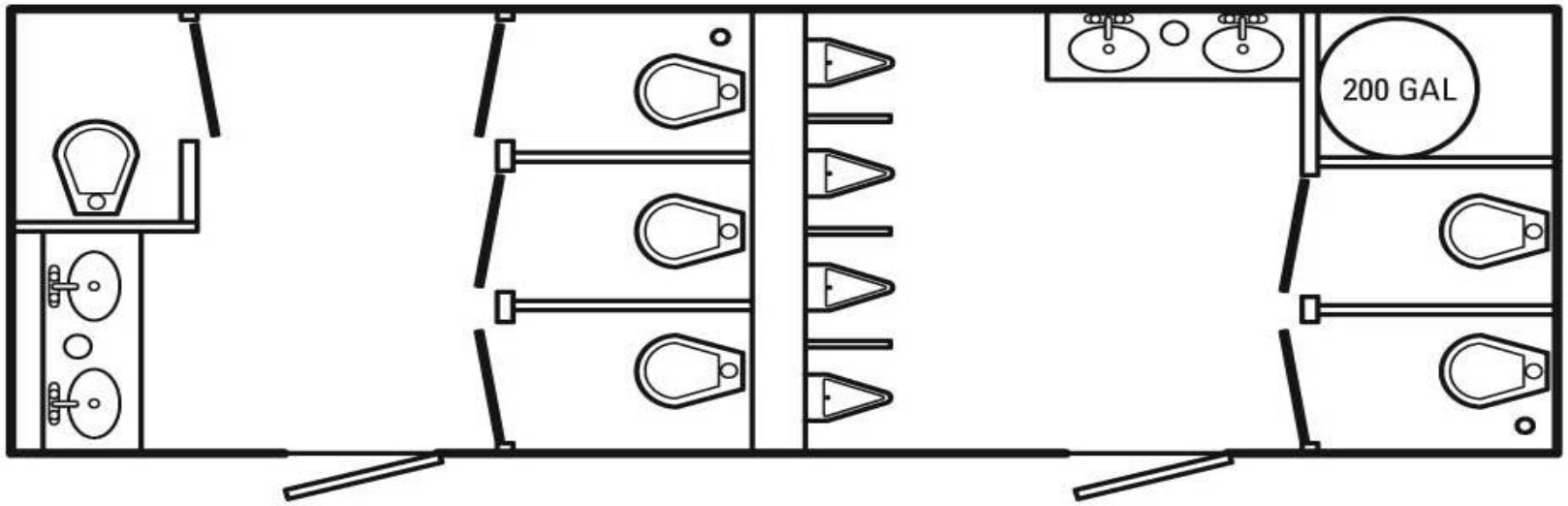
Water heaters, circulation & heat trace systems are considered sources of heated water.

# Service water heating

## Compact /Plumbing Core

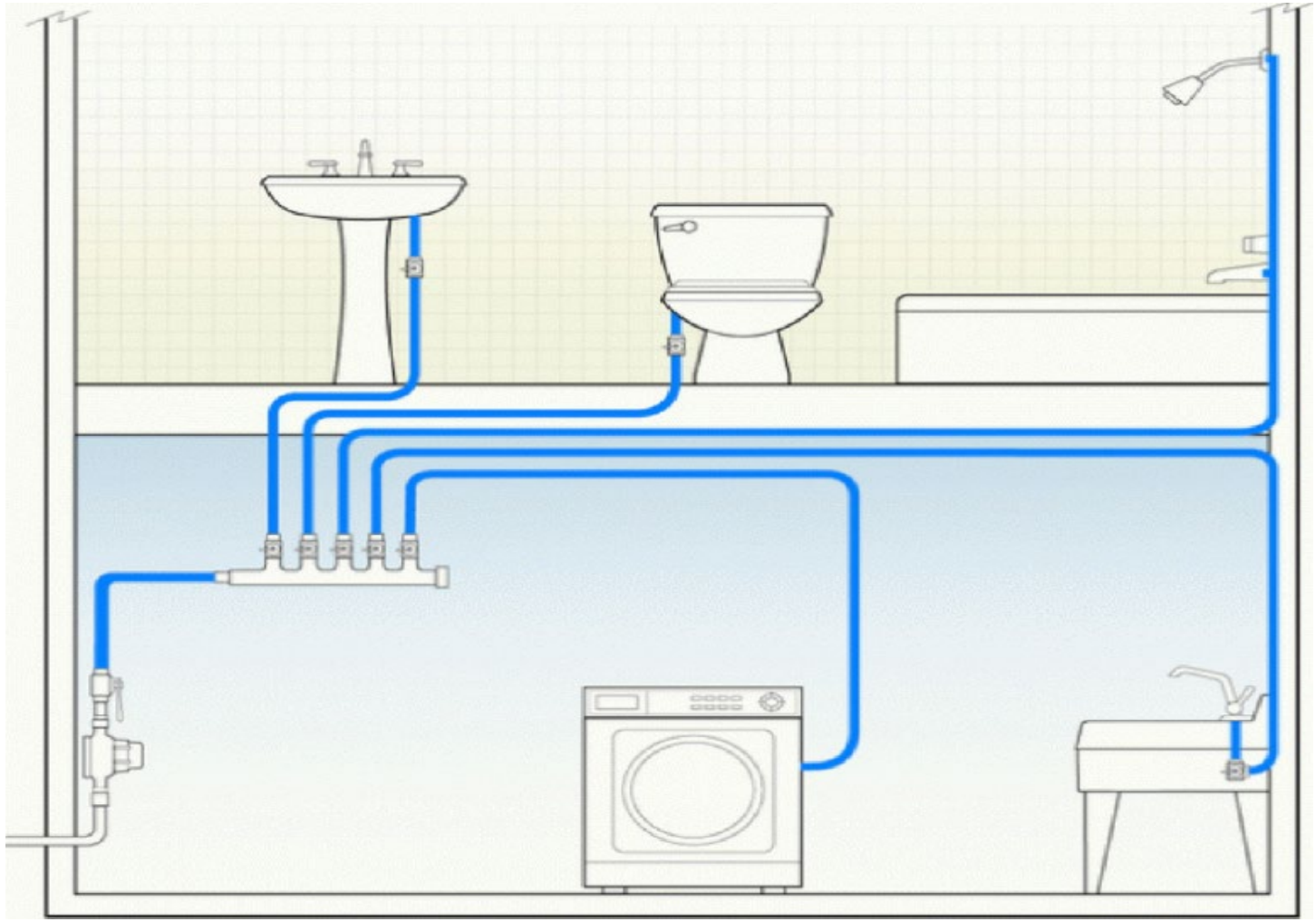
- Water heaters located in close proximity to point of use
- Zoned plumbing core




# Service water heating

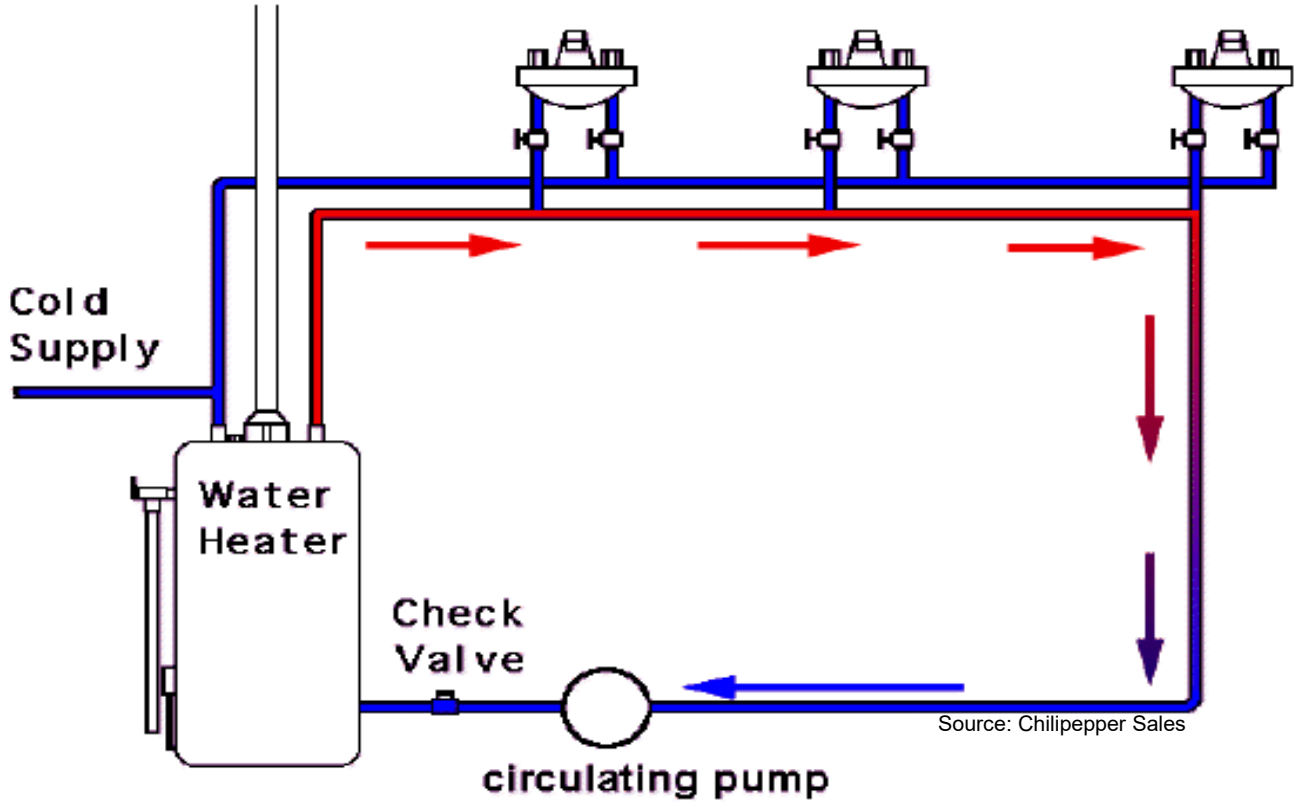
- **Home-run manifold**
  - Reduces waiting time for hot water



# Service water heating

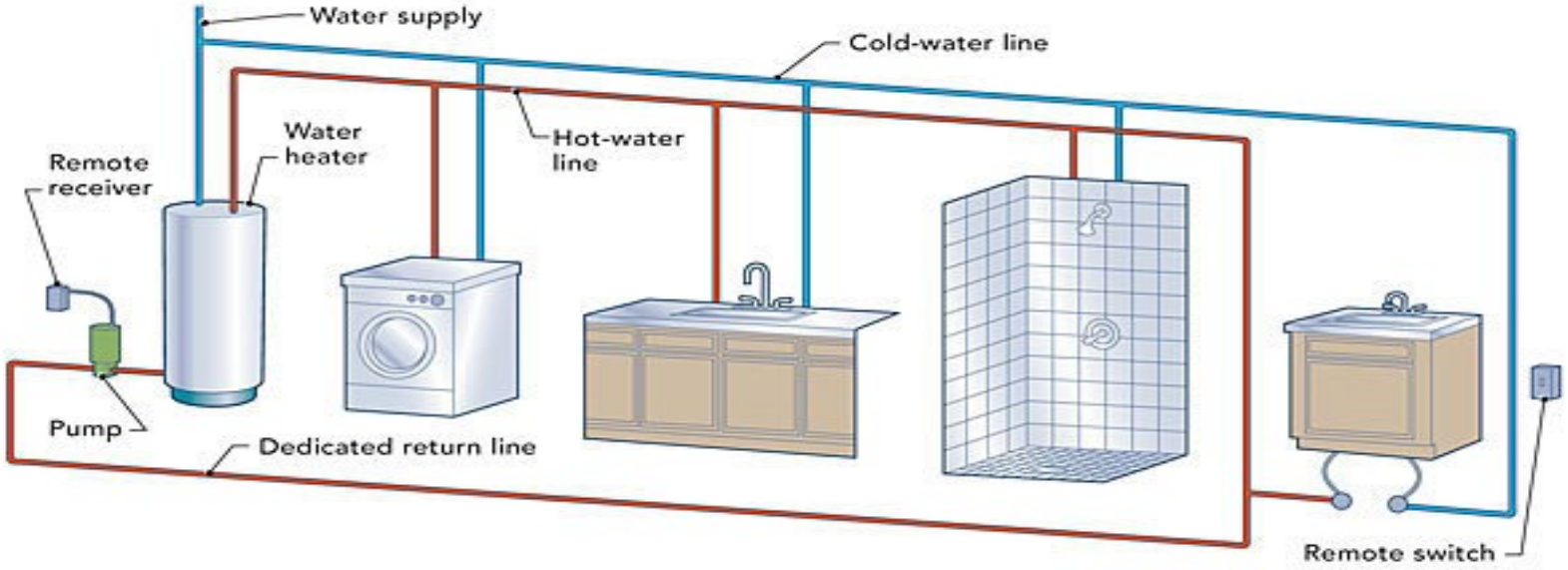
## Recirculation System

- Required for remotely located hot water fixtures
- Return line shall be a dedicated return pipe or a cold water supply pipe

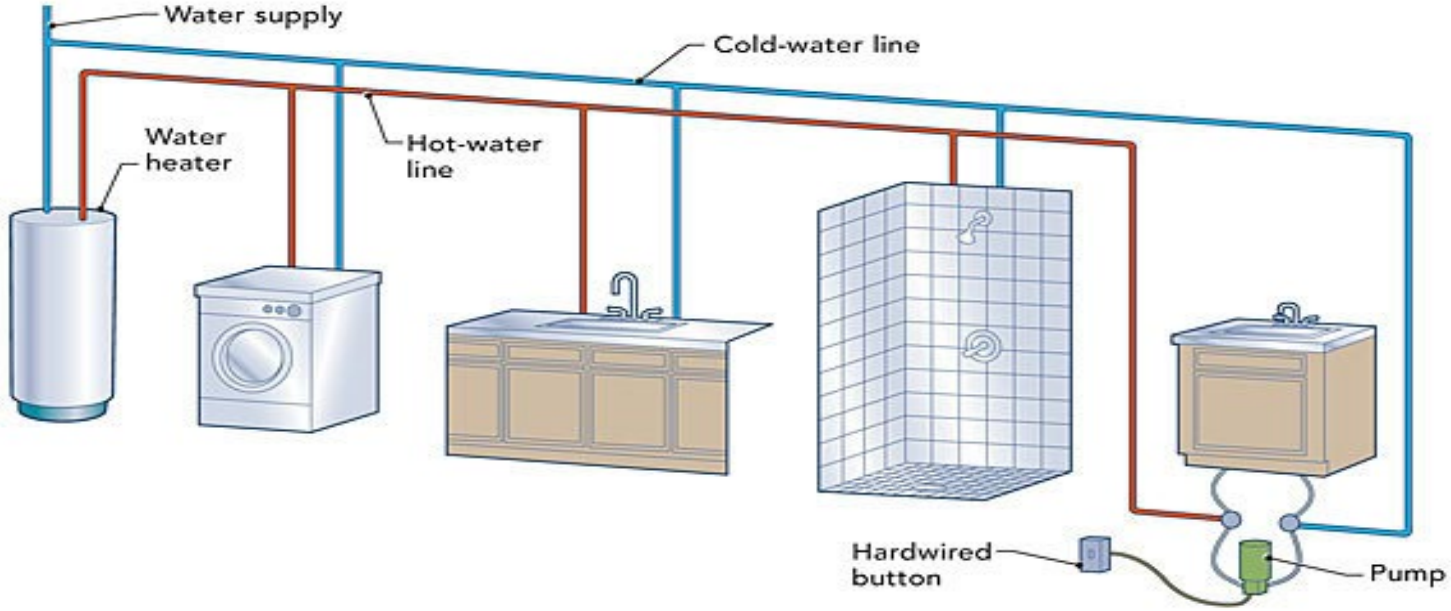



Hot water circulating system with fixtures, pump, check valve & water heater.

**Dedicated hot-water return line**




**Cold-water piping used as return line**



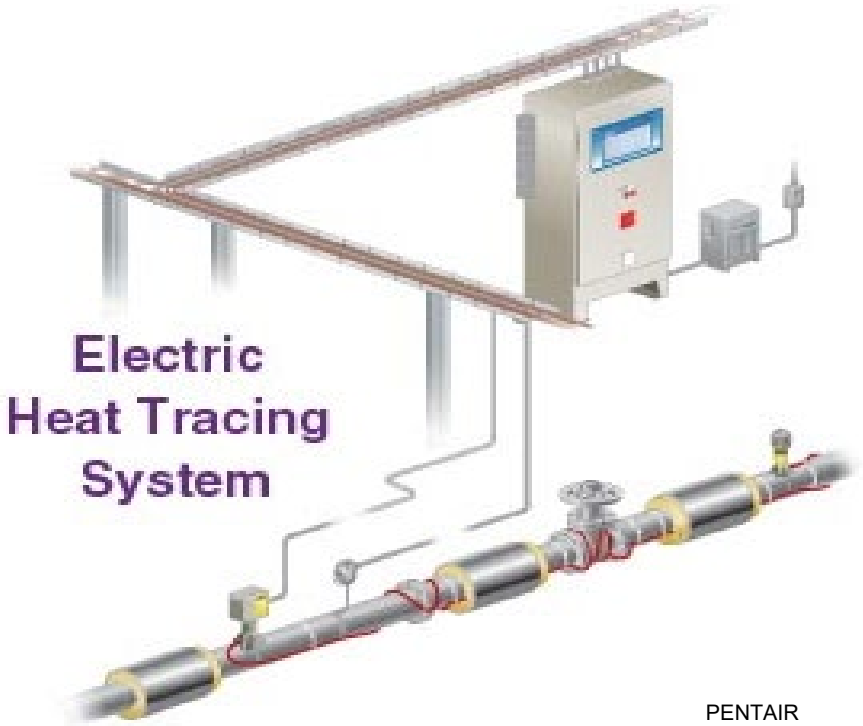
# Service water heating

- **Hot water circulation system controls**
  - ✓ Controls start the pump upon receiving a signal from the action of a user, sensing the presence of a user or sensing the flow of hot or tempered water to a fixture fitting or appliance
  - ✓ Controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not demand for hot water

*C404.6.1*

# Service water heating

- **Electric heat trace systems**
  - ✓ Controls shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy
  - ✓ Heat trace shall be arranged to be turned off automatically when there is no hot water demand




*C404.6.2*

# Energy compliance software
## Provides Design Flexibility

- COMcheck can show compliance through the trade-off, mandatory and prescriptive approach.
  - **Thermal envelope**
    - Trade-off
  - **Mechanical systems**
    - Mandatory/Prescriptive
  - **Service Water Heating**
    - Mandatory/Prescriptive
  - **Lighting**
    - Mandatory/Prescriptive

1 COMcheck™ Windows version or Mac version

2 COMcheck-Web™

**www.energycodes.gov**

**COMcheck Software Version 4.1.5.5**

# Mechanical Compliance Certificate

## Project Information

| | |
|---|---|
| Energy Code: | 2021 IECC |
| Project Title: | Soho Salon |
| Location: | Scottsdale, Arizona |
| Climate Zone: | 2b |
| Project Type: | Alteration |

Construction Site:
16580 N. 92nd Street, Ste. 101
Scottsdale, AZ 85260

Owner/Agent:

Designer/Contractor:
Jorge Suchilt
NP Mechanical, Inc.
17215 N. 72nd Drive, Ste. D-145
Glendale, AZ 85308
602-249-6311
jorge@npmechanical.com

## Mechanical Systems List

| Quantity | System Type & Description |
|---|---|
| 1 | HVAC System 1 (Single Zone):<br>Split System Heat Pump<br>Heating Mode: Capacity = 24 kBtu/h,<br>Proposed Efficiency = 8.50 HSPF, Required Efficiency = 8.20 HSPF<br>Cooling Mode: Capacity = 31 kBtu/h,<br>Proposed Efficiency = 14.50 SEER, Required Efficiency: 14.00 SEER<br>Fan System: FAN SYSTEM 1 -- Compliance (Motor nameplate HP method) : Passes<br><br>Fans:<br>FAN 1 Supply, Constant Volume, 1200 CFM, 0.5 motor nameplate hp, 0.0 fan efficiency grade |
| 1 | HVAC System 2 (Single Zone):<br>Split System Heat Pump<br>Heating Mode: Capacity = 35 kBtu/h,<br>Proposed Efficiency = 8.20 HSPF, Required Efficiency = 8.20 HSPF<br>Cooling Mode: Capacity = 41 kBtu/h,<br>Proposed Efficiency = 14.00 SEER, Required Efficiency: 14.00 SEER<br>Fan System: FAN SYSTEM 2 -- Compliance (Motor nameplate HP method) : Passes<br><br>Fans:<br>FAN 2 Supply, Constant Volume, 1600 CFM, 0.8 motor nameplate hp, 0.0 fan efficiency grade |
| 1 | Water Heater 1:<br>Electric Storage Water Heater, Capacity: 80 gallons w/ Circulation Pump<br>Proposed Efficiency: 0.34 SL, %/h (if > 12 kW), Required Efficiency: 0.64 SL, %/h (if > 12 kW) |

## Mechanical Compliance Statement

*Compliance Statement:* The proposed mechanical alteration project represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2021 IECC requirements in COMcheck Version 4.1.5.5 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

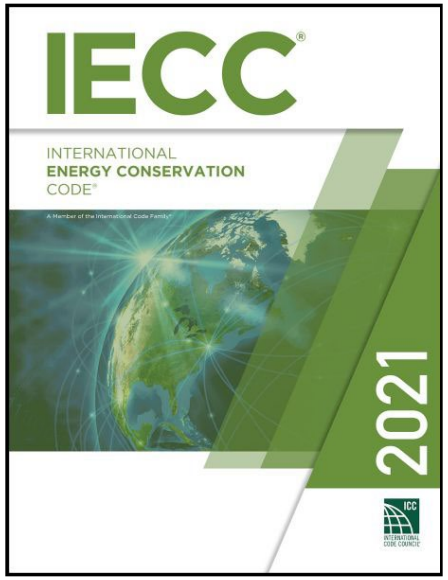
JORGE SUCHILT – DESIGNER — Name - Title

Jorge Suchilt — Signature

9-26-24 — Date

# Chapter 4 – Energy Efficiency Requirements

- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Lighting systems scope

- **Interior lighting**
  - Controls (mandatory) - C405.2
  - Lighting power allowances (prescriptive)

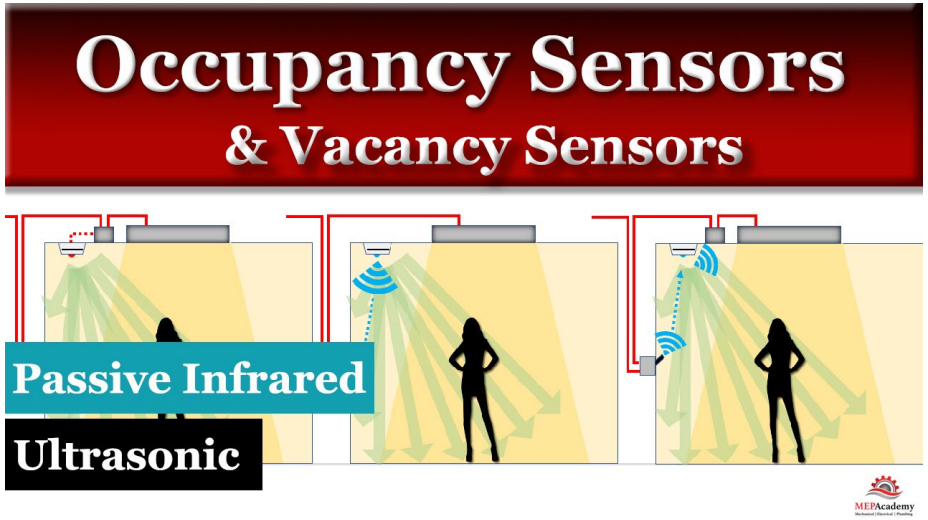
  **Exceptions**:
    - Security or emergency areas that must be continuously lighted
    - Interior exit stairways, exit ramps and exit passageways
    - Emergency egress lighting that is normally off
- **Exterior Lighting**
  - Controls (mandatory) - C405.2.7
  - Lighting Power Allowances (mandatory)


Design by Todd

# Occupant Sensor Controls - C405.2.1

- Occupant sensor controls shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms.
3. Copy/print rooms.
4. Lounges/breakrooms.
5. Enclosed offices.
6. Open plan office areas
7. Restrooms.
8. Storage rooms.
9. Locker rooms.
10. Corridors.
11. Warehouse storage areas.
12. Other spaces 300 square feet or less that are enclosed by floor-to-ceiling height partitions.



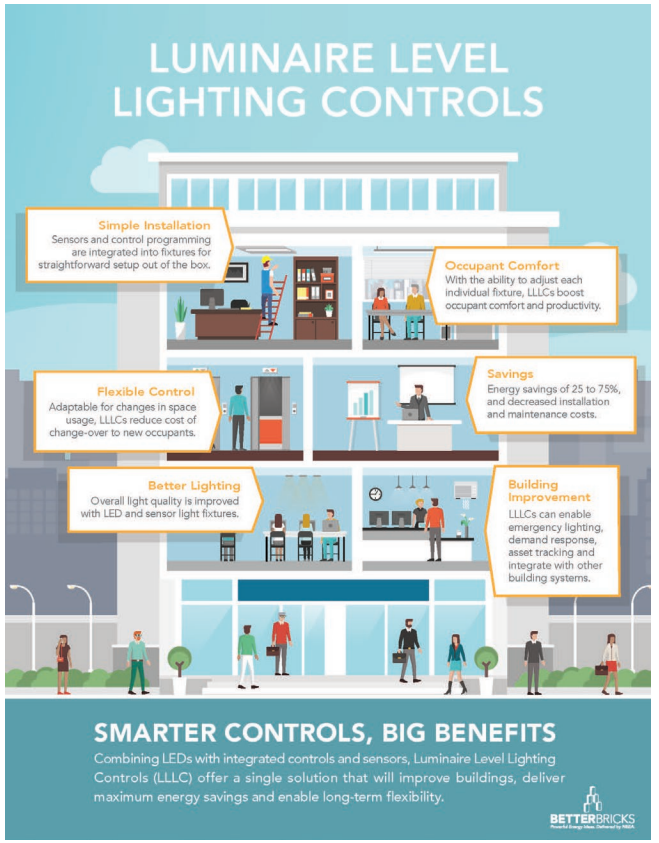
# Plan Review Correction Stamp

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

1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms.
3. Copy/print rooms.
4. Lounges/breakrooms.
5. Enclosed offices.
6. Open plan office areas.
7. Restrooms.
8. Storage rooms.
9. Locker rooms.
10. Corridors.
11. Warehouse storage areas.
12. Other spaces 300 square feet or less that are enclosed by floor-to-ceiling height partitions.

# Time-Switch Controls - C405.2.2

- Where not provided with occupant sensor controls, general lighting shall be provided with time-switch controls that comply with the following:
  1. Automatically turn off lights when the space is scheduled to be unoccupied.
  2. Have a minimum 7-day clock.
  3. Setting capability for seven different day types per week.
  4. Automatic holiday “shutoff” feature.
  5. Have program backup capabilities to prevent loss of settings if power is interrupted.
  6. Override switch with manual control that when initiated, permit the controlled lighting to remain on for not more than 2 hours for an area not larger than 5,000 sq. ft.

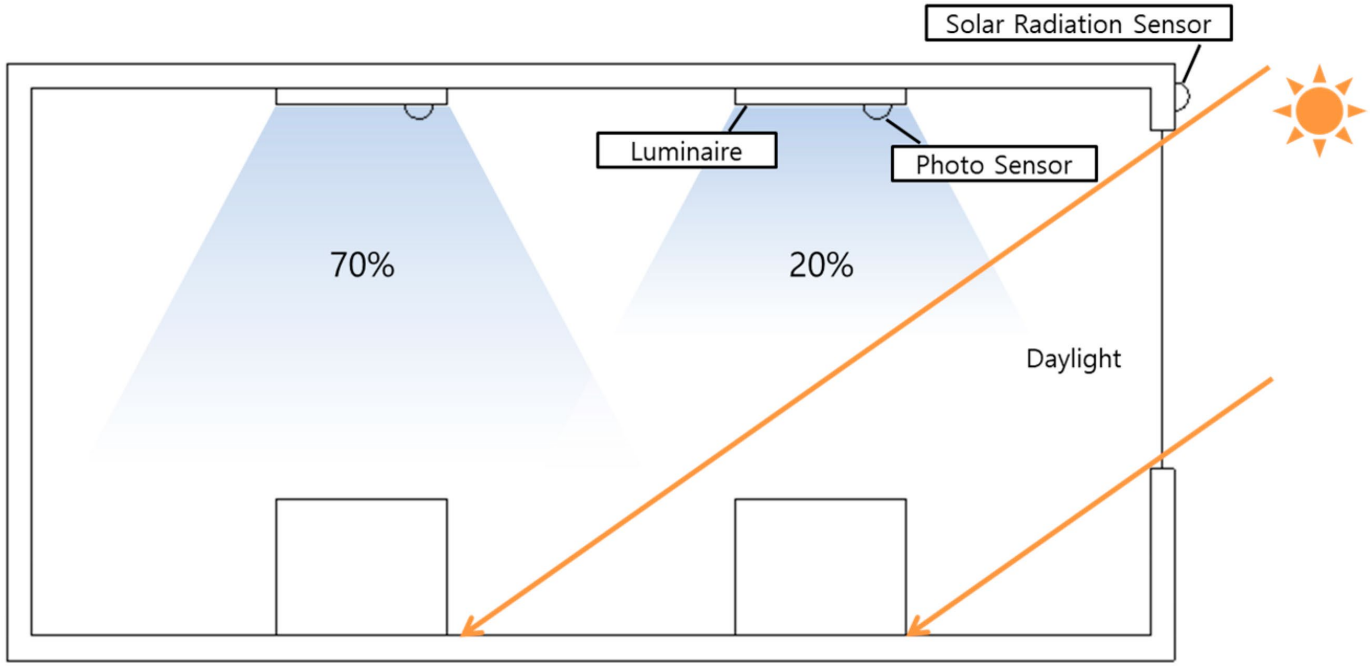


# Light Reduction Controls - C405.2.3

- Where not provided with occupant sensor controls, general lighting shall be provided with one of the following light-reduction controls
  - Manual control that allows the occupant to reduce the connected lighting load by not less than 50% in a uniform illumination pattern with an intermediate step in addition to full on/off position; or
  - Continuous dimming control; or
  - Switching alternate luminaires or rows of luminaires to achieve a reduced output

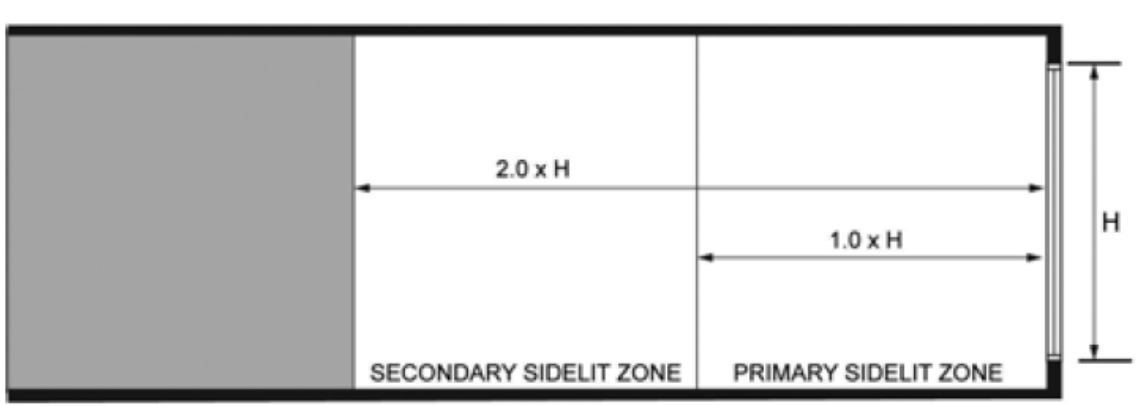
# Daylight-Responsive Controls - C405.2.4

- Daylight-responsive controls shall be provided to control the general lighting within daylight zones in the following spaces:
  - Spaces with more than 150 watts of general lighting within primary sidelit daylight zones.
  - Spaces with more than 300 watts of general lighting within sidelit daylight zones.
  - Spaces with more than 150 watts of general lighting within toplit daylight zones.

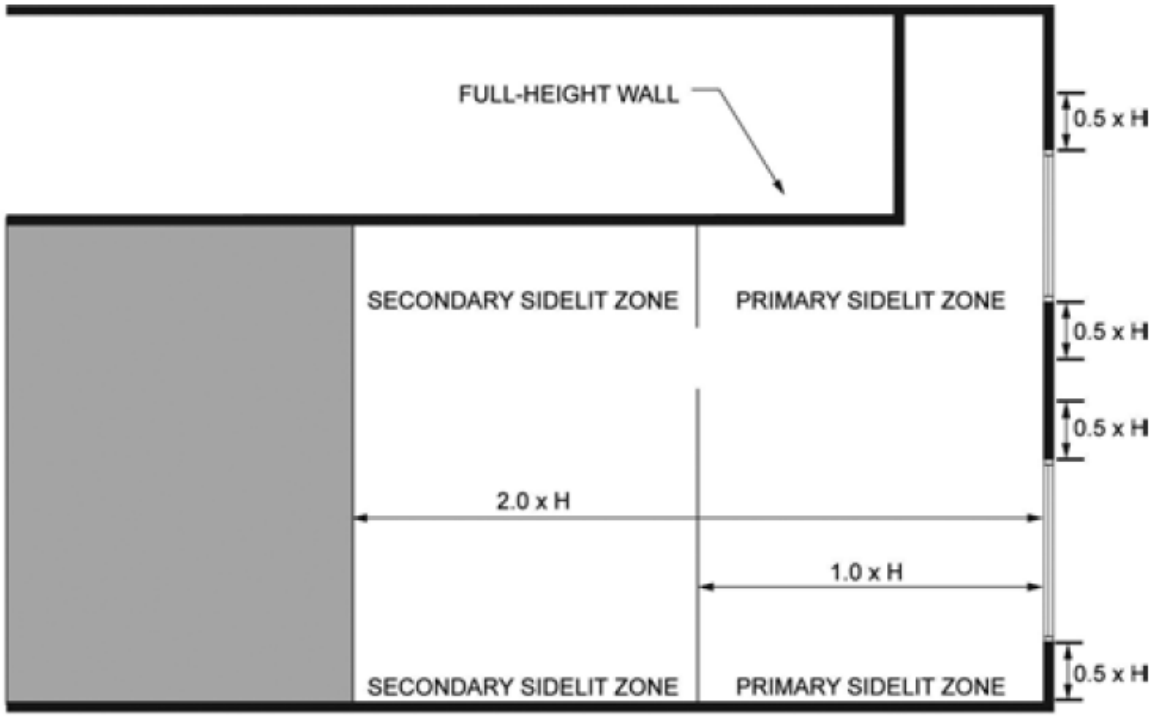



Exception: Spaces in health care facilities where patient care is directly provided.

# Primary and Secondary Sidelit Daylight Zone




(a) Section view




(b) Plan view

FIGURE C405.2.4.2(1)
PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

# Plan Review Correction Stamp

**IECC C405.2.4 Daylight-responsive controls.** *Daylight responsive controls* complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of *general lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.
2. Spaces with a total of more than 300 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.
3. Spaces with a total of more than 150 watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

# Specific application controls – C405.5

## Independent and dedicated controls

- The following lighting shall be controlled by an occupant sensor or time-switch control. A manual control shall also be provided.
  - Display and accent
  - Lighting in display cases
  - Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting
  - Task lighting for medical and dental purposes that is in addition to general lighting

# Specific application controls – C405.2.5

## Independent and dedicated controls

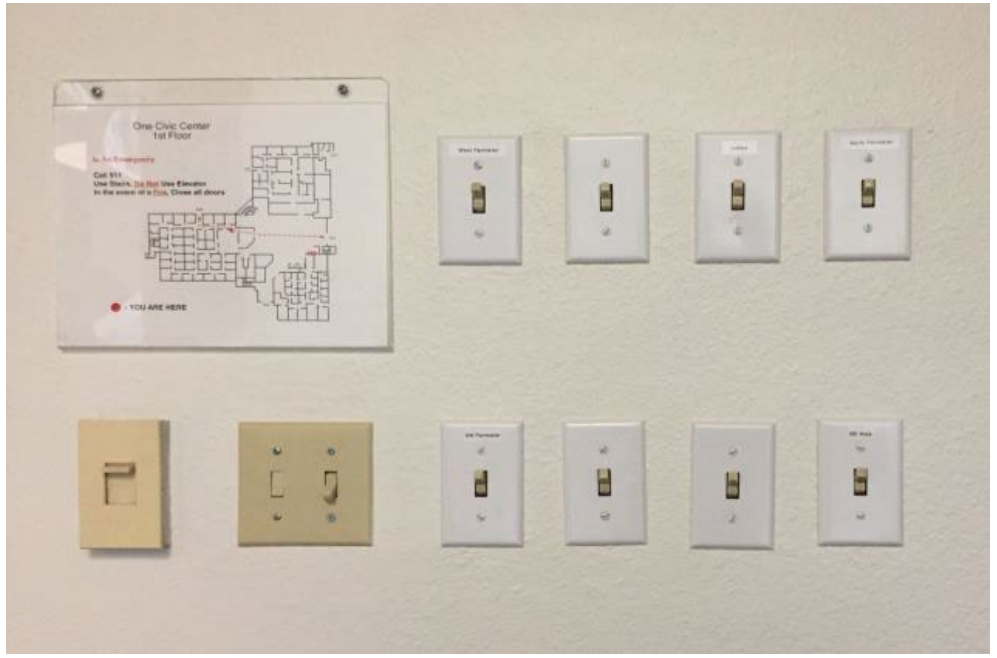
- Sleeping units shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

**Exceptions:**

1. Lighting and switched receptacles controlled by captive key systems.
2. Spaces where patient care is directly provided.


# Manual controls – C405.2.6

- Where required, manual controls shall be readily accessible to occupants.
- Shall be located where the controlled lights are visible, or shall identify the area served by the lights and indicate their status.


*C405.2.6*

# Exterior lighting controls – C405.2.7

- Lights shall automatically turn off when daylight is present.
- Building facade and landscape lighting automatically shut off from not later than 1 hour before business closing to not more than 1 hour before business opening.
- Lighting serving outdoor parking areas shall be controlled so that the total wattage is automatically reduced by not less than 50% during any time where activity has not been detected for 15 minutes or more.

Homewood Suites

# Parking Garage Lighting Control - C405.2.8

- Parking garage lighting shall be controlled by an occupant sensor or a time-switch control. Additional lighting controls shall be provided as follows:
  - Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes.
  - Lighting zones for this requirement shall be not larger than 3,600 sq. ft.

# Interior Lighting Power Requirements - C405.3

- Interior lighting power allowance
  - Measured in watts per sq. ft.
  - Sometimes referred to as lighting power density (LPD)
  - It serves as a yardstick by which the total connected interior lighting power is measured to determine whether a building is within limits for interior lighting power

TABLE C405.3.2(1)
INTERIOR LIGHTING POWER ALLOWANCES:
BUILDING AREA METHOD

| BUILDING AREA TYPE | LPD (watts/ft$^2$) |
|---|---|
| Automotive facility | 0.75 |
| Convention center | 0.64 |
| Courthouse | 0.79 |
| Dining: bar lounge/leisure | 0.80 |
| Dining: cafeteria/fast food | 0.76 |
| Dining: family | 0.71 |
| Dormitory[a, b] | 0.53 |
| Exercise center | 0.72 |
| Fire station[a] | 0.56 |
| Gymnasium | 0.76 |
| Health care clinic | 0.81 |
| Hospital[a] | 0.96 |
| Hotel/Motel[a, b] | 0.56 |
| Library | 0.83 |
| Manufacturing facility | 0.82 |
| Motion picture theater | 0.44 |
| Multiple-family[c] | 0.45 |
| Museum | 0.55 |
| Office | 0.64 |

# Interior lighting power

## Prescriptive provisions

Connected interior lighting power must not exceed interior lighting power allowance

1. **Determine proposed connected lighting power**
   - Calculate total lighting wattage
   - Lighting exceptions
2. **Determine interior lighting power allowance**
   - Building area method or
   - Space-by-space method
3. **Compare values:** proposed wattage must be less than or equal to allowed wattage

# Determine proposed connected lighting power

**Lighting power (watts) is the sum of all interior lighting for all the areas in the building including following:**

- ✓ Labeled wattage of the luminaires for screw-in lamps
- ✓ Wattage of transformer supplying low-voltage lighting
- ✓ Wattage of line-voltage lighting tracks and plug-in busways
  1. Specified wattage of the luminaires but at least 30 W/linear ft. **OR**
  2. Wattage limit of system's circuit breaker **OR**
  3. Wattage limit of other permanent current limiting devices on system

Y Lighting

*C405.3.1*

# Exceptions to interior lighting power

**Following is not included in calculating total connected lighting power**

1. Television broadcast lighting for playing areas in sports arenas.
2. Emergency lighting automatically off during normal building operation.
3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
4. Casino gaming areas.
5. Mirror lighting in dressing rooms.
6. Task lighting for medical and dental purposes that is in addition to general lighting.

*C405.3.1*

# Exceptions to interior lighting power

7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
8. Lighting for theatrical purposes, including performance, stage, film production and video production.
9. Lighting for photographic processes.
10. Lighting integral to equipment or instrumentation and installed by the manufacturer.
11. Task lighting for plant growth or maintenance.
12. Advertising signage or directional signage.
13. Lighting for food warming.
14. Lighting equipment that is for sale.

*C405.3.1*

# Exceptions to interior lighting power

15. Lighting demonstration equipment in lighting education facilities.
16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.
20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

# Determine lighting power allowance

- Interior lighting power allowance is determined by one of the following tables:
  - **Building Area Method** – Table C405.4.2(1) or
    - Use floor area for each building area type listed including accessory and incidental areas (i.e., corridors, restrooms, lobby)
  - **Space-by-Space Method** – Table C405.4.2 (2)
    - Use floor area of each space that most closely represents the proposed use of the space

# Determine lighting power allowance

## Building Area Method

Example: Office building

- 100,000 $ft^2$
- Includes lobby, restrooms, storage and dining room
- 0.82 $w/ft^2$ for the entire building

Total office area: 100,000 $ft^2$

0.82 $w/ft^2$ = 82,000 watts allowed

| BUILDING AREA TYPE | LPD ($w/ft^2$) |
|---|---|
| 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 |
| Gymnasium | 0.94 |
| Health care clinic | 0.90 |
| Hospital | 1.05 |
| Hotel/Motel | 0.87 |
| Library | 1.19 |
| Multifamily | 0.51 |
| Museum | 1.02 |
| **Office** | 0.82 |
| Parking garage | 0.21 |
| Performing arts theater | 1.39 |
| Retail | 1.26 |
| School/university | 0.87 |

*Table C405.3.2(1)*

# Determine lighting power allowance

## Space-by-Space Method

Example: Office building

- Lobby – 2,000 ft$^2$ (0.9 w/ft$^2$)
- Breakroom – 10,000 ft$^2$ (0.73 w/ft$^2$)
- Enclosed offices – 20,000 ft$^2$ (1.11 w/ft$^2$)
- Open office plan – 60,000 ft$^2$ (0.98 w/ft$^2$)
- Restrooms – 4,000 ft$^2$ (0.98 w/ft$^2$)
- Storage room - 4,000 ft$^2$ (0.63 w/ft$^2$)

Total office area: 100,000 ft$^2$

w/ft$^2$ = 96,540 watts allowed per table

| COMMON SPACE TYPE | LPD (w/ft$^2$) |
|---|---|
| Conference/meeting/multipurpose room | 1.23 |
| Copy/print room | 0.72 |
| **Lobby** | |
| In facility for visually impaired[b] | 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 |
| **Lounge/breakroom** | |
| In a healthcare facility | 0.92 |
| Otherwise | 0.73 |
| **Office** | |
| Enclosed | 1.11 |
| Open plan | 0.98 |
| **Restroom** | |
| In facility for visually impaired[b] | 1.21 |
| Otherwise | 0.98 |
| **Storage room** | 0.63 |

*Table C405.3.2(2)*

# Retail lighting power allowance

## Additional interior lighting power allowance = 1000 watts +

(Retail Area 1 x 0.45 W/ft$^2$) + (Retail Area 2 x 0.45 W/ft$^2$) +
(Retail Area 3 x 1.05 W/ft$^2$) + (Retail Area 4 x 1.87 W/ft$^2$)

Where:

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

*C405.3.2.2.1*

# Retail lighting power allowance

Exception to retail lighting allowance:

- Other merchandise categories may be included in retail areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the code official

*C405.3.2.2.1*

# Plan Review Correction Stamp

**IECC C405.3.2 Interior lighting power allowance.** The total interior lighting power allowance (watts) shall be determined according to Table C405.3.2(1) using the Building Area Method or Table C405.3.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a building shall be determined according to Table C405.3.2(2) using the Space-by-Space Method.

COMcheck Software Version COMcheckWeb

# Interior Lighting Compliance Certificate

## Project Information

| | |
|---|---|
| Energy Code: | 2021 IECC |
| Project Title: | Soho Salon |
| Project Type: | Alteration |

Construction Site:
16510 N 92nd St, Suite 102
Scottsdale, Arizona 85260

Owner/Agent:

Designer/Contractor:

## Allowed Interior Lighting Power

| A<br>Area Category | B<br>Floor Area (ft2) | C<br>Allowed Watts / ft2 | D<br>Allowed Watts |
|---|---|---|---|
| 1-Salon (Retail) | 1067 | 0.84 | 896 |
| | | Total Allowed Watts = | 896 |

## Proposed Interior Lighting Power

| A<br>Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast | B<br>Lamps/ Fixture | C<br># of Fixture | D<br>Fixture Watt. | E<br>(C X D) |
|---|---|---|---|---|
| Salon (Retail, 1067 sq.ft.) | | | | |
| Undercabinet LED Strip: LUC4: Undercabinet LED: Other: | 1 | 3 | 20 | 60 |
| LED Pendant: PL: Large LED Pendant: Other: | 6 | 1 | 40 | 40 |
| LED Pendant: PM: Medium LED Pendant: Other: | 1 | 2 | 12 | 24 |
| LED Pendant: PS: Small LED Pendant: Other: | 1 | 4 | 13 | 52 |
| LED Downlight: R6: Recessed 6" LED Downlight: Other: | 1 | 12 | 18 | 216 |
| LED Trackhead: TH: Trackhead LED: Other: | 1 | 8 | 16 | 128 |
| LED Wall Sconce: WS: LED Wall Sconce: Other: | 1 | 12 | 10 | 120 |
| LED Wall Sconce: WS2: LED Wall Sconce: Other: | 1 | 2 | 60 | 120 |
| | | | Total Proposed Watts = | 760 |

**Interior Lighting PASSES**

# Exterior lighting power limits –C405.5.1

- Connected exterior lighting power must not exceed exterior lighting power allowance
  1. **Determine proposed connected lighting power**
     - Calculate total lighting wattage
     - Account for exterior lighting exceptions
  2. **Determine exterior lighting power allowance**
     - Lighting power densities by applicable lighting zone and exterior function – Tables C405.5.2(1) and C405.5.2(2)
  3. **Compare values:** proposed wattage must be less than or equal to allowed wattage

# Exceptions to exterior lighting power

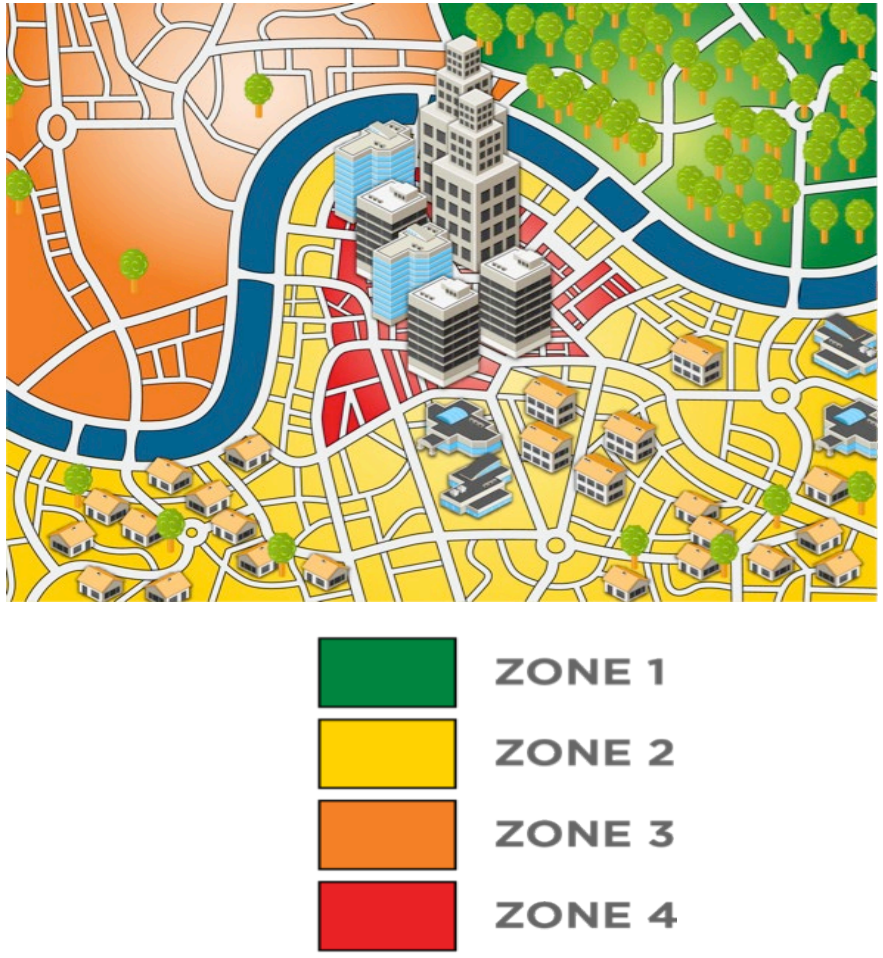
Lighting used for the following applications shall not be included:

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.

# Exceptions to exterior lighting power

8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

# Exterior lighting zones




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

*Table C405.5.2(1)*

# Exterior lighting power allowances

TABLE C405.5.2(2)
LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

| | LIGHTING ZONES | | | |
|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
| Base Site Allowance | 350 W | 400 W | 500 W | 900 W |
| **Uncovered Parking Areas** | | | | |
| Parking areas and drives | 0.03 W/ft$^2$ | 0.04 W/ft$^2$ | 0.06 W/ft$^2$ | 0.08 W/ft$^2$ |
| **Building Grounds** | | | | |
| Walkways and ramps less than 10 feet wide | 0.50 W/linear foot | 0.50 W/linear foot | 0.60 W/linear foot | 0.70 W/linear foot |
| Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas | 0.10 W/ft$^2$ | 0.10 W/ft$^2$ | 0.11 W/ft$^2$ | 0.14 W/ft$^2$ |
| Dining areas | 0.65 W/ft$^2$ | 0.65 W/ft$^2$ | 0.75 W/ft$^2$ | 0.95 W/ft$^2$ |
| Stairways | 0.60 W/ft$^2$ | 0.70 W/ft$^2$ | 0.70 W/ft$^2$ | 0.70 W/ft$^2$ |
| Pedestrian tunnels | 0.12 W/ft$^2$ | 0.12 W/ft$^2$ | 0.14 W/ft$^2$ | 0.21 W/ft$^2$ |
| Landscaping | 0.03 W/ft$^2$ | 0.04 W/ft$^2$ | 0.04 W/ft$^2$ | 0.04 W/ft$^2$ |
| **Building Entrances and Exits** | | | | |
| Pedestrian and vehicular entrances and exits | 14 W/linear foot of opening | 14 W/linear foot of opening | 21 W/linear foot of opening | 21 W/linear foot of opening |
| Entry canopies | 0.20 W/ft$^2$ | 0.25 W/ft$^2$ | 0.40 W/ft$^2$ | 0.40 W/ft$^2$ |
| Loading docks | 0.35 W/ft$^2$ | 0.35 W/ft$^2$ | 0.35 W/ft$^2$ | 0.35 W/ft$^2$ |
| **Sales Canopies** | | | | |
| Free-standing and attached | 0.40 W/ft$^2$ | 0.40 W/ft$^2$ | 0.60 W/ft$^2$ | 0.70 W/ft$^2$ |
| **Outdoor Sales** | | | | |
| Open areas (including vehicle sales lots) | 0.20 W/ft$^2$ | 0.20 W/ft$^2$ | 0.35 W/ft$^2$ | 0.50 W/ft$^2$ |
| Street frontage for vehicle sales lots in addition to “open area” allowance | No allowance | 7 W/linear foot | 7 W/linear foot | 21 W/linear foot |

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m$^2$.

*Table C405.5.2(2)*

# COMcheck Software Version COMcheckWeb
# Exterior Lighting Compliance Certificate

## Project Information

| | |
|---|---|
| Energy Code: | 90.1 (2019) Standard |
| Project Title: | MACK PARK |
| Project Type: | New Construction |
| Exterior Lighting Zone | 2 (Residential mixed use area (LZ2)) |

Construction Site:
NEC LOOP & BELL ROAD
SCOTTSDALE, AZ

Owner/Agent:

Designer/Contractor:
Ryan Mcgrew

## Allowed Exterior Lighting Power

| A Area/Surface Category | B Quantity | C Allowed Watts / | D Tradable Wattage | E Allowed Watts (B X C) |
|---|---|---|---|---|
| PARKING LOT (Parking area) | 1652400 | 0.04 | Yes | 66096 |
| | | | Total Tradable Watts (a) = | 66096 |
| | | | Total Allowed Watts = | 66096 |
| | | | Total Allowed Supplemental Watts (b) = | 400 |

(a) Wattage tradeoffs are only allowed between tradable areas/surfaces.
(b) A supplemental allowance equal to 400 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

## Proposed Exterior Lighting Power

| A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast | B Lamps/ Fixture | C # of Fixture | D Fixture Watt. | E (C X D) |
|---|---|---|---|---|
| PARKING LOT (Parking area, 1652400 ft2): Tradable Wattage | | | | |
| LED 1: SA, EM: WALL FIXTURE: LED Roadway-Parking Unit 223W: | 1 | 35 | 15 | 525 |
| LED 2: SB, SB1, SB2: POLE FIXTURE: LED Roadway-Parking Unit 223W: | 1 | 5 | 270 | 1350 |
| LED 3: SC: POLE FIXTURE: LED Roadway-Parking Unit 223W: | 1 | 20 | 270 | 5400 |
| LED 4: SD: DOWN LIGHT: LED A Lamp 25W: | 1 | 22 | 22 | 484 |
| LED 5: SF: WALL FIXTURE: LED Roadway-Parking Unit 82W: | 1 | 16 | 120 | 1920 |
| LED 6: SH: POLE FIXTURE: LED Roadway-Parking Unit 220W: | 1 | 2 | 217 | 434 |
| | | | Total Tradable Proposed Watts = | 10113 |

**Exterior Lighting PASSES: Design 85% better than code**

## Exterior Lighting Compliance Statement

*Compliance Statement:* The proposed exterior lighting design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed exterior lighting systems have been designed to meet the 90.1 (2019) Standard requirements in COMcheck Version COMcheckWeb and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

# Electrical energy consumption – C405.6

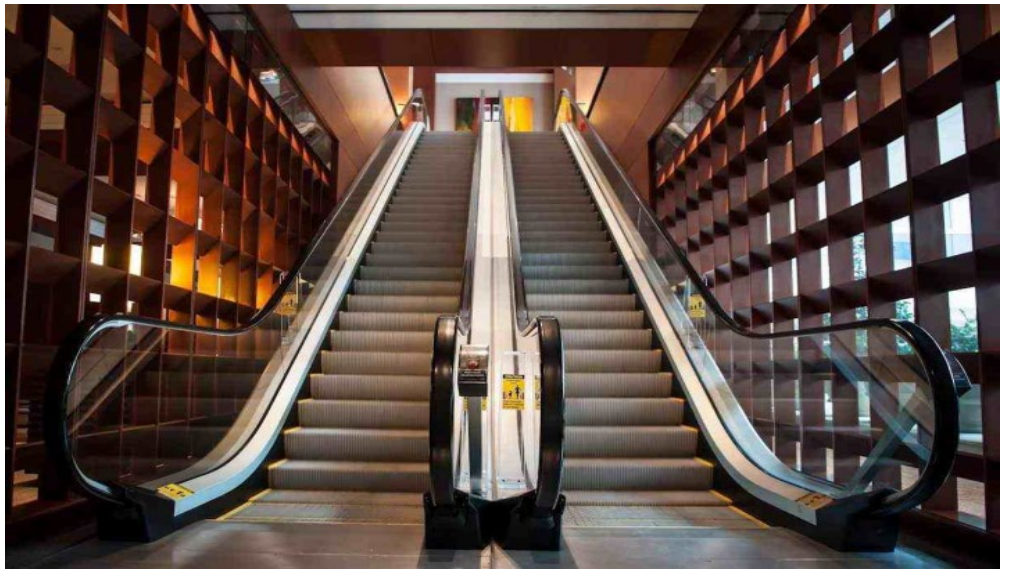
Each dwelling unit located in a Group R-2 building shall have a separate electrical meter.

Image: PowerCostMonitor

# Elevators, escalators and moving walks – C405.9


MEI

- Automatic controls to reduce speed to a minimum when not conveying passengers
- Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction

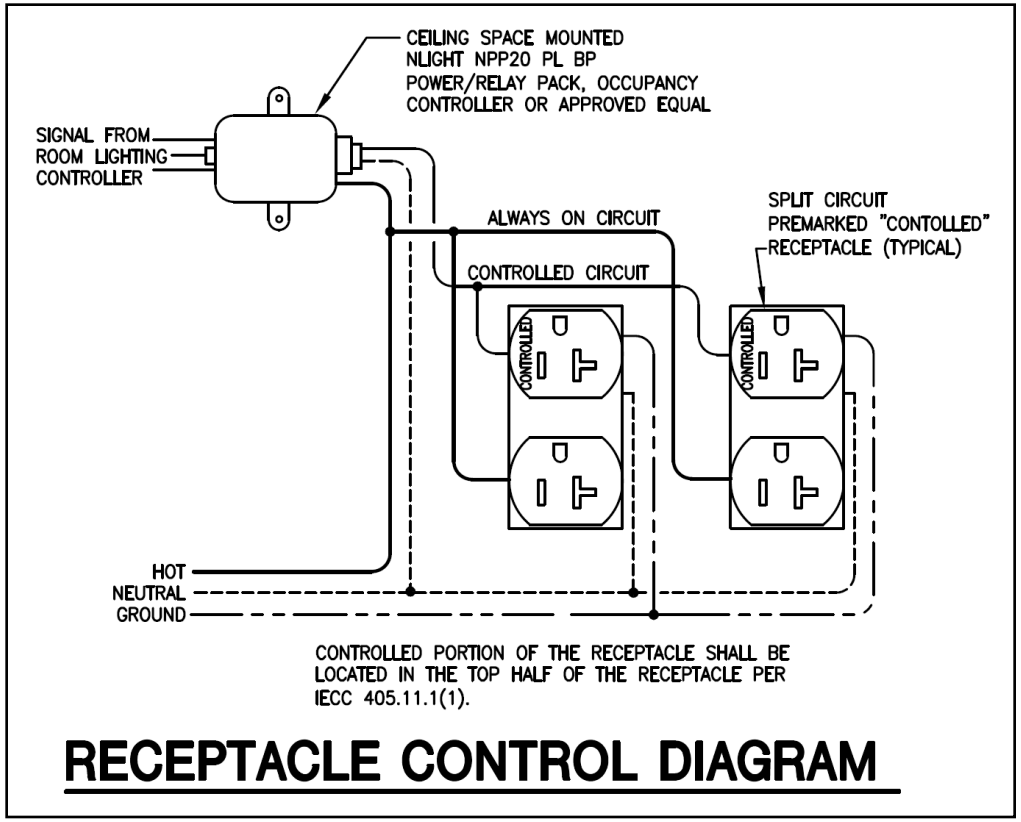


- De-energize ventilation fans and lighting systems when the elevator is stopped, unoccupied and with the doors closed for over 15 minutes

*C405.9*

# Automatic Receptacle Control – C405.11

- At least 50% of all 125V, 15- and 20-amp receptacles located in:
  - Enclosed offices, conference rooms, breakrooms, class-rooms and individual work-stations provided with either:
    - Split controlled receptacles or
    - Controlled receptacle within 12 inches of each uncontrolled receptacle

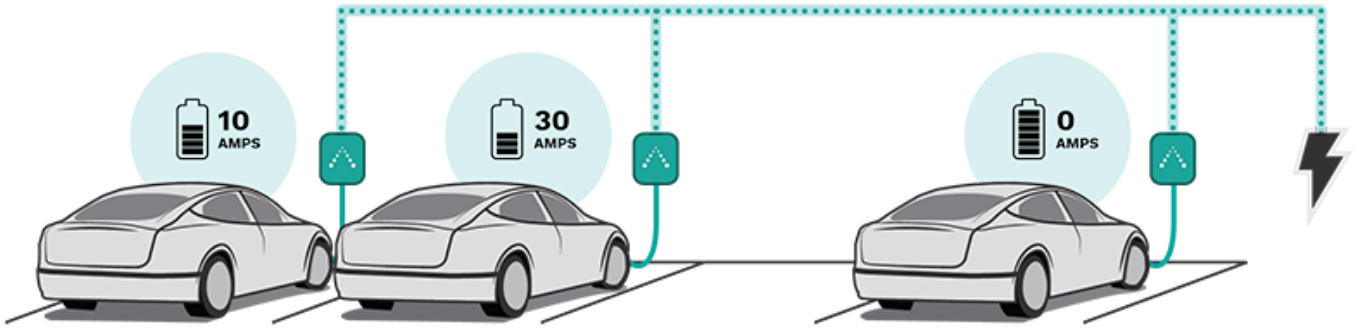


# Plan Review Correction Stamp

**IECC 405.11 Automatic receptacle control.** At least 50% of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems shall be provided with either split controlled receptacles with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches of each uncontrolled receptacle.

# Electric Vehicle Capable Charging – C405.13

- **EV-capable for new multifamily & hotels**
  - 4%-installed and 20% EV-capable parking spaces shall provide accommodates for future EV charging (ALMS)
  - For EV-capable, reserve electrical service panel space for future circuit breakers labeled "Future EV Charging"
  - Install raceway from the electrical service panel to parking area, with junction box or outlet labeled "Future EV Charging".




Source: EverCharge SmartPower

*C405.13 Amendment*

# Plan Review Correction Stamp

**IgCC 501.3.7.3 Electric vehicle charging facilities.** EV installed spaces and EV capable spaces shall be provided in accordance with the following:

**IgCC amended TABLE 501.3.7.3**
**ELECTRIC VEHICLE CHARGING INFRASTRUCTURE REQUIREMENTS**

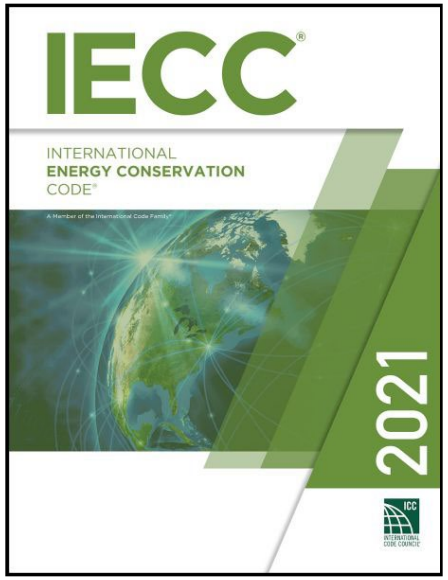
| Occupancy Group | Minimum number of *EV Installed* Spaces | Minimum number of *EV Capable* Spaces |
|---|---|---|
| Group R-1 (hotels, motels) and Group R-2 (apartments, condominiums) | 4% of total required parking spaces | 20% of total required parking spaces |
| Group A, B, E, F, I, M, and S | 4% of total required parking spaces or not less than 8% of designated employee only parking spaces | 10% of total required parking spaces |

**EV capable space:** A designated parking space provided with electrical raceway and capacity to support future EV charging.

**EV installed space:** A designated parking space with dedicated electric vehicle supply equipment.

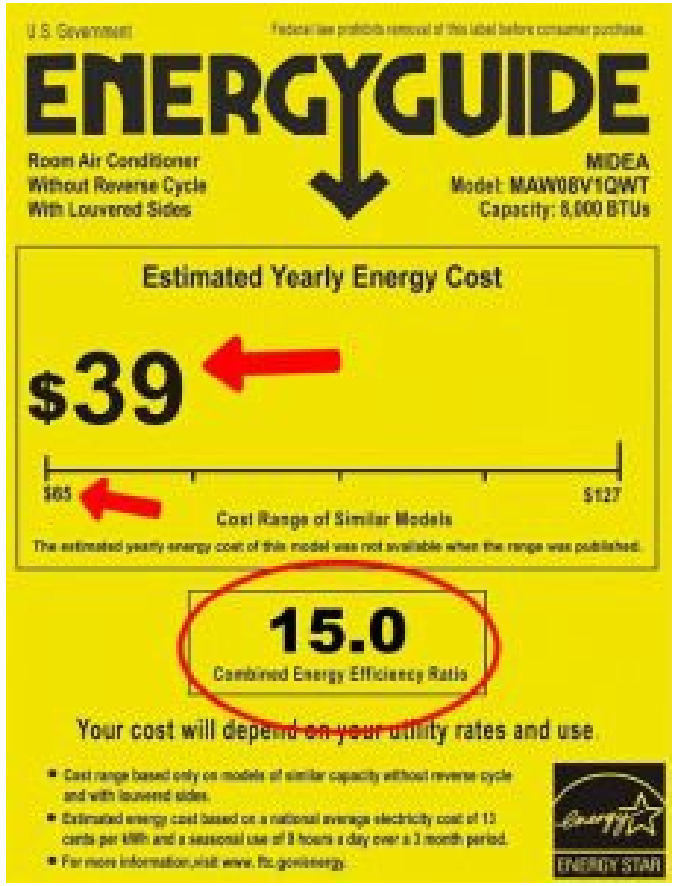
# Chapter 4 – Energy Efficiency Requirements

- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Additional Efficiency Requirements C406
## Prescription Compliance Path – 10 credits

1. More efficient HVAC equipment performance
2. Reduced lighting power
3. Enhanced lighting controls
4. On-site renewable energy
5. Dedicated outside air system
6. High efficiency service water-heating
7. Enhanced envelope performance
8. Reduced air infiltration
9. Energy monitoring system
10. Fault detection and diagnostics system
11. Efficient kitchen equipment



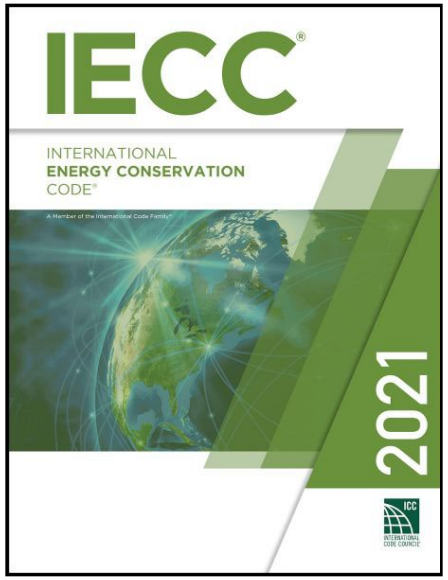
# Plan Review Correction Stamp

**IECC C406 Additional efficiency credit requirements.**
For new buildings, provide a total of 10 credits based on the building use and credit calculation as specified in the relevant subsections of the following options (see IECC C406 for more information).

1. More efficient HVAC performance (C406.2).
2. Reduced lighting power (C406.3).
3. Enhanced lighting controls (C406.4).
4. On-site renewable energy (C406.5).
5. Dedicated outside air system (C406.6).
6. High efficiency service water-heating (C406.7).
7. Enhanced envelope performance (C406.8).
8. Reduced air infiltration (C406.9).
9. Energy monitoring system (C406.10).
10. Fault detection and diagnostics system (C406.11).
11. Efficient kitchen equipment (C406.12).

# Chapter 4 – Energy Efficiency Requirements

- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
  - Section C406 – Additional Efficiency Packages
- **Performance Path**
  - Section C407 – Total Building Performance
- **Commissioning**
  - Section C408 - System Commissioning



# Performance Compliance Path – C407

## Simulated/Model Energy Performance Analysis

- **Mandatory requirements**
  - Mandatory provisions of building envelope, mechanical, service water heating and lighting
- **Energy loads that must be included in the energy simulation analysis**
  - Thermal envelope
  - Heating, cooling systems and fans systems
  - Service water heating
  - Lighting power
  - Receptacle and process loads

TABLE C407.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

| SECTION[a] | TITLE |
|---|---|
| Envelope | |
| C402.5 | Air leakage—thermal envelope |
| Mechanical | |
| C403.1.1 | Calculation of heating and cooling loads |
| C403.1.2 | Data centers |
| C403.2 | System design |
| C403.3 | Heating and cooling equipment efficiencies |
| C403.4, except C403.4.3, C403.4.4 and C403.4.5 | Heating and cooling system controls |
| C403.5.5 | Economizer fault detection and diagnostics |
| C403.7, except C403.7.4.1 | Ventilation and exhaust systems |
| C403.8, except C403.8.6 | Fan and fan controls |
| C403.9 | Large-diameter ceiling fans |
| C403.11, except C403.11.3 | Refrigeration equipment performance |
| C403.12 | Construction of HVAC system elements |
| C403.13 | Mechanical systems located outside of the building thermal envelope |
| C404 | Service water heating |
| C405, except C405.3 | Electrical power and lighting systems |
| C408 | Maintenance information and system commisioning |

# Sample Total Building Performance Report

## Project information

| | |
|---|---|
| Project Name: | The Kimsey |
| Building Type: | Residential |
| Project Address: | 7120 E INDIAN SCHOOL RD, SCOTTSDALE, AZ 85251 |
| Contact Person: | Johanna Collins |
| City: | Scottsdale |

## Energy Code

| | | |
|---|---|---|
| Code Official: | City, State, or County | City of Scottsdale |
| Compliance Path: | (COMCHECK) (Perscriptive) (Total Building Performance) | Total Building Performance |
| Energy Code: | ASHRAE or IECC | IECC 2015 |
| Mandatory Requirements | C402.5, C403.2, C403.3 through C403.3.2, C403.4 through C403.4.2.3, C403.5.5, C403.7, C403.8.1 through C403.8.4, C403.10.1 through C403.10.3, C403.11, C403.12, C404, C405, C407 and C408. | See appendix A |
| Methodology | Compliance based on total building performance requires that a proposed building (proposed design) be shown to have an annual energy cost that is less than or equal to the annual energy cost of the standard reference design. The reduction in energy cost of the proposed design associated with on-site renewable energy shall be not more than 15 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the standard reference design and the proposed design. | |

## Energy Modeler

| | | |
|---|---|---|
| Energy Modeling Company | | Quest Energy Group |
| Energy Modeler | | Rima Daghman |
| Energy Modeler Email | | rima@questenergy.com |
| Energy Modeler Phone | | 480.467.2480 |
| Stamping Engineer | | Henny van Lambalgen |

## Energy Model Info

| | | |
|---|---|---|
| Simulation program | | eQuest |
| Weather data | | TMYx\Phoenix_TMYx2004-2018.BIN |
| Utility rates (Electric) | | ASP E-32 Rate , ASP Res Lite Choice |
| Utility rates (Gas) | | EIA Gas Average |
| Heating unmet hours | | Baseline 12, Proposed 77 |
| Cooling unmet hours | | Baseline 0 , Proposed 0 |
| Number of errors | | 0 |

## Energy Results Summary

| | | |
|---|---|---|
| Baseline Regulated Energy Costs | $ | 241,216.47 |
| Design Regulated Energy Costs | $ | 200,255.53 |
| Energy Savings Greater than 15% | | 17.0% |
| *See detailed Energy Results for more information | | COMPLIES |

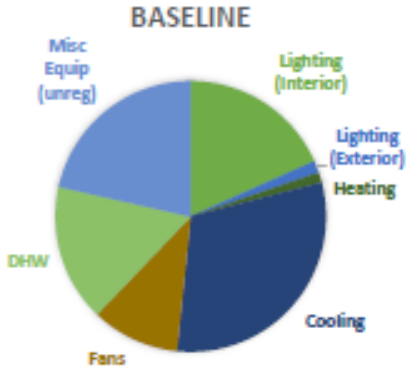
## Compliance Statement

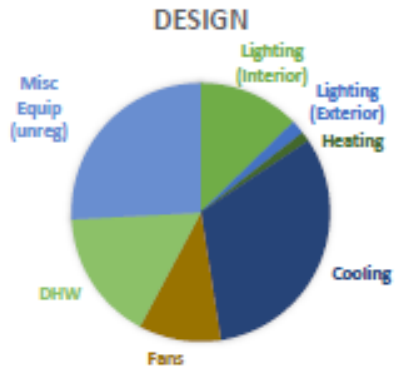
The design detailed in the above referenced plans complies with the Mandatory Provisions of the ANSI/ASHRAE/IES 90.1-2013 Standard and the Design Energy Cost does not exceed the Energy Cost Budget. Therefore this design DOES COMPLY with the ANSI/ASHRAE/IES 90.1-2013 ECB Compliance Methodology. See Detailed Energy Results section of this report for more detail.


| | |
|---|---|
| Individual certifying authenticity of the data provided in this analysis: | Henny van Lambalgen |

## Energy Summary by End Use

| End Use | Energy Type | Baseline Building Energy (10^6 Btu/yr) | Baseline Building Peak (10^3 Btu/h) | Proposed Building Energy (10^6 Btu/yr) | Proposed Building Peak (10^3 Btu/h) | Proposed / Baseline Energy (%) |
|---|---|---|---|---|---|---|
| Lighting (Interior) | Electric | 1915.63 | 347.68 | 1103.65 | 251.50 | 42.39% |
| Lighting (Exterior) | Electric | 149.13 | 34.13 | 149.13 | 34.13 | 0.00% |
| Heating | Gas | - | - | - | - | - |
| Heating | Electric | 127.26 | 415.40 | 107.49 | 357.68 | 15.53% |
| Cooling | Electric | 3205.67 | 1212.40 | 2765.85 | 930.69 | 13.72% |
| Fans | Electric | 1100.71 | 218.23 | 893.05 | 191.06 | 18.87% |
| DHW | Gas/Electric | 1711.12 | 391.81 | 1417.86 | 305.02 | 17.14% |
| Misc Equip (unreg) | Electric | 2243.35 | 530.00 | 2243.35 | 530.00 | 0.00% |
| | | | | | | |
| Total Building Consumption | | 10508.93 | 3156.82 | 8736.45 | 2607.26 | 16.87% |



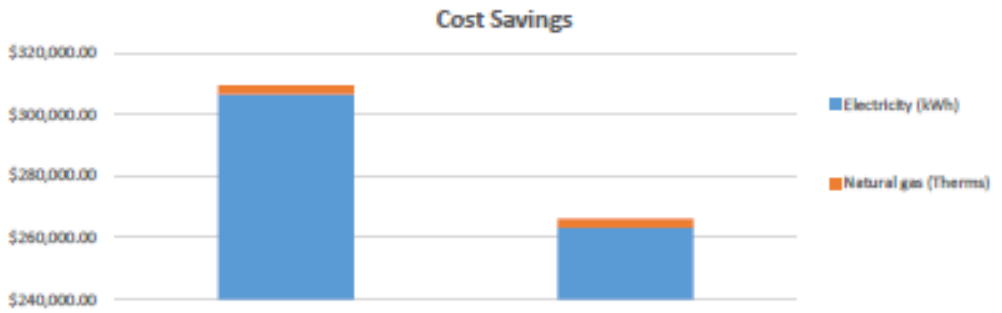




## Energy Summary

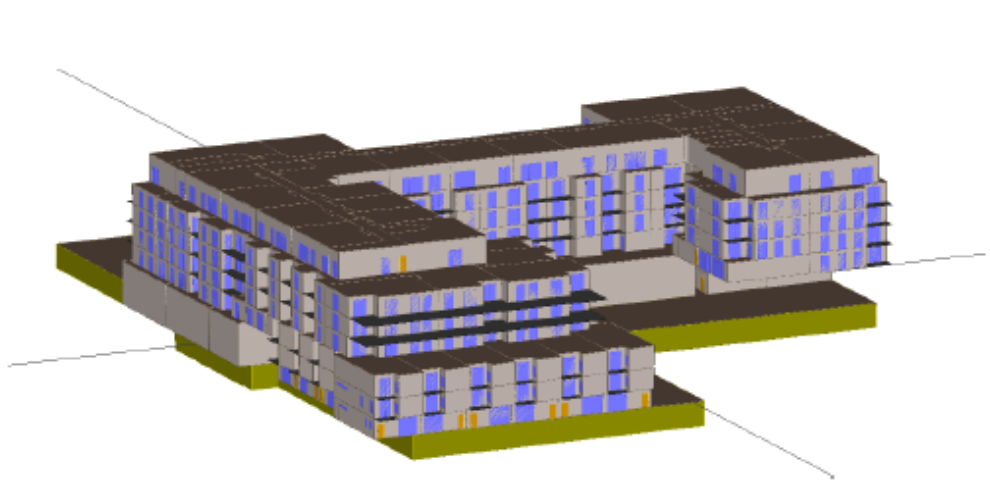
| End Use | Baseline Building Energy Use | Baseline Building Energy Cost | Proposed Building Energy Use | Proposed Building Energy Cost | Proposed / Baseline (%) |
|---|---|---|---|---|---|
| Electricity (kWh) | 3004584 | $ 306,742.00 | 2485253 | $ 263,302 | 14.16% |
| Natural gas (Therms) | 4374 | $ 2,940.00 | 4374 | $ 2,940 | 0.00% |
| Unregulated (misc. equipment) | | $ 68,465.53 | | $ 65,986.47 | 3.62% |
| Total Regulated $ | | $ 241,216.47 | | $ 200,255.53 | 16.98% |

* These results use assumptions for showing compliance during a typical year; actual energy costs may be substantially different.

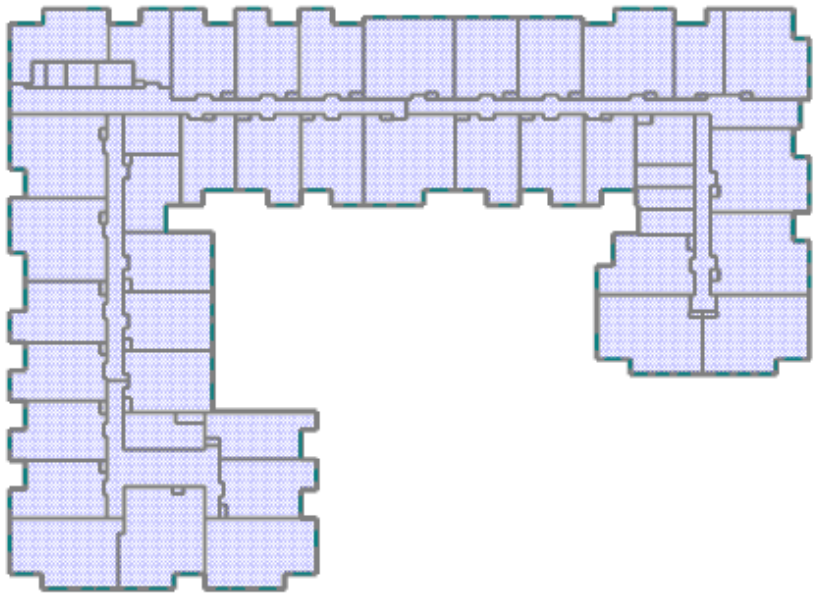
COMPLIES



## Energy Model



eQUEST3D Model



eQUEST 2D Floor Plan

## Envelope

| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | | PROPOSED DESIGN | | Inspection Checklist |
|---|---|---|---|---|---|
| Roof | Type: | Insulation above deck | Type: | Insulation above deck | |
| | R-Value | R25 CI | R-Value | R30 CI | |
| | U-factor: | 0.039 | U-factor: | 0.032 | |
| Walls | Type: | Steel-framed | Type: | Steel-framed | |
| | R-Value | R13 + R7.5ci | R-Value | R19 + 2" ci | |
| | U-factor: | 0.064 | U-factor: | 0.071 | |
| Floors | Type: | joist/framing | Type: | joist/framing | |
| | R-Value | R30 | R-Value | R30 | |
| | U-factor: | 0.033 | U-factor: | 0.033 | |
| Glazing | Area: | Per Drawings | Area: | Per Drawings | |
| | Frames: | Included Below | Frames: | Modeled Separately | |
| | U-factor: Operable | 0.65 | U-Factor | 0.29 | |
| | U-factor: Fixed | 0.5 | U-Factor | 0.29 | |
| | SHGC: | 0.25 | SHGC: | 0.23 | |
| | External shading and PF: | None | External shading and PF: | Patio Overhangs | |

## Interior Lighting

| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | | PROPOSED DESIGN | | Inspection Checklist |
|---|---|---|---|---|---|
| | Method | Space by Space (W/sf) | Method | As-Designed (W/sf) | |
| Lighting Interior | Parking Garage | 0.19 W/sf | Parking Garage | 0.05 W/sf | |
| | Corridors | 0.66 W/sf | Corridors | 0.29 W/sf | |
| | Units | 0.91 W/sf | Units | 0.91 W/sf | |

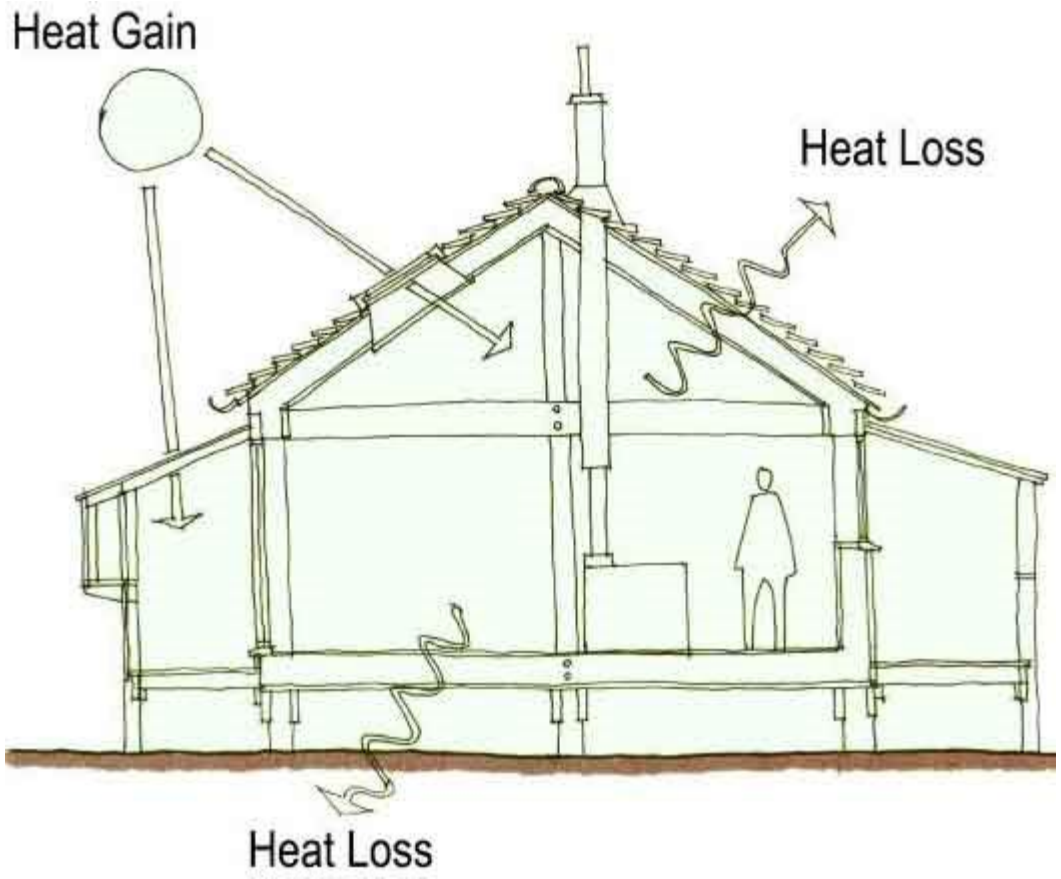
## Mechanical

| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | | PROPOSED DESIGN | | Inspection Checklist |
|---|---|---|---|---|---|
| Mech ventilation | Outside Air (C403.2.5) | Same As Proposed | Outside Air | As Designed | |
| Fuel Type | Fuel type: | Electric | Fuel type: | Electric | |
| Common Area Heating/Cooling/Fans | Equipment type: | System 9: Pkg rooftop Heat Pump | Equipment type: | Split Heat Pumps | |
| | Heating Efficiency: | 8.2 HSPF | Heating Efficiency: | (8.2-8.5) HSPF | |
| | Cooling Efficiency: | 14 SEER | Cooling Efficiency: | (14-16) SEER | |
| | Economizer: | Per Section C403.4.1 | Economizer: | None | |
| | Fan Power: | Per Section C403.2.10.1 (1) | Fan Power: | As Designed | |
| Residential Heating/Cooling/Fans | Equipment type: | System 8 Pkg Term Heat Pump | Equipment type: | Split Heat Pumps | |
| | Heating Eff: | 2.81 COP | Heating Efficiency: | (8.2-8.5) HSPF | |
| | Cooling Eff: | 9.5 EER | Cooling Efficiency: | (14-16) SEER | |
| | Fan Power: | Per Section C403.2.10.1 (1) | Fan Power: | As Designed | |
| Capacity | Sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design. | | As Proposed | | |

## DHW

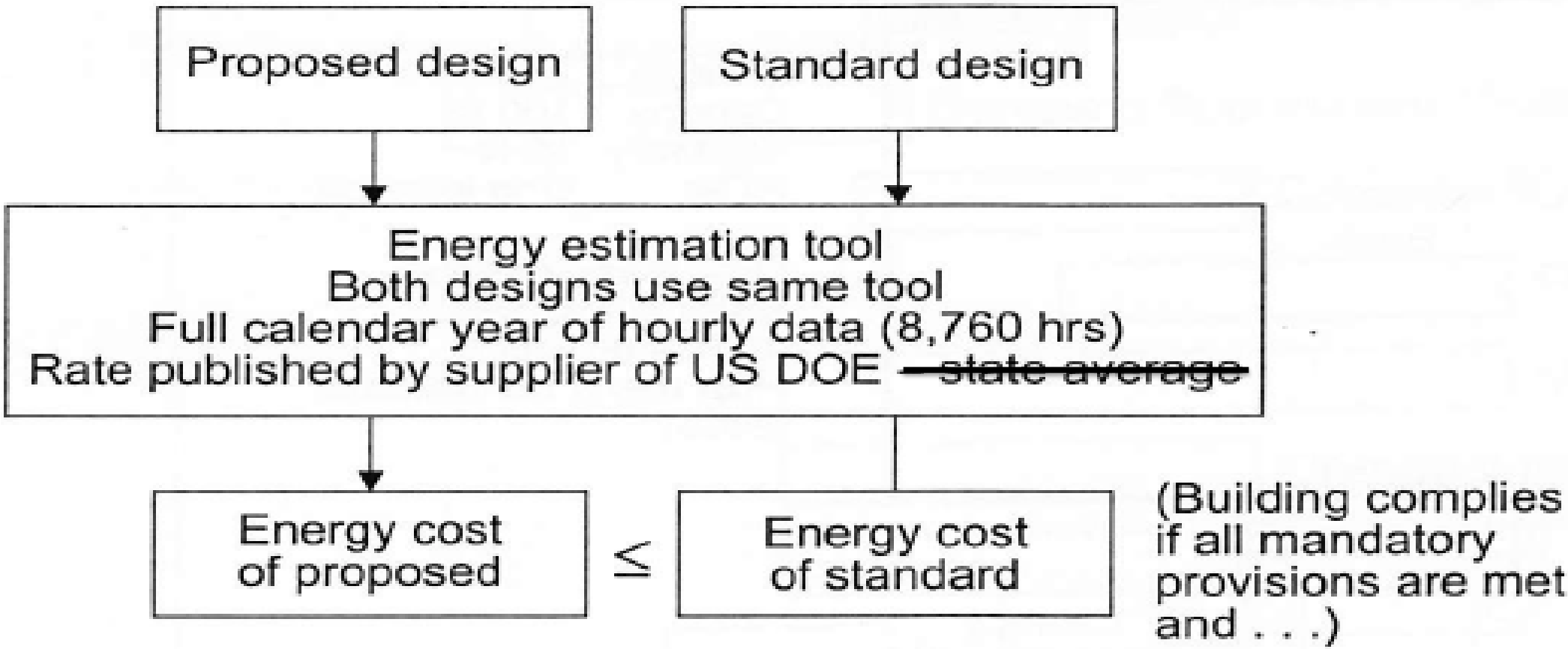
| BUILDING COMPONENT | STANDARD REFERENCE DESIGN | | PROPOSED DESIGN | | Inspection Checklist |
|---|---|---|---|---|---|
| Service water heating | Fuel type: | Electric | Fuel type: | Electric | |
| | Efficiency: | 1 COP | Efficiency: | 1 COP | |
| | Showers | 2.5 GPM | Showers | 2.0 GPM | |
| | Lavatories | 2.5 GPM | Lavatories | 1.5 GPM | |

# Heat gain/loss calculations




- **Heat gains**
  - Solar thru windows/walls
  - Summer transfer/infiltration
  - Internal
    - Electric use, lighting
    - Body heat
- **Heat loss**
  - Air leaks (infiltration)
  - Transfer (conduction & radiant) though
    - Walls
    - Roofs
    - Floors
    - Windows

# Proposed Design and Standard Reference comparison




**Energy Cost Savings must be at least 20%.**

# Chapter 4 – Energy Efficiency Requirements

- **Scope and Application**
  - Section C401 – Prescriptive or Total Building Performance or ASHRAE 90.1
- **Mandatory and Prescriptive Path Provisions**
  - Section C402 - Building Envelope
  - Section C403 - Mechanical Systems
  - Section C404 - Service Water Heating
  - Section C405 - Electrical Power and Lighting
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- **Performance Path**
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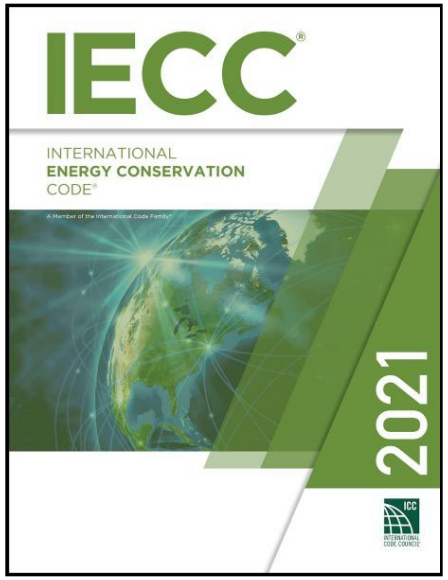
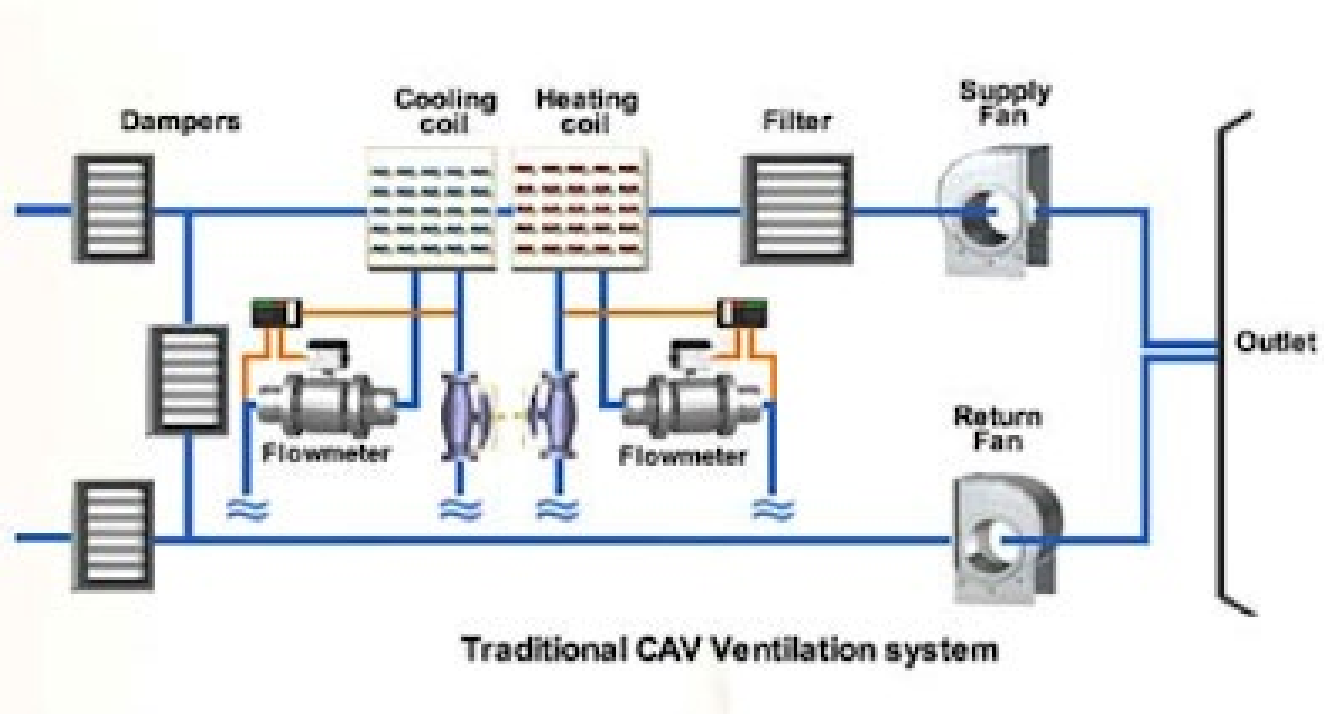


# Maintenance Information and System Commissioning - C408

- **Functional Testing of Mechanical and Service Water-heating Systems – C408.2**

Exceptions :

- Total mechanical equipment capacity less than 180,000 Btu/h (15 tons) for cooling, 300,000 Btu/h (87.9 kW) for space-heating and 10,000 cfm for ventilation.
- Service water-heating systems rated under 50,000 Btu/h.



Traditional CAV Ventilation system

*C408.2 amended*

# Maintenance Information and System Commissioning - C408

- **Functional Testing of Lighting Fixtures – C408.3**
  - Lighting control systems shall be tested to ensure control hardware and software are calibrated, adjusted, programmed and in proper working condition.
    - Occupant sensor controls
    - Time-switch controls
    - Daylight responsive controls
  - Operation manuals
  - Report
    - Performance test results

**LIGHTING SYSTEM FUNCTIONAL TESTING**

PER IECC C408.3, AN APPROVED PARTY, INDEPENDENT FROM THE CONSTRUCTION OF THE PROJECT SHALL BE RESPONSIBLE FOR THE FUNCTIONAL TESTING AND SHALL PROVIDE DOCUMENTATION TO THE BUILDING OFFICIAL CERTIFYING THAT THE INSTALLED LIGHTING CONTROLS MEET THE PROVISIONS OF IECC C405.

WHERE OCCUPANT SENSORS, TIME SWITCHES, PROGRAMMABLE SCHEDULE CONTROLS, PHOTO SENSORS OR DAYLIGHTING CONTROLS ARE INSTALLED, THE FOLLOWING PROCEDURES SHALL BE PERFORMED:

1. CONFIRM THAT THE PLACEMENT, SENSITIVITY, AND TIME–OUT ADJUSTMENTS FOR OCCUPANT SENSORS YIELD ACCEPTABLE PERFORMANCE.
2. CONFIRM THAT THE TIME SWITCHES AND PROGRAMMABLE SCHEDULE CONTROLS ARE PROGRAMMED TO TURN THE LIGHTS OFF.
3. CONFIRM THAT THE PLACEMENT AND SENSITIVITY ADJUSTMENTS FOR PHOTO SENSOR CONTROLS REDUCE ELECTRIC LIGHT BASED ON THE AMOUNT OF USABLE DAYLIGHT IN THE SPACE AS SPECIFIED.

FUNCTION TESTING SHALL BE IN ACCORDANCE WITH SECTIONS C408.3.1.1 THROUGH C408.3.1.3 FOR THE APPLICABLE CONTROL TYPE.

ALL TEST DOCUMENTATION AND MANUALS PER IECC C408.3.2 SHALL BE PROVIDED IN A TIMELY MANNER AND PRESENTED TO THE PARTIES REQUIRING THEM.

## FUNCTIONAL TESTING OF LIGHTING CONTROLS (IECC C408.3)

Prior to passing final inspection, the registered design professional or approved agency shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions.

Functional testing shall be in accordance with Sections C408.3.1.1 (occupant sensor controls), C408.3.1.2 (time-switch controls), and C408.3.1.3 (daylight responsive controls) for the applicable control type. All test documentation, including manuals and reports shall comply with C408.3.2.

# Plan Review Correction Stamps

## IECC COMMISSIONING

IECC Section C408 requires commissioning of mechanical systems, service water-heating, and lighting controls. Construction document shall clearly indicate provisions for commissioning and completion requirements in accordance with the provisions of the code.

A commissioning plan shall be developed and submitted to the city as a part of plan review by a registered design professional or approved agency in accordance with IECC SectionC408.2.1.

In addition, complete the following Commissioning Certificate form – 2021+IECC+Commercial+Commissioning+Certificate.pdf (scottsdaleaz.gov)

# Solar-Ready Zones – CB103

- Minimum 40% of roof area free and clear of obstructions including mechanical equipment and vents
- Provide electrical pathway for conduit run from solar-ready zone to electrical service panel with reserved space for 2-pole circuit breaker(s)
- Capped roof penetration sleeve shall be provided on roofs with a slope of 1 in 12 or less

Credit: Carlisle Roof Foam

*CB103 amended*

# Plan Review Correction Stamp

**SOLAR-READY ZONE – COMMERCIAL**

**IECC Appendix CB103.3 Solar-ready zone area.** The total solar-ready zone area shall be not less than 40 percent of the roof area calculated as the horizontally projected gross roof area less the area covered by skylights, occupied roof decks, vegetative roof areas and mandatory *access* or set back areas as required by the *International Fire Code*. The solar-ready zone shall be a single area or smaller, separated sub-zone areas. Each sub-zone shall be not less than 5 feet in width in the narrowest dimension.

Commissioning – C408

# Commercial Mechanical and Service Water-Heating Systems Commissioning

## 2021 IECC or ASHRAE 90.1-2019

Project Name:_____ Date:_____

Address:_____ Plan Check No.:_____ Permit No.:_____

### OWNER'S NOTIFICATION OF COMMISSIONING

To be filled in and signed by Owner before a building permit is issued.

The International Energy Conservation Code (IECC) and ASHRAE 90.1 requires a *registered design professional or commissioning agency* to ensure buildings are designed, constructed, and commissioned in accordance with the approved plans, specifications and commissioning plan.

I, as owner/legal agent, do hereby certify that I have retained _____ to be responsible for building commissioning services in accordance with this certificate.

Signed: _____ Print name: _____
(Signature of owner or legal representative)

Relation to Project (owner/legal agent): _____ Date: _____

### COMMISSIONING RESPONSIBILITY

To be filled in and signed by the *registered design professional or commissioning agency* before a building permit is issued.

As the commissioning agency for the above-named project, I certify that I am familiar with the design of the project and hereby assume full responsibility for carrying out the required commissioning responsibilities in accordance with this certificate.

Signed: _____ Print name: _____
(Signature of registered design professional or commissioning agency)

Design Professional Registration Number: _____ Expiration Date: _____

Name of Commissioning Agency: _____ Date: _____
(registered design professional or commissioning agency must be independent from the contractor responsible for the work being inspected)

Processed by: _____
City Plans Examiner

☐ **IECC COMMISSIONING REQUIREMENTS (Section C408)**

IECC Section C408 requires commissioning of the building mechanical systems and service water-heating systems. Construction document shall clearly indicate provisions for commissioning and completion requirements in accordance with the provisions of the code.

**Exceptions:** The following mechanical and service water-heating systems are exempt:

1. Mechanical systems in buildings where the total mechanical equipment capacity is less than 180,000 Btu/h (15 tons) for cooling capacity, 300,000 Btu/h (87.9kW) for space-heating and 10,000 cfm for ventilation.
2. Service water-heating systems rated under 50,000 Btu/h (14.7kW).
3. Water pumping and mixing systems under 5 hp (4kW).
4. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

☐ **ASHRAE 90.1-2019 COMMISSIONING REQUIREMENTS (Section 4.2.5)**

ASHRAE 90.1 Section 4.2.5.2 requires commissioning of the building mechanical systems, service water-heating, lighting controls and building envelope. Commissioning requirements shall be incorporated into the construction documents.

**Exceptions:** The following mechanical and service water-heating systems are exempt:

1. Buildings, additions, or alterations with less than 10,000 ft$^2$ of conditioned space and combined heating, cooling, and service water heating equipment totaling less than 960,000 Btu/h in capacity.
2. Buildings or portions of buildings that use the Simplified Approach Option for HVAC Systems in Section 6.3.
3. Dwelling units.
4. Nonrefrigerated warehouses.

**COMMISSIONING PLAN**

A commissioning plan shall be developed and submitted to the city as a part of plan review by a *registered design professional* or *approved agency* in accordance with IECC SectionC408.2.1 or ASHRAE 90.1 Section 4.2.5.2.2 and ASHRAE 202 Section 7.

**BUILDING OPERATIONS AND MAINTENANCE INFORMATION**

Building operations and maintenance documents shall be provided to the owner in accordance with IECC C408.1.1 or ASHRAE 90.1 Section 4.2.2.3.

**PRELIMINARY COMMISSIONING REPORT**

A preliminary report of commissioning test procedures and results shall be completed and certified by the *registered design professional* or *approved agency* and provided to the building owner or the owner's authorized agent. The report shall be organized in accordance with IECC Section C408.2.4 or ASHRAE 90.1 Section 4.2.5.2.2.

**FINAL COMMISSIONING REPORT**

A system balancing report shall be written describing the activities and measurements completed in accordance with IECC Section C408.2.5.1 or ASHRAE 90.1 Section 6.7.3.3 and ASHRAE 202 Section 14.

A final commissioning report shall be delivered to the building owner or owner's authorized agent. The report shall be organized in accordance with IECC Section C408.2.5.2 and C408.3.2.3 or ASHRAE 90.1 Section 4.2.5.2.2 and ASHRAE 202 Section 17.

### CERTIFICATE OF COMPLIANCE

To be signed by commissioning agency prior to Certificate of Occupancy issuance.

I certify that, to the best of my knowledge, the requirements of the International Energy Conservation Code or ASHRAE 90.1 including approved plans and specifications have been complied with, insofar as the portion of the work requiring verification and commissioning in accordance with the responsibilities listed on this certificate. A preliminary commissioning report has been provided to the building owner indicating that the work was or was not completed in conformance with the approved construction documents and discrepancies have been brought to the attention of the contractor for correction.

Within 90 days of the date of receipt of the Certificate of Occupancy, an operating and maintenance information, system balancing report and final commissioning report shall be provided to the building owner in accordance with this certificate. Contractor's responsibilities shall be in accordance with the performance obligations set by the Arizona Registrar of Contractors.

Signed: _____ Print name: _____
(Signature of approved commissioning agency representative)

Name of Commissioning Agency: _____ Date: _____
(commissioning agency must be independent from the contractor responsible for the work being inspected)

Copy to be retained in plan review and permit records after the Certificate of Responsibility box (above) is signed.

Copy to be retained by commissioning agency until completion of project and Certificate of Compliance box (above) is signed; then provided to Building Inspections prior to issuance of Certificate of Occupancy.

# COMMERCIAL ENERGY AND GREEN CODE BUILDING INSPECTIONS

rev. 12/5/24

## COMMERCIAL NEW CONSTRUCTION AND MULTIFAMILY

### 1. ROUGH FRAME INSPECTIONS

☐ **Construction and Demolition Waste**

Check for one or more dumpster(s) that are marked for collection of recyclable materials. Buildings less than 5,000 sq. ft. are exempt per approved plans.

☐ **Recycling Infrastructure for Multifamily (≥ 4 stories)**

Confirm rough installation of recycling and trash chutes.

### 2. FINAL INSPECTIONS

☐ **Recycling Facilities for Multifamily**

Confirm installation of kitchen cabinet pull-out bins for separation and collection of recyclable materials and trash.

☐ **Electric Vehicle (EV) Charging Infrastructure**

Confirm installation of 240V EV charging outlets with dedicated circuits per approved plans.

☐ **Third Party Energy Compliance Documentation**

- ☐ Building envelope performance verification certificate (IECC C402.5.1.5).
- ☐ Mechanical system commissioning compliance certificate (exceptions based on HVAC system size per approved plans) (amended IECC C408.2).
- ☐ Lighting controls testing report or compliance certificate per approved plans (IECC C408.3).
- ☐ Confirm on-site renewable energy system installed per approved plans (IgCC 701.3).

## COMMERCIAL TENANT IMPROVEMENTS

### 1. ROUGH FRAME INSPECTIONS

☐ **Construction and Demolition Waste**

Check for one or more dumpster(s) that are marked for collection of recyclable materials. Improvement projects less than 5,000 sq. ft. are exempt per approved plans.

### 2. FINAL INSPECTIONS

☐ **Third Party Energy Compliance Documentation**

- ☐ Mechanical system commissioning compliance certificate (exceptions based on HVAC system size per approved plans) (amended IECC C408.2).
- ☐ Lighting controls testing report or compliance certificate per approved plans (IECC C408.3).

Source: Special Inspection Training

# Planning and Development

## Office of Environmental Initiatives

Anthony Floyd, FAIA, LEED BC+C, CEM
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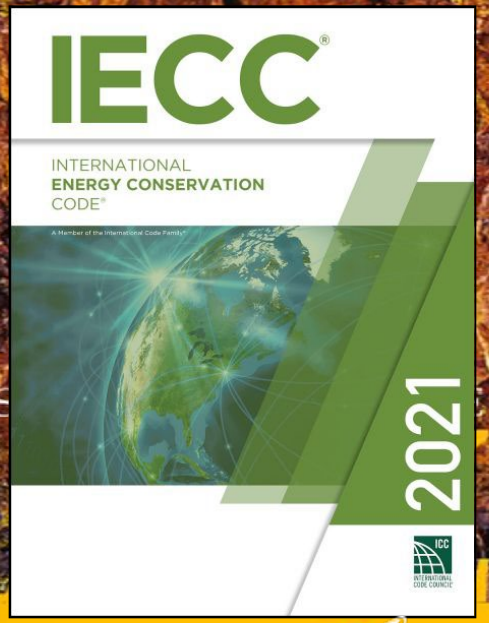
480-312-4202




CITY OF SCOTTSDALE