Nebraska's Commercial Energy Code: The 2018 IECC

Requirements and Best Practices

Nebraska Energy Code Training Program

Instructor: Matt Belcher

July 28, 2021: 11:30 am – 1:30 pm CST

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Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- CEU's will be available upon request (ICC)
  - Reporting information at the end of this presentation
- Email nwestfall@mwalliance.org with questions

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Today's Agenda

- The 2018 IECC
- Building Envelope Requirements
- Mechanical Systems
- Lighting and Power
- Key Takeaways
- Q&A

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Today's Instructor

Matt Belcher

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Introduction Poll #1

- What is your profession?
  - Code Official
  - Home Builder
  - State/local government
  - Energy Rater/Consultant
  - Architect/Engineer
  - Non-profit
  - Academic
  - Utility
  - Other (type in chat)

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Introduction Poll #2

- How long have you been in the construction industry?
  - 0-5 years
  - 5-10 years
  - 11-15 years
  - 16-20 years
  - 21+ years

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Introduction Poll #3

- How familiar are you with the residential provisions in the 2018 IECC?
  - Extremely Familiar
  - Somewhat Familiar
  - Somewhat Unfamiliar
  - Not familiar at all

The 2018 IECC

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Nebraska's New Energy Code

- Nebraska adopted the full suite of 2018 International Code Council's (ICC) Codes, including the unamended International Energy Conservation Code (IECC)
- The IECC…
  - Applies to new and renovated buildings
  - Sets minimum requirements for energy features and performance
  - Reduces energy use and polluting emissions over the life of complying buildings
  - Benefits commercial building owner, homeowners, and society by improving cost-effectiveness, comfort, productivity, and durability
- The IECC covers both residential and commercial buildings, but we are focused on commercial today

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Structure of Commercial 2018 IECC

- Ch. 1 Scope and Application / Administrative and Enforcement
- Ch. 2 Definitions
- Ch. 3 General Requirements
- Ch. 4 Commercial Energy Efficiency
- Ch. 5 Existing Buildings
- Ch. 6 Referenced Standards
- Index

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Commercial Buildings in the IECC

Under the Purview of the Commercial Code

- ✓ Buildings with commercial use
- ✓ Multifamily residential buildings four stories or greater in height

<u>Not</u> Under the Purview of the Commercial Code

- × One- and two-family residential
- × R-2, R-3, R-4 three stories or less in height

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What About Mixed Use? – C101.4.1

- Treat the residential building portion under the applicable residential code
- Treat the commercial building portion under the commercial code
- Code Official has final authority

Image: agarch.com

Commercial Compliance Options

ASHRAE 90.1-2016

OR

2018 IECC – Prescriptive

- ✓ C402 – Envelope
- ✓ C403 – Mechanical
- ✓ C404 – SWH
- ✓ C405 – Lighting

AND Pick **at Least One C406**:

- ❑ C406.2 – Eff. HVAC Performance
- ❑ C406.3 – Reduced Lighting Power
- ❑ C406.4 – Enhanced Lighting Controls
- ❑ C406.5 – On-site Supply of Renewable Energy
- ❑ C406.6 – Dedicated Outdoor Air System
- ❑ C406.7 – High Eff. Service Water Heating
- ❑ C406.8 – Enhanced Envelope Performance
- ❑ C406.9 – Reduced Air Infiltration

OR

2018 IECC – Performance

- C407 – Total Building Performance
- C402.5 – Air Leakage
- C403– Mandatory Mechanical Provisions
- C404 – SWH
- C405 - Lighting
- Building energy cost to be < 85% of standard reference design building

Additional Efficiency Package Options
Section C406

- <u>One</u> additional efficiency feature ***must*** be selected to comply with the IECC:
- C406.2 – Eff. HVAC Performance
- C406.3 – Reduced Lighting Power
- C406.5 – On-site Supply of Renewable Energy
- C406.6 – Dedicated Outdoor Air System
- C406.7 – High Eff. Service Water Heating
- C406.8 – Enhanced Envelope Performance
- C406.9 – Reduced Air Infiltration

More Efficient Lighting System

Onsite Renewables

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Building Envelope

Insulation, windows, doors, roof and floors

Building Envelope Compliance Options

3 Methods for compliance of building components:

- C402.1.3 – Insulation component R-value based method
- C402.1.4 – Assembly U-factor, C-factor or F-factor based method
- C402.1.5 – Component Performance Alternative

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Mandatory Requirements

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting
- Commissioning

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Prescriptive Compliance: Insulation

Climate Zone 5													
	Roofs			Walls, above grade					Floors		Slab-on-grade floors		
	Insulation entirely above roof deck	Metal buildings[b]	Attic and other	Mass[g]	Metal building	Metal framed	Wood framed and other	Below grade wall[d]	Mass[e]	Joist/ framing	Unheated slabs	Heated slabs[h]	Opaque, non-swinging doors
All Other	R-30ci	R-19 + R-11 LS	R-38	R-11.4ci	R-13 + R-13ci	R-13 + R7.5ci	R-13 + R3.8ci or R-20	R-7.5ci	R-10ci	R-30	R-10 for 24" below	R-15 for 36" below + R-5 full slab	R-4.75
Group R	R-30ci	R-19 + R-11 LS	R-49	R-13.3ci	R-13 + R-13ci	R-13 + R7.5ci	R-13 + R-7.5ci or R-20 + R3.8ci	R-7.5ci	R-12.5ci	R-30	R-10 for 24" below	R-15 for 36" below + R-5 full slab	R-4.75

ci – Continuous insulation
LS – Linear system
See Table C402.1.3 for other footnotes

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Prescriptive Compliance: Fenestration

Climate Zone 5		
Vertical Fenestration		
U-Factor		
Fixed Fenestration	0.38	
Operable Fenestration	0.45	
Entrance Doors	0.77	
SHGC		
Orientation	SEW	N
PF < 0.2	0.38	0.51
0.2 ≤ PF < 0.5	0.46	0.56
PF ≥ 0.5	0.61	0.61
Skylights		
U-Factor	0.50	
SHGC	0.40	

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Vertical Fenestration Requirement
Section C402.4.1 – Prescriptive (Max area)

- Percentage of Vertical Fenestration Area to Gross Wall Area
- Allowed up to 30% maximum of above grade wall
- In Climate Zones 1-6, up to 40% maximum of above grade wall with daylighting controls
- Total fenestration area (includes frame and glazing)
- Does not include opaque door area

Image: socalbudgetwindows.com

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Skylight Minimum Fenestration Area
Section C402.4.1 Prescriptive

- Limited to ≤ 3% of Roof Area
- Up to 6% allowed if automatic daylighting controls installed in toplit zones

Image: Velux.com

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Fenestration Product Rating

Section C303.1.3

- Install fenestration product rating in accordance to NFRC 100 (Windows, Doors, Skylights)
- Fenestration must be labeled and certified by the manufacturer
- Non-NFRC 100 rated fenestration
- Default Glazed Fenestration U-factor Table C303.1.3(1)
- Difficult to meet requirements using default U-factors

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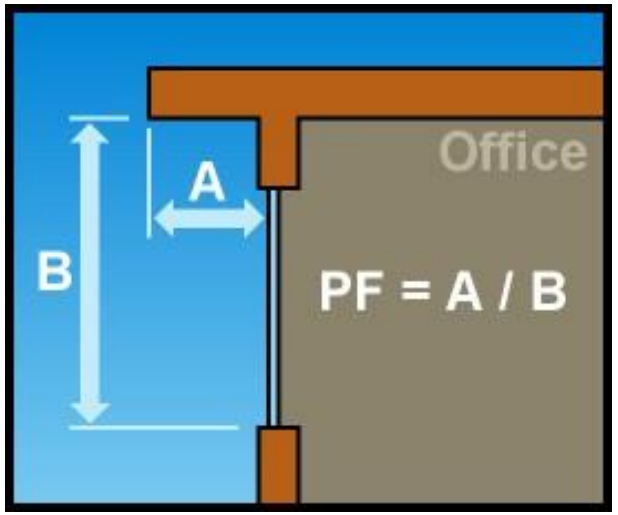
Fenestration SHGC Requirements

The Effect of Overhangs on Fenestration SHGC:

- Overhangs allow a higher SHGC product to be installed
- Projection factor must be calculated
- Evaluate separately when different windows or glass doors have different PFs



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Air Leakage
Section C402.5 (Mandatory)

- Tested (blower door) in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft^2

OR

- Comply with Sections C402.5.1 through 5.8

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Air Barrier Construction
Section C402.5.1.1 (Mandatory)

- Air barrier placement allowed:
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope

    OR

  - Any combination thereof

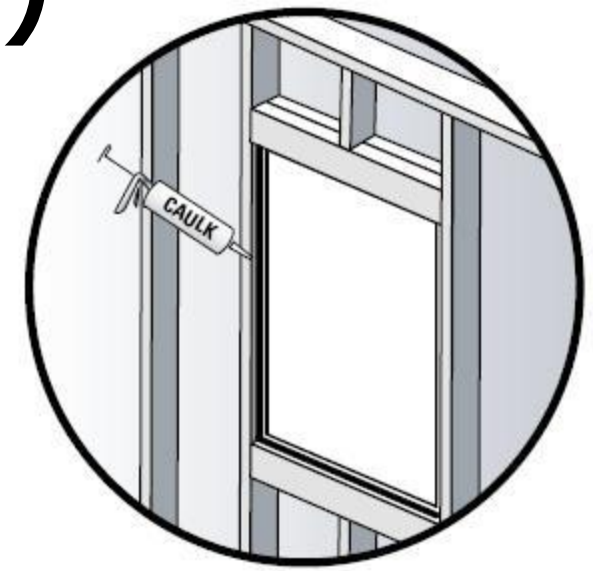

Image: bcapcodes.org

- Must be continuous for all assemblies and joints that are part of the thermal envelope

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Rooms Containing Fuel-burning Appliances
Section C402.5.3 (Mandatory)

- Appliances and combustion air openings to be located outside the building thermal envelope or enclosed in a room isolated from inside the thermal envelope in **Climate Zones 3-8**, one of the following to comply:
  - Rooms to be sealed and insulated per envelope requirements
  - Doors into the rooms fully gasketed
  - Water lines and ducts insulated
  - Combustion air ducts that pass through conditioned space, insulated to ≥ R-8

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Vestibules
Section C402.5.7 (Mandatory)

- Required to reduce infiltration into spaces
- Required on entrance doors leading into spaces ≥ 3,000 ft^2
- Doors must have self-closing devices
- **Exceptions:**
  - Buildings in Climate Zones 1 and 2
  - Doors from a sleeping unit or dwelling unit
  - Revolving doors
  - Doors that have an air curtain meeting requirements

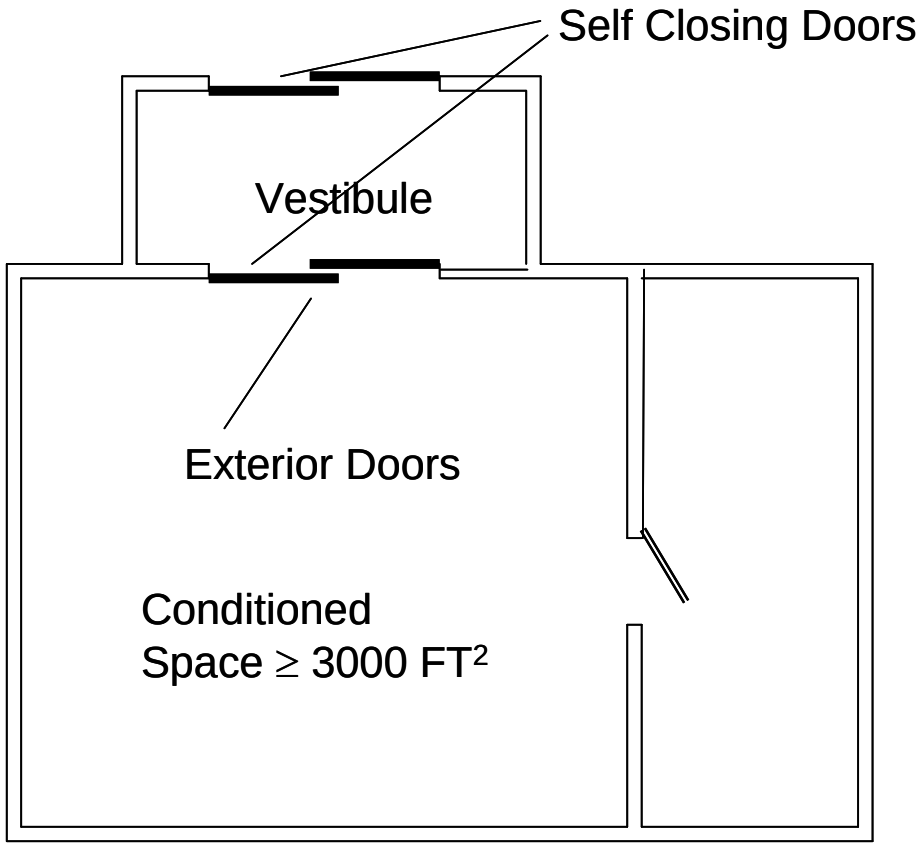

Image: U.S. Dept of Energy

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Mechanical Systems

Section C403 Reorganization

- For 2018 IECC, there was a major reorganization of the mechanical section (C403)
- Rather than separate mandatory (C403.2) and prescriptive requirements by section group:
  - Similar requirements were brought together
  - Mandatory requirements were indicated (Mandatory) for each section. Sections without the "Mandatory" designation are prescriptive.
- As a result, familiar section numbers have likely changed
- **See individual sections for exceptions**

Mechanical sections:

C403.1: General (Loads)

C403.2: System Design

C403.3: Equipment Efficiencies & Specs

C403.4: HVAC Controls

C403.5: Economizers

C403.6: Multi-zone/VAV

C403.7: Vent & Exhaust

C403.8: Fan Eff. & Controls

C403.9: Heat Rejection

C403.10: Refrigeration

C403.11: Construction

C403.12: Outside Bldg.

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Zone Isolation
Section C403.2.1 (Mandatory)

- Divided into isolation areas:
  - HVAC systems serving zones > 25,000 ft^2 in floor area OR
  - Span > one floor and are designed to operate or be occupied non-simultaneously

- Isolation areas controlled independently by a device meeting C403.4.2.2

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HVAC Load Calculations
Section C403.1.1 (Mandatory)

Heating and cooling load sizing calculations required:

- ASHRAE/ACCA Standard 183

- OR -

- Other approved computation procedures – defined in Chapter 3
    - Interior design conditions specified by Section C302
        - ≤ 72°F for heating load
        - ≥ 75°F for cooling load
- Loads reduced from energy recovery systems utilized in the HVAC system shall be accounted for in accordance with the ASHRAE HVAC Systems and Equipment Handbook

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Ventilation
Section C403.2.2 (Mandatory)

- Natural and mechanical ventilation to be provided in accordance with Chapter 4 of the IMC
- If mechanical: system to provide the capability to reduce outdoor air supply to minimum required by IMC Chapter 4

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Equipment and System Sizing
Section C403.3.1 (Mandatory)

- Output capacity of heating and cooling equipment only SHALL NOT be greater than calculated loads

- Select the system which serves the greater load – heating or cooling

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Thermostatic Controls
Section C403.4.1 (Mandatory)

- Control required for each system
- If zoned, controls required for each zone

Image: U.S. Dept of Energy

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Heat Pump Supplementary Heat
Section C403.4.1.1 (Mandatory)

Heat pump systems:

- Heat pump thermostat required when supplying electric resistance heating

- Control must prevent supplemental heat demand when heat pump can meet the heating load.
  - Except during defrost

Image: U.S. Dept of Energy

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Heated or Cooled Vestibules
Section C403.4.1.4 (Mandatory)

- Heating system for heated vestibules and air curtains with integral heating
  - Controls configured to shut off heat when outdoor air temperature is > 45°F

- Heating and cooling systems controlled by thermostat in vestibule configured to limit heating to < 60°F and cooling to >85°F

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Economizers
Section C403.5

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A	No economizer requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	Economizers on individual DX cooling units ≥ 54,000 Btu/h[a] Except for climate zone 1B
	Economizer on any chilled water cooling unit (usually central water economizer) if total cooling meets table C403.3 limits

Configured to modulate outdoor air and return air dampers to provide up to 100% of design supply air quantity as outdoor air for cooling

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Demand Controlled Ventilation
Section C403.7.1 (Mandatory)

DCV must be provided for each zone with spaces > 500 ft² and the average occupant load ≥ 25 people/1000 ft² of floor area (per IMC table 403.3.1.1) where the HVAC system has:

- An air-side economizer, **or**
- Automatic modulating control of the outdoor air damper, **or**
- A design outdoor airflow > 3,000 cfm

Demand control ventilation (DCV): a ventilation system capability that provides for the automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy.

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Energy Recovery Ventilation Systems
Section C403.7.4 (Mandatory)

- Applies to fan systems with supply airflow rates > values in Tables C403.7.4(1-2)
  - *Note that prior 0 cfm values in tables have been increased*
- Exhaust air total recovery efficiency must be ≥ 50%
- When an air economizer is required
  - include a bypass or controls that permit operation of economizer per C403.5

Energy recovery ventilation (ERV) systems: employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.

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Duct and Plenum Insulation & Sealing
Section C403.11.1 (Mandatory)

Insulation required for supply and return ducts and plenums:

- Located in unconditioned space: Minimum R-6
- Duct located outside the building; duct or plenum within building envelope assembly shall be separated from building exterior or unconditioned or exempt spaces:
  - **Minimum R-12, Climate Zones 5-8**

Image: U.S. Dept of Energy

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Piping Insulation
Section C403.11.3 (Mandatory)

All piping serving heating or cooling system must be insulated in accordance with Table C403.11.3

Minimum Pipe Insulation (in inches)

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 <1½*	*1½ 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

(Partial table)

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Questions so far?

Put questions/comments in the chat!

Lighting and Power

When do the Lighting and Power Requirements Apply?

- Original Installed Lighting System in a New Building, Addition, or Tenant Build-out
- Existing Lighting System that is Altered
- Change in Occupancy that Increases Energy
- Change in Occupancy that requires less LPD as shown in the LPD tables

Exceptions:

- Alterations where less than 10% of the luminaires in a space are replaced and installed interior power lighting is not increased
- Lighting within dwelling units
  - Where ≥ 75% of permanently installed fixtures (except low-voltage) are fitted for and include high-efficacy lamps

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Electrical Lighting and Power Systems Requirements

- Mandatory Interior Lighting requirements
  - Required Controls
  - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft^2)
- Exterior Lighting Controls
  - Required Controls
  - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft^2)
- Dwelling Electric Meters
- Electrical Transformers and Motors
- Vertical and Horizontal Transportation Systems and Equipment

Image: U.S. Dept of Energy

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High-Efficacy Lamps - Definition

- Compact fluorescent lamps, LED lamps, T8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy based on lamp wattage

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

NOTE: You can now get a 100w LED equivalent bulb with ~100 lumens/watt

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Interior Lighting Power Allowance
Section C405.3.2

Two methods to determine Lighting Power Allowance:

- Building Area Method
  - Floor area for each building area type x value for the area
  - "area" defined as all contiguous spaces that accommodate or are associated with a single building area type as per the table
- Space-by-Space Method
  - Floor area of each space x value for the area
  - Then sum the allowances for all the spaces
  - Some tradeoffs among spaces are allowed

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Lighting Power Densities
Table C405.3.2(1) and Table C405.3.2(2)

Building Area Type	LPD (w/ft²)
Automotive facility	0.71
Convention center	0.76
Courthouse	0.90
Dining: bar lounge/leisure	0.90
Dining: cafeteria/fast food	0.79
Dining: family	0.78
Dormitory	0.61
Exercise center	0.65
Fire station	0.53
Gymnasium	0.68

Common Space Types	LPD (w/ft²)
Locker room	0.48
Lounge/breakroom	
In a healthcare facility	0.78
Otherwise	0.62
Office	
Enclosed	0.93
Open plan	0.81
Parking area, interior	0.14
Pharmacy area	1.34

(partial tables)

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Lighting Controls
Section C405.2 (Mandatory)

Lighting systems required to be provided with controls as specified for:

- Occupant sensor controls – C405.2.1
- Time-switch controls – C405.2.2
- Daylight-responsive controls – C405.2.3
- Specific application controls – C405.2.4
- Manual controls – C405.2.5
- Exterior lighting controls – C405.2.6

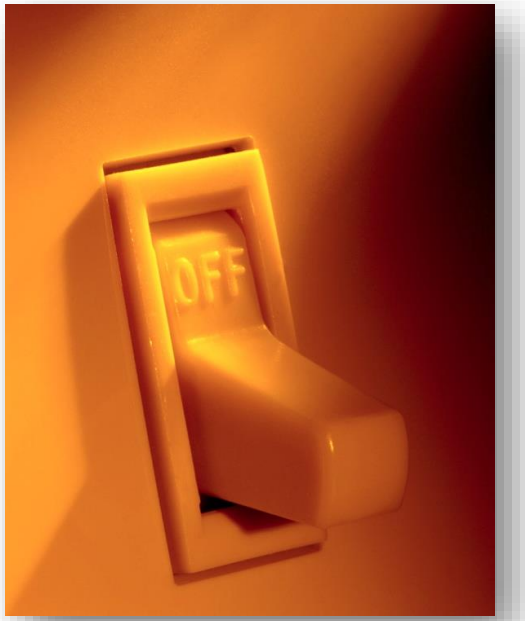

Image: U.S. Dept of Energy

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Occupant Sensor Controls
Sections C405.2.1, C405.2.1.1

Occupancy sensors are required in many spaces, including:

- Classrooms
- Conference/multipurpose rooms
- Lounges/breakrooms
- Enclosed offices
- Open plan office areas
- Restrooms
- Storage rooms
- Warehouse storage areas

Occupancy sensor function (other than for warehouses):

- Automatically turn lights off within 20 minutes after occupants have left space
- Incorporate a manual control to allow occupants to turn off lights

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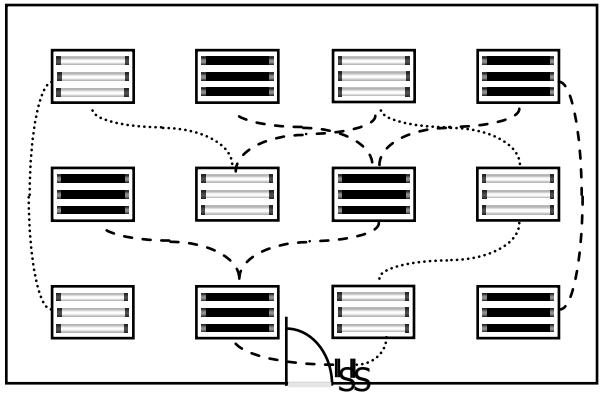
Light-reduction Control
Section C405.2.2

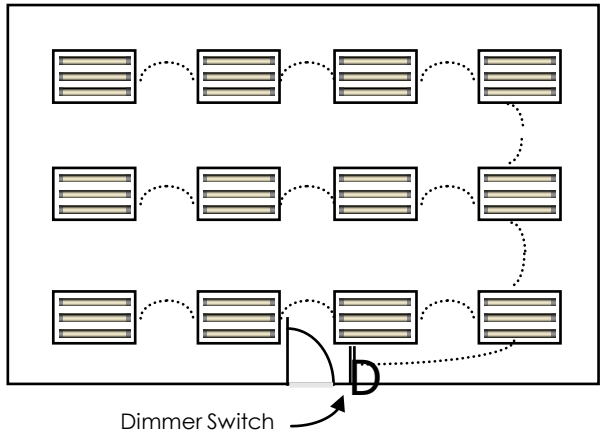
- Controlling all lamps or luminaires
- Dual switching of alternate rows of luminaires, alternate luminaires or lamps
- Switching middle lamp luminaires independently from the outer lamps
- Switching each luminaire or each lamp

Light Reduction Controls must allow the occupant to reduce connected lighting load

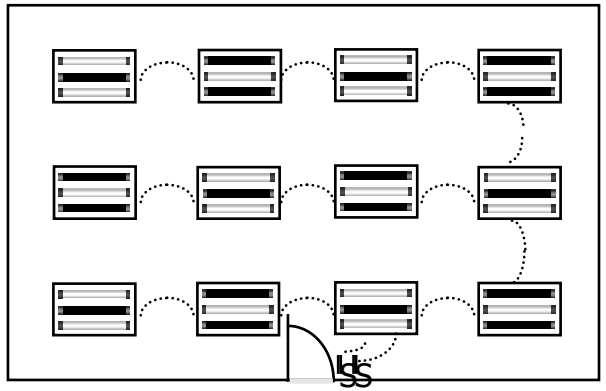
- By not less than 50%
- In a reasonably uniform illumination pattern



Alternating Luminaires



Dimming



Alternating Lamps

Image: U.S. Dept of Energy

Daylight-responsive Controls
Section C405.2.3

- Definition: A device or system that provides automatic control of electric light levels based on the amount of daylight in a space
- Required to control lighting in spaces with ≤ 150 watts of general lighting:
  - Sidelit zones
  - Toplit zones

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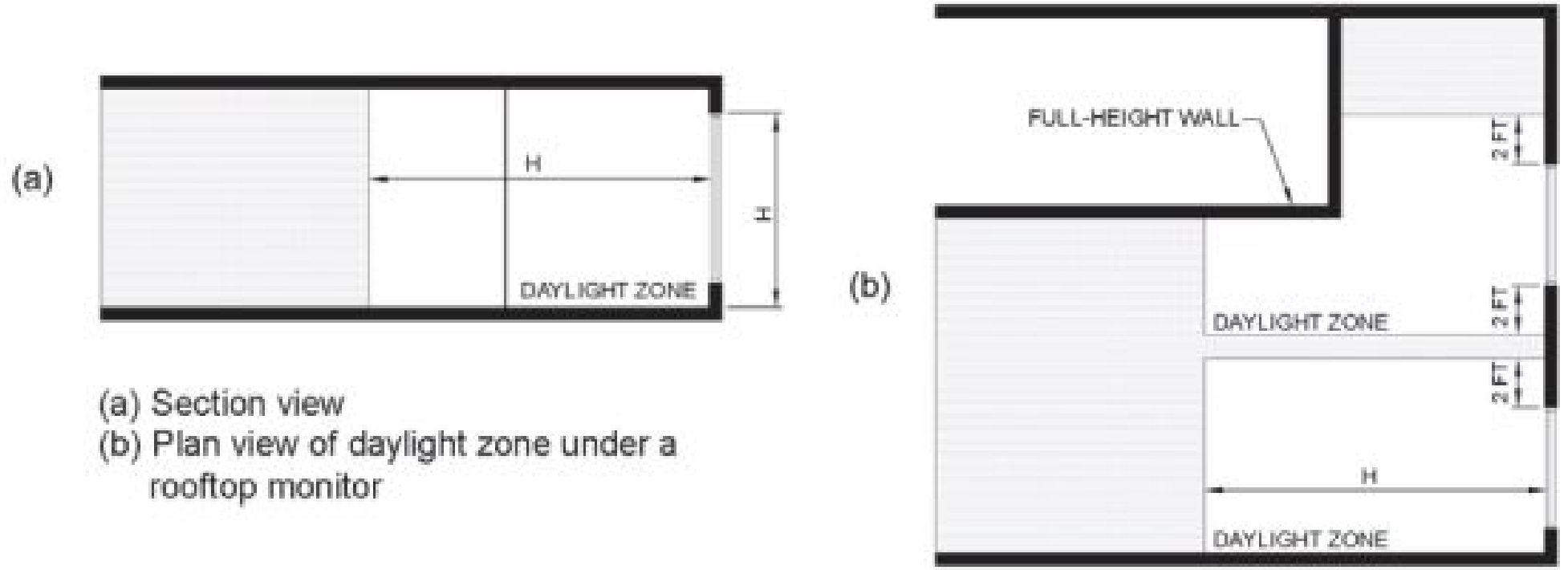
Sidelit Zone
Section C405.2.3.2



(a) Section view
(b) Plan view of daylight zone under a rooftop monitor

FIGURE C405.2.3.2 SIDELIT ZONE

Image: International Code Council

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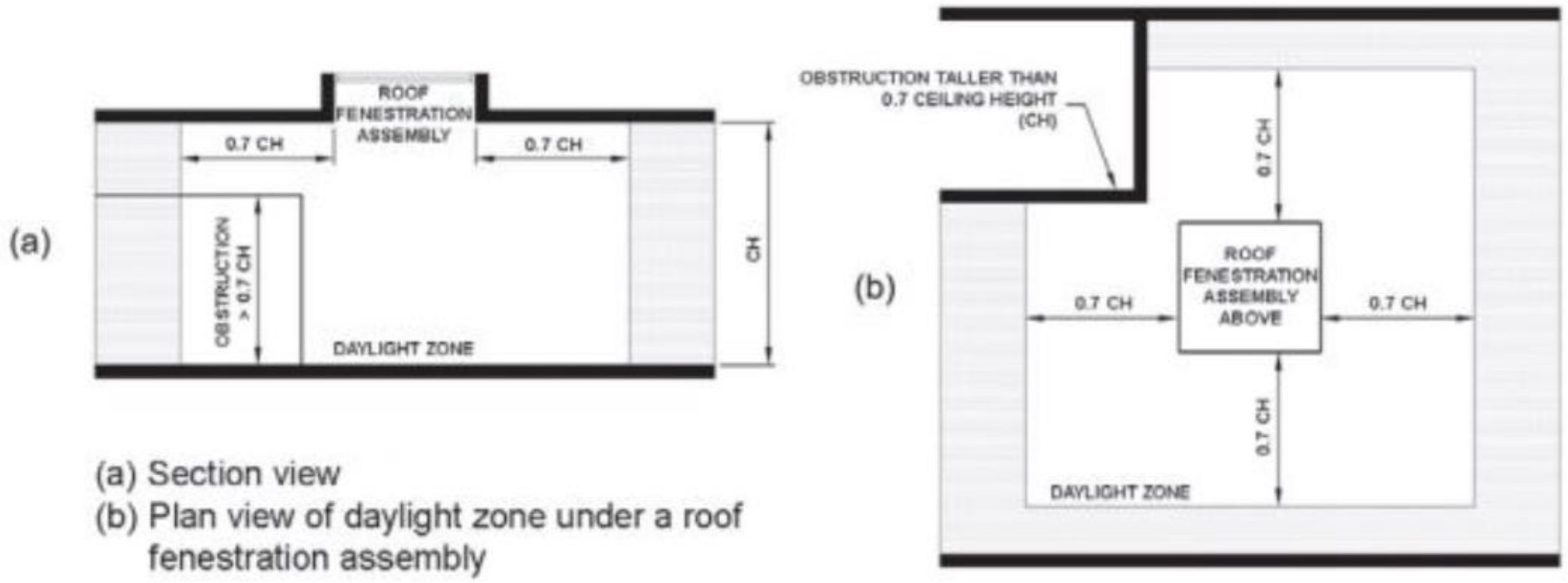
Toplit Daylight Zone
Section C405.2.3.3



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

FIGURE C405.2.3.3(1)TOPLIT ZONE

Image: International Code Council

Exterior Lighting and Building Lighting Power
Sections C405.4, C405.4.1 (Mandatory)

Connected Exterior Lighting Power must not exceed Exterior Lighting Power Allowance except where approved because of historical, safety, signage or emergency considerations:

1. Calculate exterior lighting power allowance
   - Lighting power densities by exterior function and by applicable lighting zone
2. Calculate proposed connected lighting power
   - Wattage calculation "rules"
   - Exempted lighting
3. Compare values: proposed wattage must be less than or equal to allowed wattage

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Exterior Lighting Zones
Table C405.4.2(1)

Shorthand Zone Definitions:

- Zone 1: Rural
- Zone 2: Suburban
- Zone 3: Not 1, 2, or 4
- Zone 4: Urban

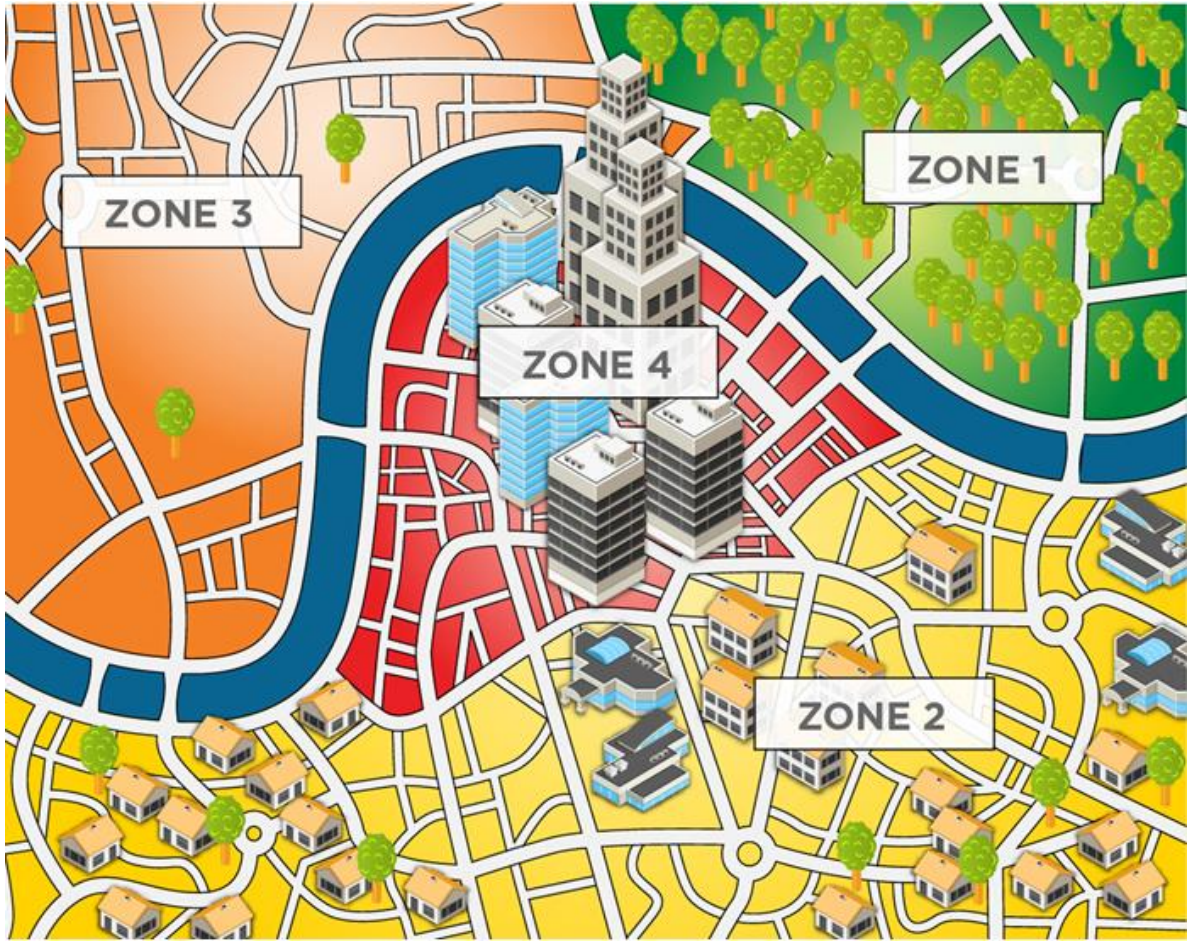

Image: U.S. Dept of Energy

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Dwelling Electrical Meter
Section C405.5 (Mandatory)

Separate metering required for each dwelling unit

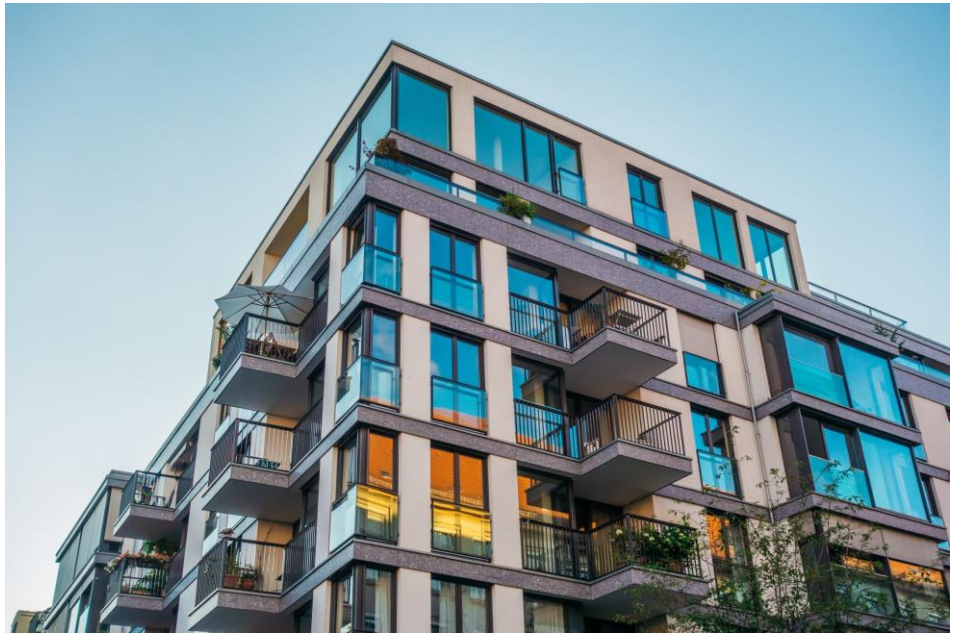

Image: chariotenergy.com

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Commissioning

Section 408

Building Controls are Complicated

- Since 2004, about 30% of all new requirements have been related to building controls
- Control requirements can be difficult to implement and verification is beyond the expertise of most building code officials
- Assumption is that they are implemented and working correctly
- Source: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26348.pdf

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Systems Commissioning and Completion Requirements

Section C408

- Commissioning is critical to ensure that buildings are **working as designed**
- Preliminary and final reports required
- Mechanical and lighting commissioning detailed in section C408

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Mechanical Systems and SWH Commissioning

Section C408.2

- Prior to the final mechanical and plumbing sections, the registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion in accordance with section C408.2
- Mechanical Systems exempt from commissioning requirements (all other systems must comply)
  - In buildings where total mechanical equipment capacity is < 480,000 Btu/h (40 tons) cooling capacity **and** < 600,000 Btu/h combined service water heating and space-heating capacity
  - Included in Section C403.3 that serve individual dwelling units and sleeping units

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Functional Testing of Lighting Controls
Section C408.3.1

- Prior to passing final inspection, registered design professional to provide evidence that lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working order per construction documents and manufacturer's installation instructions

Existing Buildings

Existing Buildings
Section C503 - Alterations

- Code applies to any new construction
  - Additions or new work in existing structures
- Unaltered portion(s) may not need to comply
- When complying via ASHRAE 90.1-2016, alterations do not need to comply with C402-C405
- Where existing building exceeds fenestration area limitations of Section C402.4.1 prior to alteration, building is exempt from C402.4.1 provided there is no increase in fenestration area

Image: montgomerycountymd.gov

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Existing Buildings
Section C503 - Alterations

- Heating and Cooling
  - New HVAC systems and duct systems that are part of the alteration to comply with Section C403
- Service hot water systems
  - New SWH systems that are part of the alteration to comply with C404
- Lighting Systems
  - New Lighting systems that are part of the alteration to comply with C405
    - **Exception** – alteration that replace <10% of the luminaires in a space provided such alteration does not increase the installed interior lighting power

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Change of Occupancy or Use
Section C505.1

- Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code
- Where the use in a space changes from one to another in Tables C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section 405

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Existing Buildings - Lighting Power and Systems Section C502.2.6

New lighting systems installed as part of an addition to comply with C405

- Total interior lighting power to comply C405.3.2
  - Stand alone addition
  - Addition + existing building as a single building
- Total exterior lighting power to comply C405.4.2
  - Stand alone addition
  - Addition + existing building as a single building
- Repairs – C504.2
  - Repairs exempt where only the bulb, ballast or both within the existing luminaires in a space are replaced, provided that the replacement does not increase the installed interior lighting power

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Key Takeaways

- There are several ways to comply with the commercial energy code
- Mandatory requirements must all be met
- System Commissioning is critical to ensure the building is operating as intended

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Questions?

Continuing Education

Participants of this training are eligible for continuing education credits through the International Code Council

- Course ID: 29122
- CEUs: 0.2

Certificates of completion will be sent out after the training. For questions, contact Karin Gredvig (kgredvig@mwalliance.org)

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Thank you!

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