

2015 IECC Commercial Electrical Power and Lighting Systems

- Energy codes and standards set minimum efficiency requirements for new and renovated buildings, assuring reductions in energy use and emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.
- Code buildings are more comfortable and cost-effective to operate, assuring energy, economic and environmental benefits.

Commercial Compliance Options

- 1** ● ASHRAE
90.1-2013

OR

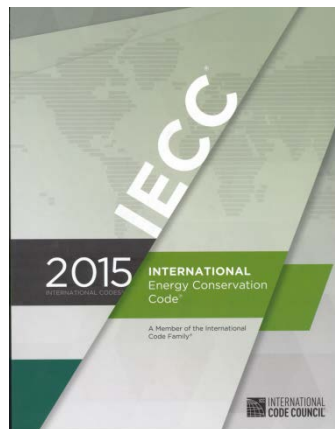
2015 IECC - Prescriptive

- 2** ● C402 - Envelope
● C403 - Mechanical
● C404 - SWH
● C405 - Lighting

OR

2015 IECC - Performance

- 3** ● C407 – Total Building Performance
● C402.5 – Air Leakage
● C403.2 – Provisions applicable to all mechanical systems



AND

- Pick One C406:

C406.2 – Eff. HVAC Performance

OR

C406.3 – Reduced Lighting Power Density

OR

C406.4 – Enhanced Lighting Controls

OR

C406.5 – On-site Supply of Renewable energy

OR

C406.6 – Dedicated Outdoor Air System

OR

C406.7 – High Eff. Service Water Heating

- C404 - SWH
● Lighting Mandatory Sections

C405.2

C405.3

C405.4

C405.6

- Building energy cost to be $\leq 85\%$ of standard reference design building

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:

- Historic buildings
 - State or National listing
 - Eligible to be listed
- 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 $\geq 75\%$ of permanently installed fixtures (except low-voltage) are fitted for and include high-efficacy lamps
- Walk-in coolers, walk-in freezers, refrigerated warehouse coolers, and refrigerated warehouse freezers comply with C403.2.15 or C403.2.16

What's Covered Under Electrical Power and Lighting Systems Requirements?

- Mandatory Interior Lighting requirements
 - Required Controls
 - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft²)
- Exterior Lighting Controls
 - Required Controls
 - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft²)
- Electric Metering
- Electrical Transformers and Motors
- Vertical and Horizontal Transportation Systems and Equipment



What's Covered Under Electrical Power and Lighting Systems Requirements?

Exception:

- Dwelling units within commercial building are not required to comply IF they comply with the residential Section R404.1

A minimum of 75 percent of the lamps in permanently installed lighting fixtures are high-efficacy lamps or 75% of permanently installed lighting fixtures contain only high efficacy lamps

Exception:

- ✓ Low-voltage lighting

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

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

Additional Efficiency Package Options

Section C406

One additional efficiency feature must be selected to comply with the IECC

- More efficient HVAC performance, OR
- **Reduced lighting power density system, OR**
- **Enhanced lighting controls, OR**
- On-site supply of renewable energy, OR
- Dedicated outdoor air system, OR
- More efficient SWH



High Efficiency HVAC



More Efficient Lighting System



Onsite Renewables

- Reduced lighting power per C406.3
 - Whole building LPD determined using 90% of values in Table C405.4.2(1) x floor area for the building types OR
 - Using 90% by the space-by-space method in Section C405.4.2
 - Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types

- Enhanced digital lighting controls per C406.4, controls located and operated in accordance with C405.2.2:
 - Luminaires capable of continuous dimming
 - Luminaires capable of being addressed individually OR a controlled group of ≤ 4 luminaires
 - ≤ 8 luminaires controlled together in a daylight zone
 - Fixtures controlled through digital control system that includes the following function:
 - Control reconfiguration based on digital addressability
 - Load shedding
 - Individual user control of overhead general illumination in open offices
 - Occupancy sensors capable of being reconfigured through the digital control system
 - Construction documents including submittal of Sequence of Operations including specs outlining each function of the fixture requirements above
 - Functional testing of controls comply with C408

Two methods to determine 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
- When used for an entire building, each building area type to be treated as a separate area

✓ Space-by-Space Method

- Floor area of each space x value for the area
- Then sum the allowances for all the spaces
- Tradeoffs among spaces are allowed

Building Area Method

Table C405.4.2(1)

Building Area Type	LPD (w/ft ²)
Automotive facility	0.8
Convention center	1.01
Courthouse	1.01
Dining: bar lounge/leisure	1.01
Dining: cafeteria/fast food	0.9
Dining: family	0.95
Dormitory	0.57
Exercise center	0.84
Fire station	0.67
Gymnasium	0.94

(partial table)

Space-By-Space Method

Table C405.4.2(2)

Common Space-by-Space Types	LPD (w/ft ²)
Atrium – First 40 feet in height	0.03 per foot in total height
Atrium – Above 40 feet in height	0.40+0.02 per foot in total height
Audience/seating area – permanent	
In an auditorium	0.63
In a convention center	0.82
In a gymnasium	0.65
In a motion picture theater	1.14
In a penitentiary	0.28
In a performing arts theater	2.43
Classroom/lecture hall/training room	
In a penitentiary	1.34
Otherwise	1.24

(partial table)

Additional Interior Lighting Power

Section C405.4.2.2.1



Additional Interior Lighting Power Allowance =
500 watts +
(Retail Area 1 x 0.6 W/ft²) +
(Retail Area 2 x 0.6 W/ft²) +
(Retail Area 3 x 1.4 W/ft²) +
(Retail Area 4 x 2.5 W/ft²),

Where:

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



Photo courtesy of Ken Baker, K energy

Exception:

- Other merchandise categories are permitted to be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the code official
- For spaces which lighting is specified to be installed in addition to general lighting or purpose of decorative appearance or for highlighting art or exhibits, provided that the add'l lighting power is $< 10.7 \text{ W/ft}^2$ of such spaces

Proposed Connected Lighting Calculation

Section C405.4.1

Proposed lighting wattage must be calculated in accordance with *Equation 4-9*

- **TCLP = [SL + LV + LTPB + OTHER]**

- TCLP = total connected lighting power (watts)
- SL = labeled wattage of luminaires for screw-in lamps
- LV = wattage of the transformer supplying low-voltage lighting
- LTPB = wattage of line-voltage lighting tracks and plug-in busways as the specified wattage of the luminaires but at least 30 W/linear feet or wattage limit of the systems circuit breaker, or the wattage limit of other permanent current-limiting devices on the system
- OTHER = the wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other approved sources

Exemptions to Proposed Interior Lighting Power Calculation

Section C405.4.1

Connected power for following not included in calculations:

- ✓ Professional sports arena playing field
- ✓ Sleeping units provided it complies with R404.1
- ✓ Emergency lighting automatically off during normal building operation
- ✓ Lighting in spaces specifically designed for use by occupants with special lighting needs including visual impairment and other medical and age related issues
- ✓ Lighting in interior spaces specifically designated as a registered interior historic landmark
- ✓ Casino gaming areas
- ✓ Minor lighting in dressing rooms
- ✓ Lighting equipment used for the following exempt if in addition to general lighting and controlled by an independent control device
 - Task lighting for medical and dental procedures
 - Display lighting for exhibits in galleries, museums and monuments

Exemptions to Proposed Lighting Power Calculation (cont'd.)

- ✓ Theatrical, stage, film, and video production
- ✓ Used for photographic processes
- ✓ Integral to equipment or instrumentation installed by manufacturer
- ✓ Plant growth or maintenance
- ✓ Advertising or directional signage
- ✓ Food warming and food prep equipment (in restaurant buildings and areas)
- ✓ Lighting equipment that is for sale
- ✓ Lighting demonstration equipment in lighting education facilities
- ✓ Approved because of safety or emergency considerations, exclusive of exit lights
- ✓ Integral to both open and glass-enclosed refrigerator and freezer cases
- ✓ In retail display windows when the display is enclosed by ceiling-height partitions
- ✓ Furniture-mounted supplemental task lighting controlled by automatic shutoff
- ✓ Exit signs

- Sum the wattage of all proposed connected lighting power

This must include all lighting that is part of the design for the space including:

- ✓ Overhead lighting
 - ✓ Task lighting
 - ✓ Decorative lighting
- Compare values; proposed wattage must be less than or equal to allowed wattage

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
- Exterior lighting controls – C405.2.5

Exemptions:

- Security or emergency areas that must be continuously lighted
- Interior exit stairways, interior exit ramps and exit passageways
- Emergency egress lighting normally off



Occupancy sensors are required in:

- ✓ Classrooms/lecture/training rooms
- ✓ Conference/meeting/multipurpose rooms
- ✓ Lounges
- ✓ Employee lunch and break rooms
- ✓ Private offices
- ✓ Restrooms
- ✓ Storage rooms
- ✓ Janitorial closets
- ✓ Locker rooms
- ✓ Other spaces < 300 ft² enclosed by floor-to-ceiling height partitions
- ✓ Warehouses

Occupancy sensor function (other than for warehouses):

- ✓ Automatically turn lights off within 30 minutes of occupants leaving space
- ✓ Either manual-on or controlled to automatically turn lighting on to not more than 50% power
- ✓ Incorporate a manual control to allow occupants to turn off the lights

Exemptions:

Full auto-on controls allowed in

- ✓ Public corridors
- ✓ Stairways
- ✓ Restrooms
- ✓ Primary building entrance areas and lobbies
- ✓ Areas where manual-on operation would endanger safety or security of room or occupants

- Aisleways and open areas
 - Automatically reduce lighting power by $\geq 50\%$ power when areas are unoccupied
 - Control lighting in each aisleway independently
 - Not control lighting beyond the aisleway being controlled by the sensor

Each area of the building that is NOT provided with occupant sensor control must have a time-switch control to turn lights off automatically.

Exceptions where a manual control can provide the light reduction and automatic control is not required:

- Sleeping units
- Spaces where patient care is directly provided
- Spaces where an automatic shutoff would endanger occupant safety or security
- Lighting intended for continuous operation
- Shop and laboratory classrooms

Must include an override switching device with the following:

- Minimum 7-day clock
- Capable of being set for 7 different day types/week
- Incorporate holiday “shutoff” feature to turn all controlled lighting loads for 24 hours and resume to normally scheduled operations
- Program backup capabilities to prevent loss of program and time setting for 10 hours if power is interrupted
- Override switch should include:
 - Manual control
 - Control lighting to remain on for ≤ 2 hours
 - Control lighting for an area $\leq 5,000$ ft²

Exceptions:

- Malls
- Arcades
- Auditoriums
- Single-tenant retail spaces
- Industrial facilities
- Arenas

- Time limit permitted to be > 2 hours provided override switch is a captive key device
- Override switch permitted to control an area > 5,000 ft² but < 20,000 ft²
- If area has a manual control:
 - spaces with 1 luminaire with rated power < 100 watts
 - spaces that use < 0.6 watts/square foot
 - corridors, equipment rooms, public lobbies, electrical or mechanical rooms

Light-reduction Controls

Section C405.2.2.2

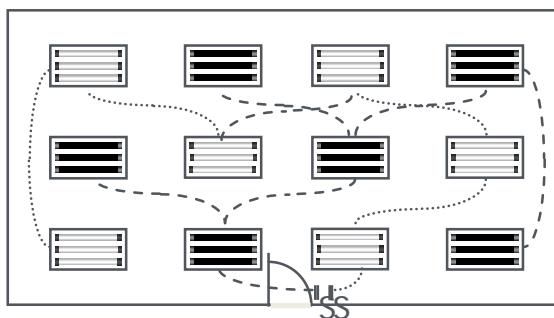


Light Reduction Controls must allow the occupant to reduce connected lighting load

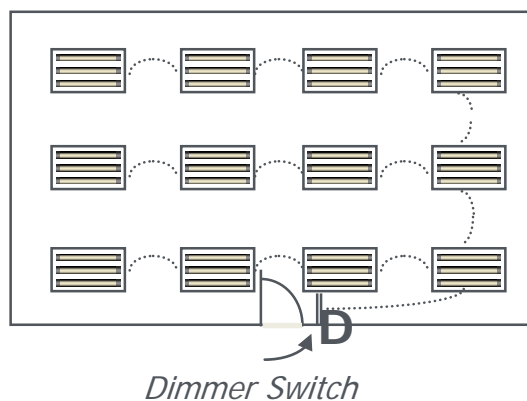
- ✓ By at least 50%
- ✓ In a reasonably uniform illumination pattern

- ✓ 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

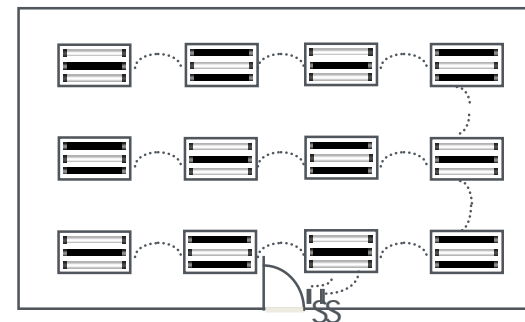
Alternating Luminaires



Dimming



Alternating Lamps



Light-reduction Controls

Section C405.2.2.2 - Exemption



Light Reduction Control **Not** required in daylight zones with daylight responsive controls complying with C405.2.3

Manual controls comply with the following:

- ✓ Readily accessible to occupants
- ✓ Located where the controlled lights are visible OR
- ✓ Must identify the area served by the lights and indicate their use

- 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 \leq 150 watts of general lighting:
 - Sidelight daylight zones
 - Toplight daylight zones
- **Exceptions:**
 - Health care facilities where patient care is directly provided
 - Dwelling units and sleeping units
 - Lighting required for specific application control per C405.2.4
 - Sidelight daylight zones on 1st floor above grade in Group A-2 and Group M occupancies

- Toplight daylight zones shall be controlled independently of lights in sidelight daylight zones
- Controls shall be configured so that they can be calibrated from within the space by authorized personnel
- Calibration mechanisms shall be readily accessible
- In offices, classrooms, laboratories, and library reading rooms, controls shall dim lights continuously from full light output to $\leq 15\%$

Daylight-responsive Controls

Section C405.2.3 – Cont'd.

- Capable of complete shutoff of all controlled lights
- Sidelight daylight zones facing different cardinal orientations (within 45 degrees of due north, east, south, west) controlled independently of each other

Exception:

- < 150 watts in each space is permitted to be controlled together with lighting in a daylight zone facing a different cardinal orientation

Definition: floor area adjacent to vertical fenestration which complies with all of the following:

- Fenestration located in a wall:
 - Daylight zone shall extend laterally to the nearest full-height wall OR
 - $< 1.0 \times$ height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 2 ft., whichever is less
- Fenestration located in a rooftop monitor:
 - Daylight zone shall extend laterally to the nearest obstruction that is (taller) $> 0.7 \times$ the ceiling height, or up to $1.0 \times$ the height from the floor to the bottom of the fenestration, whichever is less

- And longitudinally from the edge of the fenestration to the nearest obstruction that is (taller) > 0.7 x the ceiling height, ≤ 0.25 x the height from the floor to the bottom of the fenestration, whichever is less
- Area of fenestration ≥ 24 ft²
- Distance from fenestration to any building or geological information which would block access to daylight is $>$ than the height from bottom of fenestration to top of building or geologic information
- Located in existing buildings, the visible transmittance of fenestration ≥ 0.20

Definition: the floor area underneath a roof fenestration assembly which complies with all of the following:

- Zone shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is (taller) $> 0.7 \times$ the ceiling height, $> 0.7 \times$ the ceiling height, whichever is less
- No building or geological information blocks different sunlight from hitting the roof fenestration assembly at the peak solar angle on the summer solstice
- Where located in existing buildings, visible transmittance of the roof fenestration assembly and area of the rough opening of the roof fenestration assembly divided by area of daylight zone ≥ 0.008

- ✓ These types to be controlled by dedicated, independent control
 - Display and accent lighting
 - Display case lighting
 - Hotel and motel sleeping units and guest suites
 - Master control device capable of automatically switching off all installed luminaires and switched receptacles within 20 minutes of occupants leaving the room
 - **Exceptions**: lighting and switch receptacles controlled by captive key systems
 - Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting
 - Have control device integral to luminaires **OR**
 - Be controlled by readily accessibly, wall-mounted control device
 - Nonvisual applications, plant growth and food warming
 - Equipment for sale or educational demonstrations



Exit Signs

- ✓ Internally illuminated exit signs shall not exceed 5 watts per side

Where power is supplied through the energy service to the building, all exterior lighting to comply with Section C405.5.1

Exception: approved because historical, safety, signage or emergency considerations

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

The following lighting does not need to be included in the proposed lighting calculation:

- Specialized signal, directional, and marker lighting associated with transportation
- Advertising signage or directional signage
- Lighting integral to *equipment* or instrumentation and installed by its *manufacturer*
- Lighting for theatrical purposes, including performance, stage, film production, and video production
- Lighting for athletic playing areas
- Temporary lighting
- Lighting for industrial production, material handling, transportation sites, and associated storage areas
- Theme elements in theme/amusement parks
- Lighting used to highlight features of public monuments and registered *historic* landmark structures or *buildings*

Exterior Lighting Power Limits

Section C405.5.1



What areas are covered under exterior lighting allowances?

✓ Tradable surfaces

Common exterior lighted needs that can be traded for other needs

- For example, wattage allowed for parking lot lighting can be “traded” and used for canopy lighting

✓ Nontradable surfaces

Less common exterior lighted needs that **cannot** be traded for other needs

- These applications have more specific security or task illuminance needs



- ✓ Uncovered parking lots and areas
- ✓ Walkways (under and over 10 feet wide)
- ✓ Stairways
- ✓ Pedestrian tunnels
- ✓ Main building entrances and exits
- ✓ Other doors
- ✓ Entry canopies
- ✓ Free-standing and attached sales canopies
- ✓ Open sales areas
- ✓ Street frontage sales areas

- ✓ Building facades
- ✓ Automated teller machines and night depositories
- ✓ Entrances and gatehouse inspection stations at guarded facilities
- ✓ Loading areas for law enforcement, fire, ambulance and other emergency vehicles
- ✓ Drive-up windows/doors
- ✓ Parking near 24-hour retail entrances



Exterior Lighting Zones

Table C405.5.2(1)

Power allowances are listed by lighting zone

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas not classified as lighting zone 1, 2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

Exterior Lighting Zones

Table C405.5.2(1)



Exterior Lighting Zones

Table C405.5.2(2)

Allowances include a base allowance plus tradeable allowance

		<u>Zone 1</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>
Base Site Allowance		500 W	600 W	750 W	1300 W
Tradable Surfaces	Uncovered Parking Areas				
	Parking areas and drives	0.04 W/ft ²	0.06 W/ft ²	0.10 W/ft ²	0.13 W/ft ²
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater Plaza areas Special Feature Areas	0.14 W/ft ²	0.14 W/ft ²	0.16 W/ft ²	0.2 W/ft ²
	Stairways	0.75 W/ft ²	1.0 W/ft ²	1.0 W/ft ²	1.0 W/ft ²
	Pedestrian Tunnels	0.15 W/ft ²	0.15 W/ft ²	0.2 W/ft ²	0.3 W/ft ²

Partial Table

Exterior Lighting Zones cont'd.

		<u>Zone 1</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>
Nontradable Surfaces	Building facades	No allowance	0.075 W/ft ² of gross above-grade wall area	0.113 W/ft ² of gross above-grade wall area	0.15 W/ft ² of gross above-grade wall area
	Automated teller machines (ATM) and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area	0.75 W/ft ² of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area
	Drive-up window/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

Exterior Lighting Control Requirements

Section C405.2.5

Other than emergency lighting intended to be turned off during building operation, lighting specifically required to meet health and life and safety requirements or decorative gas lighting systems shall:

- ✓ Turns off as a function of available daylight
- ✓ Building façade or landscape have controls that automatically shut off as a function of dawn/dusk and set opening and closing time



- ✓ Building façade or landscape NOT covered above shall have controls configured to automatically reduce connected lighting power $\geq 30\%$ no later than midnight to 6 am from 1 hour after business closing to 1 hour before opening and any period where activity has not been detected longer than 15 minutes
- ✓ All time switches should be able to retain programming and the time setting during loss of power for a period of ≥ 10 hours
- **Exception**: Covered vehicle entrances or exits from buildings or parking structures where required for safety, security or eye adaptation

Electrical Energy Consumption Mandatory Requirement *Section C405.6*

Separate metering required for each dwelling unit



Electrical Transformers

Section C405.7 - Mandatory

- Electric transformers must meet minimum efficiency requirements of Table C405.7 when tested and rated in accordance with test procedure DOE 10 CFR 431
- Efficiency to be verified through certification under an approved certification program or when program does not exist, ratings shall be supported by data furnished by transformer manufacturer

Exceptions:

- If meet EPA Act 2005 exclusions based on **10CFR431**
 - Special purpose applications
 - Not likely in general purpose applications
 - Have multiple voltage taps where highest tap is $\geq 20\%$ more than lowest tap
- Some specific products are listed

Electrical motors

Section C405.8 - Mandatory

- Electric motors must meet minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with test procedure DOE 10 CFR 431
- Efficiency to be verified through certification under an approved certification program or when program does not exist, ratings shall be supported by data furnished by motor manufacturer

Vertical and Horizontal Transportation System and Equipment

Section C405.9.1 – Elevator Cabs

- The sum of lumens divided by the sum of the watts ≥ 35 lumens/W (not including signal and displays)
- Ventilation fans without their own air-conditioning system shall not consume ≤ 0.33 watts/cfm at the max. rated speed of the fan
- Controls shall be provided that will de-energize ventilation fans and lighting systems when the elevator is stopped, unoccupied and with its doors closed for > 15 minutes

Vertical and Horizontal Transportation System and Equipment

Section C405.9.1 – Escalators and Moving Walks

- Must comply with ASME A17.1/CSA B44
- Automatic controls configured to reduce speed to minimum permitted speed in accordance with ASME A17.1/CSA B44 or applicable local code when not conveying passengers
- Regenerative drive
 - Escalators designed for one-way down operation only or for reversible operation
 - Must have a variable frequency regenerative drive that supplies electrical energy to the building electrical system when escalator is loaded with passengers with a combined weight > 750 pounds

- ✓ 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

- Certify location and aiming per manufacturer recommendation
- Test all sensors if project ≤ 7
- If > 7 sensors, test for each unique combination of sensor type and space geometry
- Where multiples of each unique combination of sensor type and space geometry are provided $\geq 10\%$, but in no case < 1 of each combination shall be tested unless the code official or design professional requires a higher percentage to be tested
- Where $\geq 30\%$ of tested controls fail, all remaining identical combinations must be tested

Verify the following:

- Status indicator, verify correct operation
- Lights turn off or down to permitted level within required time
- Auto-on – lights turn on to permitted level when someone enters the space
- Manual on – lights turn on only when manually activated
- Lights aren't incorrectly turned on by movement in nearby areas or by HVAC operation

- Confirm programmed schedules
 - Document schedules for owner
 - Verify correct time and date are set
 - Verify any battery backup is installed and energized
 - Verify override time limit set to ≤ 2 hours
 - Simulate occupied condition and verify and document:
 - Lights turn on and off with respective switches
 - Switch only operates lights in enclosed space where switch is located
 - Simulate unoccupied condition and verify and document:
 - All nonexempt lights turn off
 - Manual override only operates lighting where it is located
 - Additional testing as specified by the *registered design professional*
-
- For daylight responsive controls
 - Properly located, field-calibrated, and set to have appropriate setpoints and threshold light levels
 - Daylight controlled lighting loads adjust to correct levels with available daylight
 - Location where calibration adjustments are made is readily accessible only to authorized personnel

Documentation Requirements

Section C408.3.2

- Construction documents specify that documents certifying installed lighting controls meet documented performance criteria of Section C405
- Provided to building owner within 90 days from date of receipt of *certificate of occupancy*



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

- Total interior lighting power to comply C405.4.2
 - Stand alone addition
 - Addition + existing building as a single building
- Total exterior lighting power to comply C405.5.1
 - 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