



2012 IECC Commercial Electrical Power and Lighting Systems

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PNNL-SA-82199

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

Mandatory Interior Lighting requirements

- ✓ Required Controls
- ✓ Wattage/Efficiency Limits

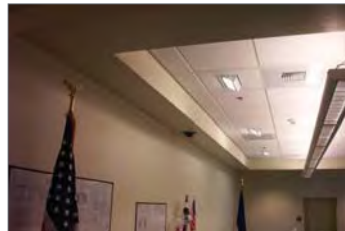
Interior Lighting Power Allowances (watts/ft<sup>2</sup>)

Exterior Lighting Controls

- ✓ Required Controls
- ✓ Lamp Efficiency

Exterior Lighting Power Allowances (watts/ft<sup>2</sup>)

Electric Metering



## 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 50% 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

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## High-Efficacy Lamps - Definition

- ✓ 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

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## Interior Lighting Power Allowance C405.5.2

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

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## Building Area Method Table C405.5.2(1)

Building Area Type	LPD (w/ft <sup>2</sup> )
Automotive facility	0.9
Convention center	1.2
Courthouse	1.2
Dining: bar lounge/leisure	1.3
Dining: cafeteria/fast food	1.4
Dining: family	1.6
Dormitory	1.0
Exercise center	1.0
Fire station	0.8
Gymnasium	1.1

(partial table)

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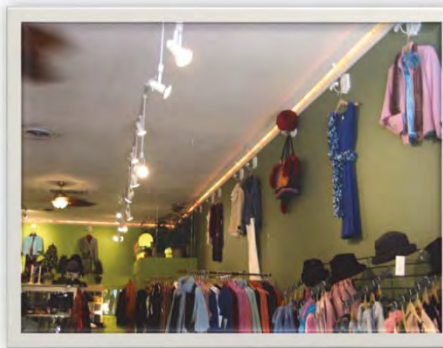
## Space-By-Space Method Table C405.5.2(2)

Common Space-by-Space Types	LPD (w/ft <sup>2</sup> )
Atrium – First 40 feet in height	0.03 per ft. ht.
Atrium – Above 40 feet in height	0.02 per ft. ht.
Audience/seating area – permanent	
For auditorium	0.9
For performing arts theater	2.6
For motion picture theater	1.2
Classroom/lecture/training	1.30
Conference/meeting/multipurpose	1.2
Corridor/transition	0.7
Dining area	
Bar/lounge/leisure dining	1.40
Family dining area	1.40

(partial table)

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## Additional Retail Lighting Power Allowance Table C405.5.2(2) – Footnotes



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

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.

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## Additional Retail Lighting Power Allowance Table C405.5.2(2) – Footnotes



Photo courtesy of Ken Baker, K energy

### Exception:

Other merchandise categories may 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 authority having jurisdiction.

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## Connected Lighting Calculation

### C405.5.1.1-C405.5.1.4

Lighting wattage must be calculated in accordance with Section C405.5.1

- ✓ Screw lamp holders: maximum labeled wattage of the luminaire
- ✓ Low voltage lighting: transformer wattage
- ✓ Line voltage track:
  1. specified wattage with minimum of 30 W/linear ft **OR**
  2. wattage limit of system's circuit breaker **OR**
  3. wattage limit of other permanent current limiting devices
- ✓ Other: manufacturer's rated wattage of lamp and associated ballast



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## Exemptions to Proposed Lighting Power Calculation C405.5.1

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Connected power for following not included in calculations:

- ✓ Professional sports arena playing field
- ✓ Sleeping unit lighting
- ✓ 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
- ✓ 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

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

U.S. DEPARTMENT OF  
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- ✓ 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

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## Connected Interior Lighting Power Calculation

U.S. DEPARTMENT OF  
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Renewable Energy

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

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## Interior Lighting Control C405.2 Basic Control

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Independent Lighting Control required for each space surrounded by floor-to-ceiling partitions

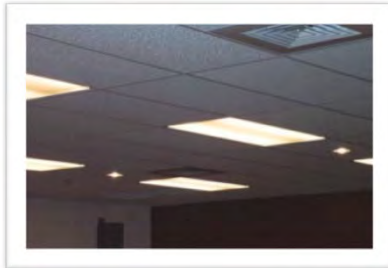
- ✓ Must be located in the space served, **- OR -**
- ✓ Switched from a remote location
  - Must have indicator that identifies the lights served and their status (off or on)
- ✓ **Exemptions**
  - Security or emergency areas that must be continuously lighted
  - Lighting in stairways or corridors that are elements of the means of egress



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## Interior Lighting Control

### C405.2.1.2 Light Reduction



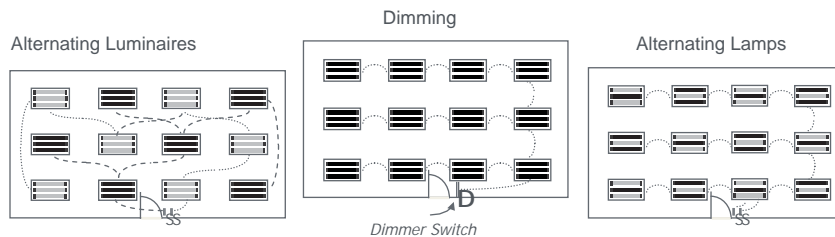
Light Reduction Controls must allow the occupant to reduce connected lighting

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

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## Light Reduction Control Options

- ✓ 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
- ✓ Each luminaire or each lamp



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## Interior Lighting Control

### C405.2.1.2 - Light Reduction Exemptions



### Light Reduction Control **Not** required for the following:

- ✓ Areas with only one luminaire with rated power < 100 W
- ✓ Areas controlled by occupancy sensor
- ✓ Corridors, equipment rooms, storerooms, restrooms, public lobbies, electrical or mechanical rooms
- ✓ Sleeping units
- ✓ Spaces with <math><0.6\text{ w/ft}^2</math>
- ✓ Daylight spaces complying with Section C405.2.2.3.2

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## Interior Lighting Control

### C405.2.2 Automatic Shutoff

Each area required to have a manual control to also have controls meeting:

- C405.2.2.1 – Automatic time switch control devices
- C405.2.2.2 – Occupancy sensors
- C405.2.2.3 – Daylight zone control

#### **Exempted spaces**

- ✓ Sleeping units
- ✓ Lighting for patient care
- ✓ When an automatic shutoff would endanger occupant safety or security
- ✓ Lighting intended for continuous operation

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## Automatic Time Switch Control Devices

### C405.2.2.1 Additional Lighting Controls

Override switching devices:

- ✓ Readily accessible
- ✓ Within view of the lights or area controlled
- ✓ Manually operated
- ✓  $\leq 2$  hour override
  - The override allows lighting to remain on no more than 2 hours when override is initiated
- ✓ Controls an area  $\leq 5,000$  ft<sup>2</sup>

#### **Exemptions**

- Emergency egress lighting
- In spaces with occupancy sensors
- Can be over 2 hour override in malls and arcades, auditoriums, single-tenant retail space, industrial facilities and arenas when using captive key override
- Override in malls and arcades, auditoriums, single-tenant retail space, industrial facilities and arenas can cover up to 20,000 ft<sup>2</sup>

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## Additional Lighting Controls

### C405.2.2.1 Occupancy Sensors

Occupancy sensors are required in:

- ✓ Classrooms
- ✓ Conference/meeting rooms
- ✓ Employee lunch and break rooms
- ✓ Private offices
- ✓ Storage rooms and janitorial closets
- ✓ Other spaces  $< 300$  ft<sup>2</sup> enclosed by floor-to-ceiling height partitions

Features:

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

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### Exemptions

Full auto-on controls allowed in

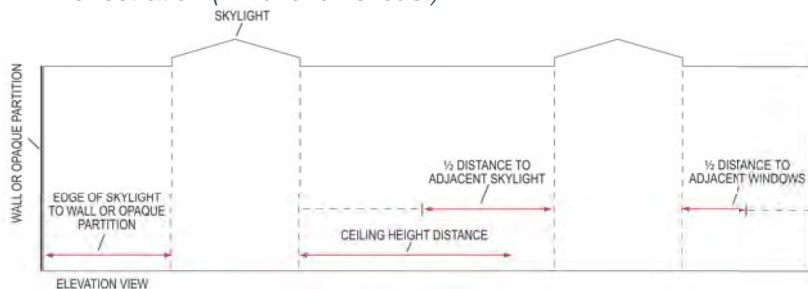
- ✓ Public corridors
- ✓ Stairways
- ✓ Restrooms
- ✓ Primary building entrance areas and lobbies
- ✓ Areas with safety or security concern

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### **Daylight Zone Definition** Under Skylights

The area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension plus the smaller of:

- ✓ The floor-to-ceiling height, **or**
- ✓ The distance to a ceiling height opaque partition, **or**
- ✓ One-half the distance to adjacent skylights or vertical fenestration (*whichever is least*)



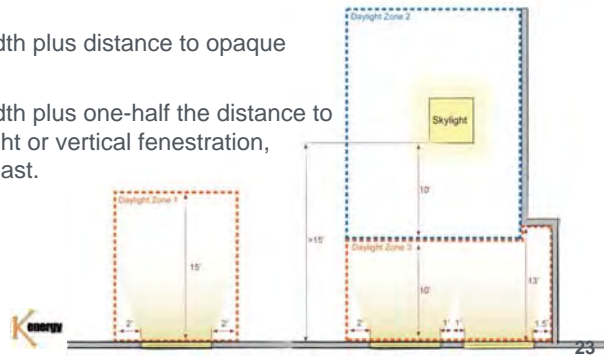
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## Daylight Zone Definition Adjacent to Vertical Fenestration

The daylight zone depth is assumed to be 15 feet into the space or to the nearest ceiling height opaque partition, whichever is less

The daylight zone width is assumed to be:

- ✓ the width of the window plus 2 feet on each side,  
**or**
- ✓ the window width plus distance to opaque partitions, **or**
- ✓ the window width plus one-half the distance to adjacent skylight or vertical fenestration, whichever is least.



## Daylight Zone Control Requirements

### C405.2.2.3

#### Daylight Zones

- ✓ Must have individual control of the lights independent of general area lighting and
- ✓ Controlled per C405.2.2.3.1 manual daylighting controls or C405.2.2.3.2 automatic daylighting controls
- ✓ Each daylight control zone to be  $\leq 2500 \text{ ft}^2$

#### Contiguous daylight zones adjacent to vertical fenestration

- ✓ Can be controlled by a single controlling device if the zone doesn't include areas facing more than two adjacent orientations (*i.e., north, east, south, west*)

#### Daylight zones under skylights > 15 ft from the perimeter

- ✓ Must be controlled separately from daylight zones adjacent to vertical fenestration

#### Exception

- ✓ Daylight spaces 1) enclosed by walls or ceiling height partitions and 2) containing two or fewer light fixtures
  - not required to have a separate switch for general area lighting

*Note: required controls may be manual or automatic*

## Manual Daylighting Controls

### C405.2.2.3.1

Manual controls in daylight zones

#### **Exemption:**

Unless automatic controls are installed per C405.2.2.3.2  
Automatic Daylighting Controls

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## Automatic Daylighting Controls

### C405.2.2.3.2

Set-point and other controls for calibrating the lighting control device to be readily accessible

Daylighting controls device to be capable of automatically reducing the lighting power in response to available daylight either by

- Continuous dimming using dimming ballasts and daylight-sensing automatic controls
  - capable of reducing general lighting power in daylit zone continuously to < 35% of rated power at maximum light output

#### **OR**

- Stepped dimming using multi-level switching and daylight-sensing controls capable of reducing lighting power automatically. System to:
  - provide at least two control channels per zone
  - be installed so that at least one control step is between 50-70% of design lighting power and another control step is no greater than 35 % of design power

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## Multi-Level Lighting Controls

C405.2.2.3.3

- ✓ Where multi-level lighting controls are required:
  - general lighting in daylight zone to be separately controlled by at least one multi-level lighting control
    - that reduces lighting power in response to daylight available in the space
- ✓ Where daylight illuminance in the space is > rated illuminance of the general lighting
  - general lighting to be automatically controlled so its power draw is no greater than 35 % of its rated power
- ✓ Multi-level lighting control to be located so that calibration and set point adjustment controls are readily accessible and separate from light sensor

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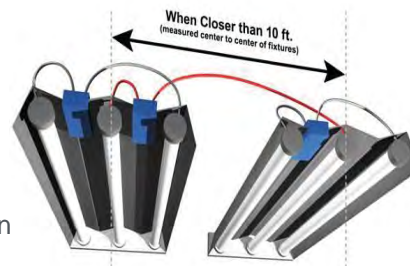
## Tandem Wiring

C405.3

Tandem Wiring for all Odd  
Numbered Lamp Configurations

### Exceptions

- ✓ Where electronic high frequency ballasts are used
- ✓ Luminaires on emergency circuits
- ✓ Luminaires with no available pair in the same area



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## Exit Signs C405.4



### Exit Signs

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

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## Specific Application Controls C405.2.3

- ✓ These types be controlled by dedicated, independent control
  - Display and accent lighting
  - Display case lighting
  - Nonvisual applications (i.e., plant growth and food warming)
  - Lighting equipment for sale or demonstration in lighting education
- ✓ Hotel and motel sleeping units and guest suites
  - Master control device at main room entry
    - Controls all permanently installed luminaires and switched receptacles
- ✓ 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

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## Exterior Lighting Power Limits

### C405.6.2

### Connected Exterior Lighting Power must not exceed Exterior Lighting Power Allowance

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 Power Limits

### C405.6.2



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.

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## Tradable Surfaces



- ✓ 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

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## Nontradable Surfaces

- ✓ 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



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## Exterior Lighting Zones

Table C405.6.2(1)

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

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## Exterior Lighting Zones

Table C405.6.2(1)



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## Exterior Lighting Zones

Table C405.6.2(2)

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

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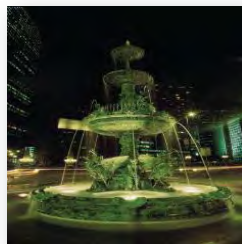
## Exterior Lighting Zones cont'd

		<b>Zone 1</b>	<b>Zone 2</b>	<b>Zone 3</b>	<b>Zone 4</b>
<b>Tradable Surfaces</b>	<b>Building Entrances and Exits</b>				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry Canopies	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>
	<b>Sales Canopies</b>				
	Free-standing and attached	0.6 W/ft <sup>2</sup>	0.6 W/ft <sup>2</sup>	0.8 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>
	<b>Outdoor Sales</b>				
	Open areas (including vehicle sales lots)	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.5 W/ft <sup>2</sup>	0.7 W/ft <sup>2</sup>
	Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot

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**Exterior Lighting Control Requirements**  
**C405.2.4**

- ✓ For dusk-to-dawn lighting: astronomical time switch or photosensor
- ✓ For all other: astronomical time switch OR photosensor + time switch
- ✓ All time switches must have at least 10 hour battery backup



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**Exterior Building Grounds Lighting**  
**C405.6.1**

Building grounds lighting luminaires over 100 watts must have source efficacy of at least 60 lumens per watt

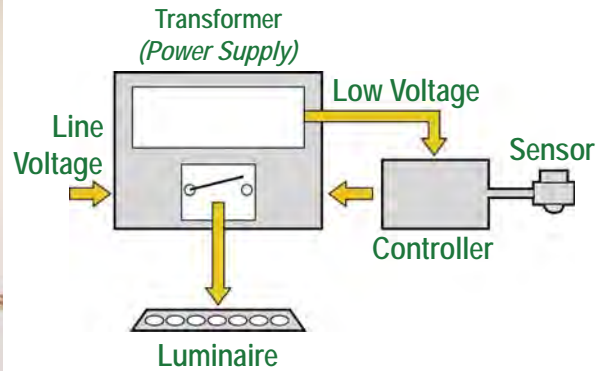
Light Source	Typical System Efficacy Range in LPW <i>(varies depending on wattage and lamp type)</i>
Incandescent	10-18
Halogen incandescent	15-20
Compact fluorescent (CFL)	35-60
Linear fluorescent	50-100
Metal halide	50-90

**Exceptions**

- ✓ Controlled by motion sensor
- ✓ Any of the exterior lighting power allowance exceptions

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## Exterior Grounds Lighting Controls C405.6.1



Exterior grounds lighting over 100 W provides >60 lm/W unless on motion sensor or fixture is exempt from scope of code or from external LPD

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## Exemptions from Exterior Calculation C405.6.2

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 and casinos
- Lighting used to highlight features of public monuments and registered *historic* landmark structures or *buildings*

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## Electrical Energy Consumption Mandatory Requirement C405.7

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Separate metering required for each dwelling unit



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## Lighting System Functional Testing C408.3.1

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- ✓ Testing to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working order per construction documents and manufacturer's installation instructions
- ✓ Construction documents to state who will conduct the testing
- ✓ Where required by the code official
  - ✓ an approved independent party shall be responsible for the testing and documentation certifying the installed controls meet the provisions

## Lighting System Functional Testing C408.3.1 Cont'd

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Renewable Energy

Where the following are installed:

- Occupant sensors ————— Time switches
- Programmable schedule controls — Photosensors
- Daylighting controls

It is required that the following be confirmed:

- ✓ Placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance
- ✓ Time switches and programmable schedule controls are programmed to turn the lights off
- ✓ Placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified

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## Lighting System Functional Testing C408.3.1

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**Delete Section C408.3 and subsection C408.3.1 in their entirety and replace, as follows:**

C408.3 Lighting system functional testing. Controls for automatic lighting systems shall comply with Section C408.3.1

C408.3.1 Functional testing. Lighting control devices and control systems shall be 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 installation instructions. The requirement for functional testing shall be stated in construction documents. When *occupancy sensors*, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

1. *Occupancy Sensors*:

- 1.1. Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
- 1.2. For projects with up to seven (7) *occupancy sensors*, all shall be tested.
- 1.3. For projects with more than seven (7) *occupancy sensors*, testing shall be . . .

**Look up requirements in S NV Amendments**

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