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Building Energy Codes Program

2009 IECC

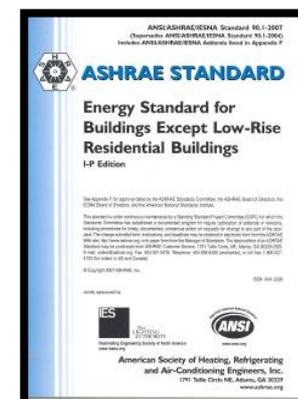
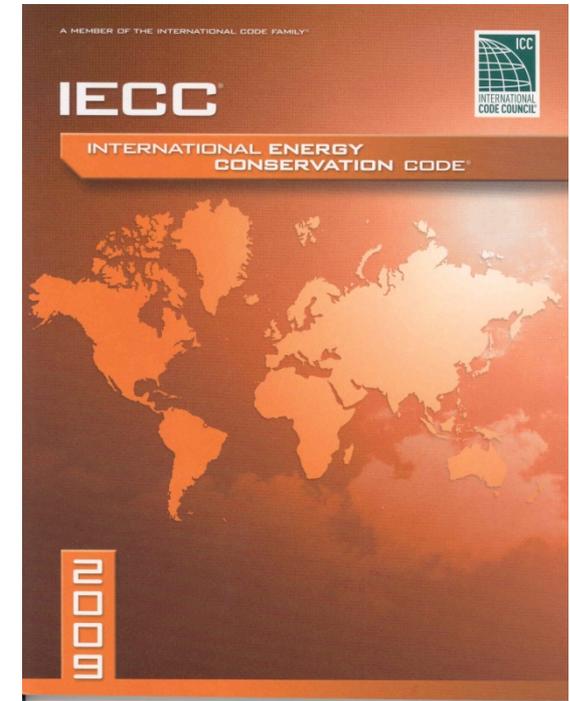
Commercial Lighting Requirements

Eric Richman
Pacific Northwest National Laboratory

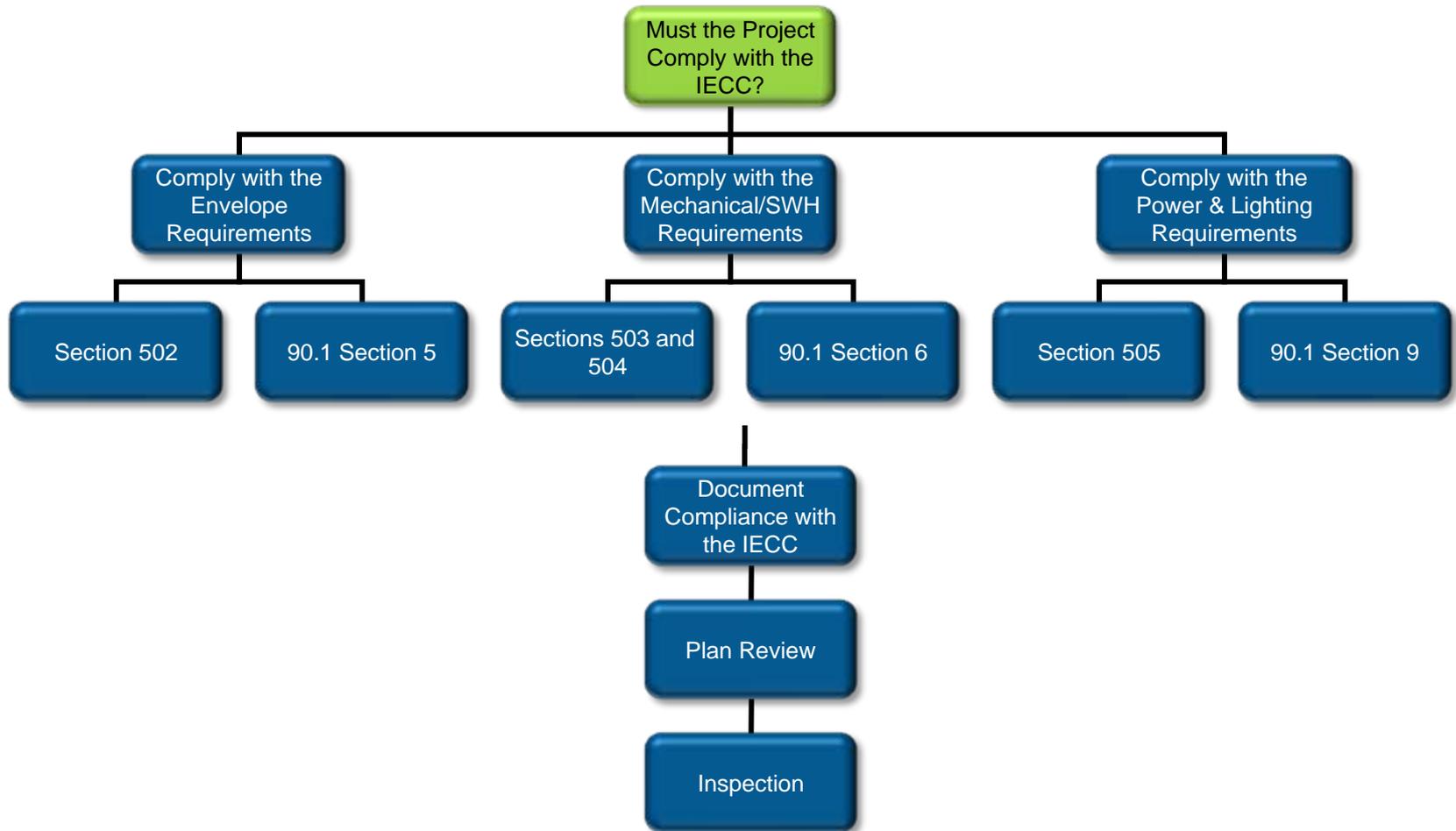


Commercial Lighting Requirements in 2009 IECC

- Commercial provisions contained in Chapter 5...with reference to ASHRAE 90.1-2007
- Covers lighting controls and power density for interior and exterior
- Major changes in the 2009 version
 - Daylight zone control
 - New exterior lighting zones



The IECC Code Compliance Process



Does My Project Need to Comply with the Commercial Requirements of IECC ?



First: Is IECC (2009) the applicable code in your state or jurisdiction? ...If you don't know, check out the Status of State Codes at www.energycodes.gov

...If yes, is the building **commercial** or **high-rise residential** other than:

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



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

Exceptions:

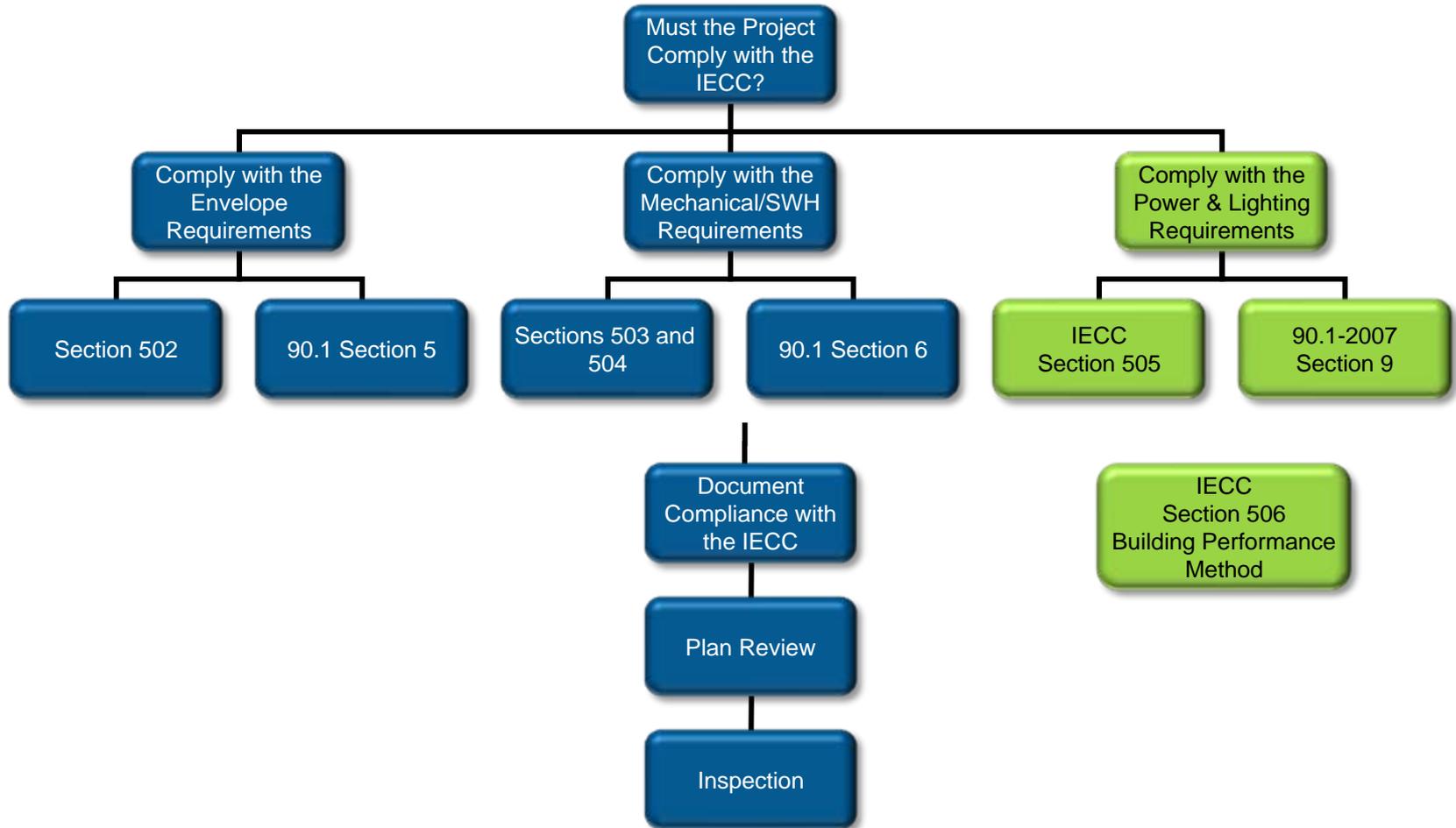
- Historic buildings
 - State or National listing
 - Eligible to be listed
- Alterations where less than 50% of the luminaires are replaced and power is not increased
- Lighting within dwelling units
 - Where $\geq 50\%$ of permanently installed fixtures include high-efficacy lamps

High-Efficacy Lamps

- Defined in the 2009 IECC as:
 - 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

The IECC Code Compliance Process



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

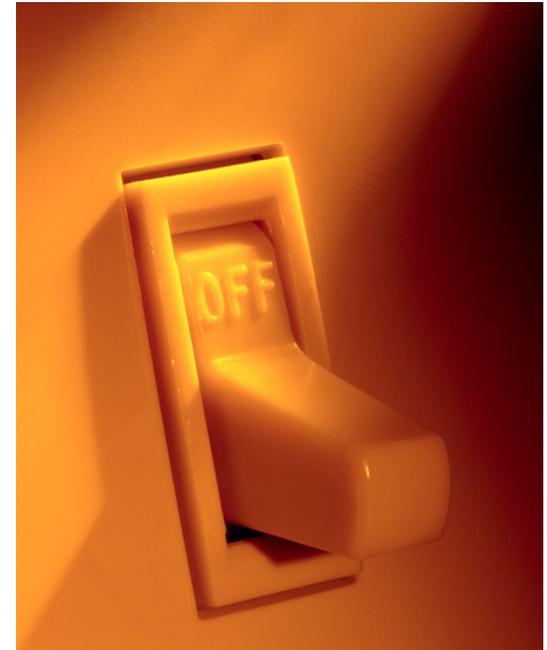
- Mandatory Interior Lighting requirements
 - Required Controls
 - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft²)
- Exterior Lighting Controls
 - Required Controls
 - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft²)
- Electric Metering



Interior Lighting Control (505.2): Basic Control

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



Intent: Allow occupants to
control unneeded lighting!

Interior Lighting Control: Light Reduction

Light Reduction Controls must allow the occupant to reduce connected lighting

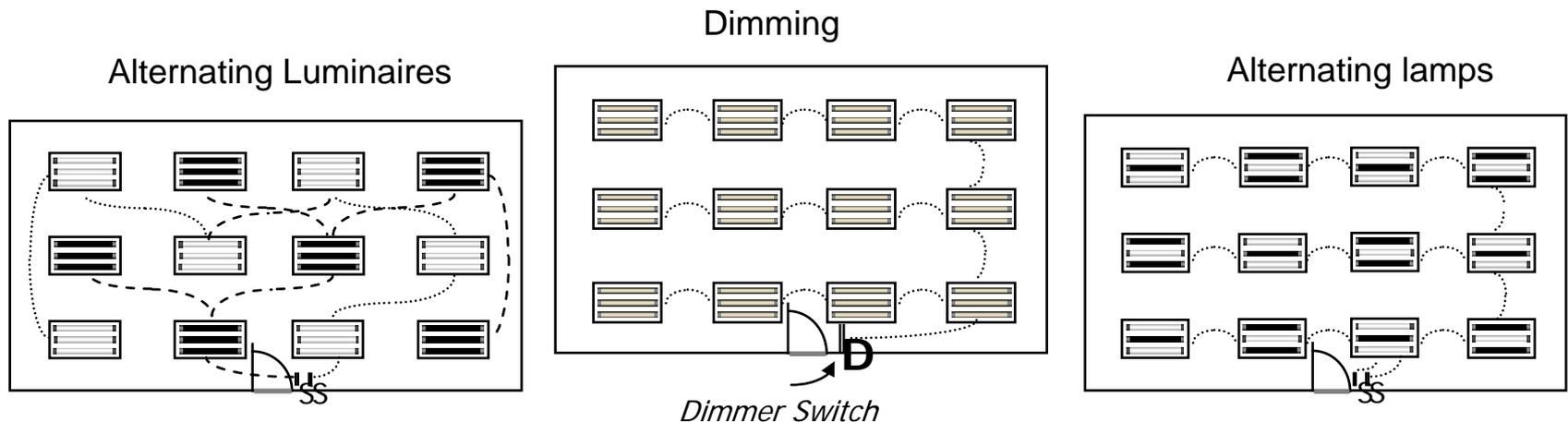
- By at least 50%
- In a reasonably uniform illumination pattern



Intent: Allow occupants to moderate light levels to save energy!

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



Interior Lighting Control: Light Reduction Exemptions

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

- Areas with only one luminaire
- Areas controlled by occupancy sensor
- Corridors, storerooms, restrooms or public lobbies
- Sleeping units
- Spaces with <0.6 w/ft²



Interior Lighting Control: Automatic Shutoff

Automatic lighting shutoff control device required in all buildings larger than 5,000 ft²

Building Defined:

- “Any structure used or intended for supporting or sheltering any use or occupancy”
- Building area surrounded by exterior walls and fire walls

Exempted spaces

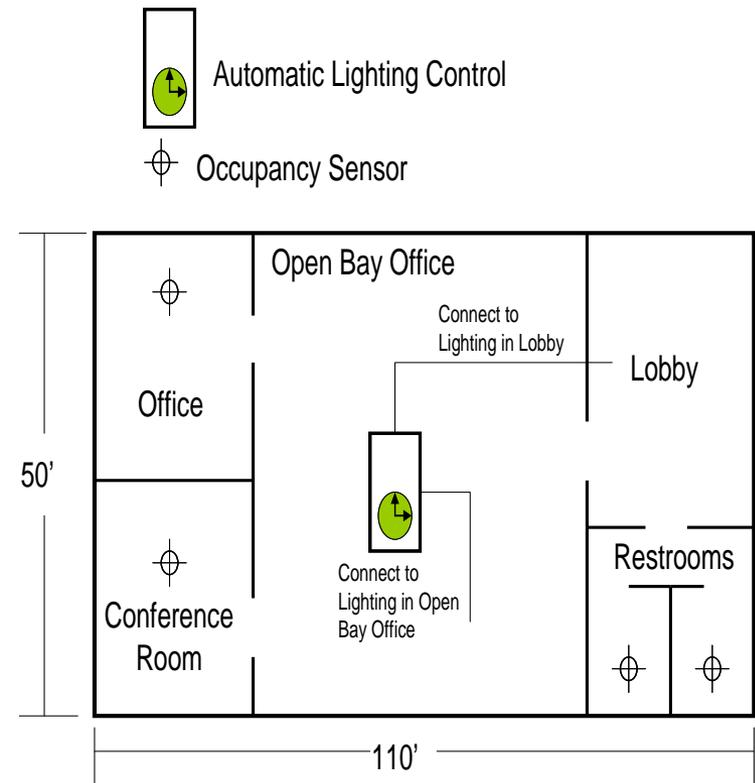
- Sleeping units
- Lighting for patient care
- When an automatic shutoff would endanger occupant safety or security

Intent: Eliminate after hours lighting waste!

Interior Lighting Control: Automatic Shutoff Options

Automatic Lighting Shutoff Compliance Options

1. Control lights on a scheduled basis (automatic time switch)
 - Time-of-day controller
 - Controls $\leq 25,000$ ft² and not more than one floor, or
2. Occupant sensor
 - Turn lights off within 30 minutes of occupant leaving the space
3. Signal from another control or alarm that indicates the area is unoccupied



Courtesy Britt-Makela Group

Interior Lighting Control: Automatic Shutoff Override

- Readily accessible
- Within view of the lights or area controlled
- Manually operated
- ≤ 2 hour override
- Controls an area $\leq 5,000$ ft²
- Exemptions
 - 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 ft²

Interior Lighting Control: Holiday Scheduling

- Feature that turns off all loads for 24 hours then resumes the normally scheduled operation
- Exceptions:
 - Retail stores and associated malls
 - Restaurants
 - Grocery stores
 - Places of religious worship
 - Theaters

Daylight Zone Definition – Under Skylights

The area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension in that direction plus either the floor-to-ceiling height or the dimension to a ceiling height opaque partition, or one-half the distance to adjacent skylights or vertical fenestration, whichever is least.

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

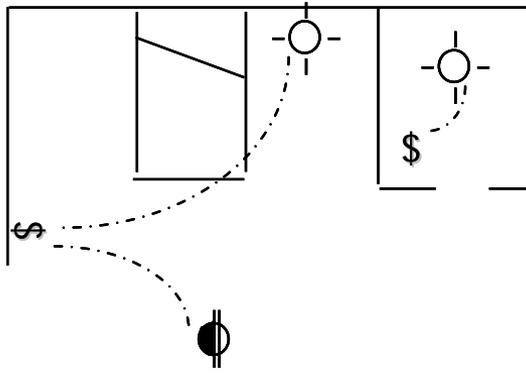
- Daylight Zones
 - Must have individual control of the lights independent of general area lighting
- Contiguous daylight zones adjacent to vertical fenestration
 - Can be controlled by a single controlling device if the zone doesn't include areas facing more than two adjacent orientations (i.e., north, 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

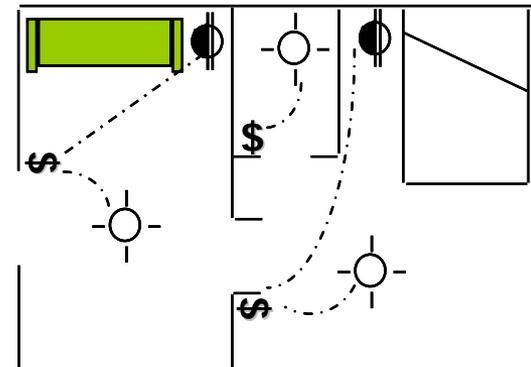
Interior Lighting Control: Sleeping Unit Lighting Control

- Applies to hotels, motels, boarding houses, or similar
- Master switch required at each room or main room entry
- Must control all permanently wired luminaires or switched receptacles
 - Exceptions: bathrooms

Intent: Allow occupant to turn off lights at exit point!



Standard Room



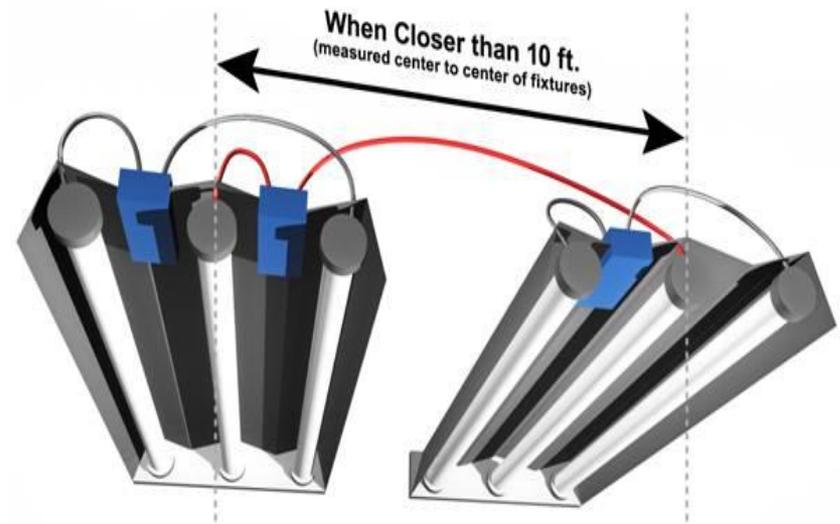
Suite

Tandem Wiring (505.3)

- 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



Intent: Eliminate the use of magnetic ballasts driving single lamps!

Exit Signs (505.4)

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



Interior Lighting Power Limits (505.5)

Connected Interior Lighting Power must not exceed Interior Lighting Power Allowance

1. Calculate Interior Lighting Power Allowance
 - Building Area type allowance
 - Additional allowances
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



Intent: Eliminate waste from sloppy lighting design and application!

Interior Lighting Power Allowance

- Building Area Type

Table 505.5.2

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	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
Gymnasium	1.1
Healthcare – clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ^b	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

Interior Lighting Power Allowance Calculation

- First, choose an appropriate “Building Area Type” from the allowance table (505.5.2)
 - “Building Area” includes all spaces that are associated with that business or function type. For example a space with:
 - Corridors,
 - Restrooms,
 - A lobby, and
 - Office space...would be considered an Office Building Area Type
- Then...multiply the lighting power density (W/ft^2) by the total building square footage to get allowed watts for compliance

Office - Example

A 200,000 ft² office building that contains corridor, restrooms, break rooms and a lobby is given 1.0 W/ft² for the entire building

Office: 200,000 ft²
 1.0 W/ft² = 200,000 W

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Automotive Facility	0.9
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Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare – clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
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Interior Lighting Power Allowance for Multiple Occupancy Building

How is an allowance determined if the building has more than one Building Area Type?

Example – A building contains the following area types

- Museum: 40,000 ft²
- Retail: 5,000 ft²
- Cafeteria: 10,000 ft²

- Use the more specific building area type where more than one area type exists in the building
- Sum the individual (lighting power density X area square footage) values for Total Power Allowance

Multiple Occupancy Building - Example

Museum: 40,000 ft²
at 1.1 W/ft² = 44,000 W

Cafeteria: 10,000 ft²
at 1.4 W/ft² = 14,000 W

Retail: 5,000 ft²
at 1.5 W/ft² = 7,500 W

Total watts allowed = 65,500 W

Table 505.2

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	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
Gymnasium	1.1
Healthcare – clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ^b	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

Additional Retail Lighting Power Allowance (Table 505.5.2 – Footnotes)

Additional Interior Lighting Power Allowance = 1000 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.

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.



Intent: Allow flexibility in design for critical retail applications!

Connected Interior Lighting Power Calculation

- 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



Note: Wattage must be calculated based on actual power draw...not just nominal lamp rating

Connected Lighting Calculation: Rules

Lighting wattage must be calculated in accordance with Section 505.5.1

- 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

Exemptions to Proposed Lighting Power Calculation

- 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
- 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

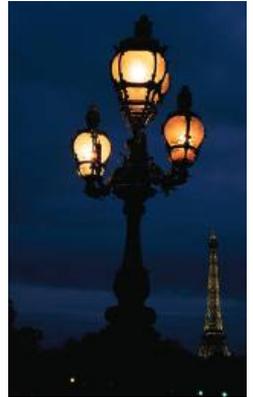
What if My Proposed Design Does Not Meet Code?

- Check calculations
 - Appropriate area type allowances used?
 - Actual lighting equipment wattages used?
- ...and design
 - Reasonable illuminance levels provided?
 - Efficient light sources used?
- Use alternate Standard 90.1-2007*
- Use total Building Performance Method

*Section 501.2 Application requires 90.1 to be used in its entirety (Envelope, Lighting, Mechanical) if used as an alternate compliance path

Exterior Lighting Control Requirements (505.2.4)

- 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 10 hour battery backup



Exterior Efficiency Requirement (505.6.1)

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 (varies depending on wattage and lamp type)
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
- As approved for a historical, safety, signage, or emergency consideration

Exterior Lighting Power Limits (505.6.2)

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

Exterior Lighting Power Limits (505.6.2)

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.



Tradable Surfaces

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



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



Exterior Lighting Zones [Table 505.6.2(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

Exterior Lighting Zones

		<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

Exterior Lighting Zones con't

		<u>Zone 1</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>
Tradable Surfaces	Building Entrances and Exits				
	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			
	Entry Canopies	0.25 W/ft ²	0.25 W/ft ²	0.4 W/ft ²	0.4 W/ft ²
	Sales Canopies				
	Free-standing and attached	0.6 W/ft ²	0.6 W/ft ²	0.8 W/ft ²	1.0 W/ft ²
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft ²	0.25 W/ft ²	0.5 W/ft ²	0.7 W/ft ²
	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

Exterior Lighting Zones con't

Non-Tradable Surfaces	Building Facades	No allowance	0.1 W/ft ² for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft ² for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft ² for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines 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 fac.	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 windows/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

Exemptions from Exterior Calculation (505.6.2)

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

What if My Proposed Exterior Lighting Does Not Meet Code?

- Check calculations
 - Appropriate surface allowances used?
 - Actual lighting equipment wattages used?
- ...and design
 - Reasonable illuminance levels provided?
 - Efficient light sources used?
- Use alternate Standard 90.1-2007*
- Use total Building Performance Method

*Section 501.2 Application requires 90.1 to be used in its entirety (Envelope, Lighting, Mechanical) if used as an alternate compliance path

Electrical Energy Consumption Mandatory Requirement (505.7)

- Separate metering required for each dwelling unit



Intent: Occupant understanding of actual energy use can promote effective energy use!