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Energy Codes and Lighting: What You Need to Know ~ Current Codes and the future ~

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U.S. Department of Energy - Building Energy Codes Program
July 10, 2017

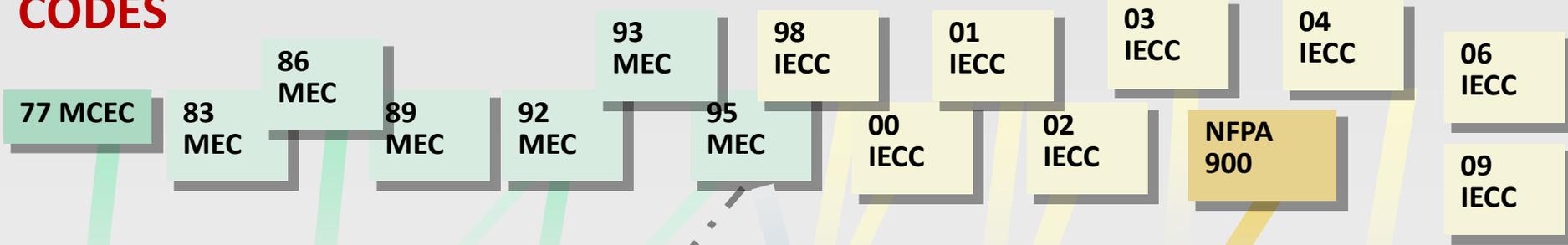
The Basis for Energy Code Requirements

- ▶ In the 1990s, the Energy Conservation and Production Act (amended by EPCA 1992) required that States adopt energy codes
- ▶ The U.S. DOE determines the effective stringency level to meet or exceed (currently 90.1-2013)
- ▶ States adopt (or develop) codes or standards to meet these requirements
- ▶ Many versions of nationally available codes (90.1, IECC) are enforced....and some states still have no statewide code 😊

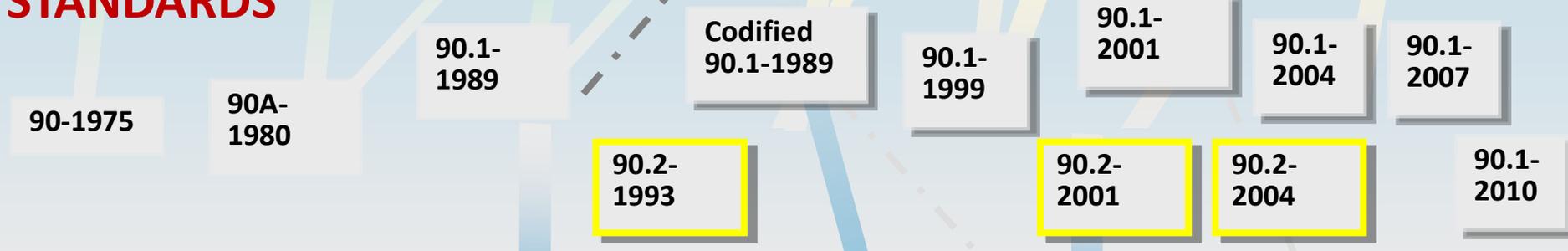


Energy Codes and Standards History (not updated)

CODES



STANDARDS



FEDERAL



STATE SPECIFIC (Unique or based on a Code/Standard)

California and others

Energy Code Compliance Options

(to meet DOE directives)

- ▶ Adopt a nationally available building energy code (that meets DOE determined stringency)
 - ASHRAE/IES 90.1
 - IECC
 -with amendments?
- ▶ Develop a State Specific Code (that meets DOE determined stringency)
 - Historically: California, Washington, Oregon, Florida
 - Currently: primarily California
- ▶ Do something else.....
 - Request delay or waiver from DOE

NOTE: National codes (90.1, IECC) are just available documents. They are not in effect until adopted!

ANSI/ASHRAE/IES 90.1 Standard/Code

- ▶ The 90.1 building energy Standard is jointly sponsored/developed by ASHRAE and IES.
- ▶ Developed as a set of technical code requirements by engineers, builders, designers/architects, manufacturers, building operators, and energy advocates
- ▶ Prepared as a standard but written in adoptable code language
- ▶ Provisions are often adopted or modified for use in other energy codes
- ▶ Current published version is 90.1-2016

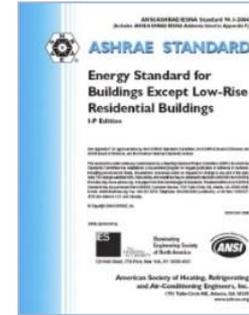
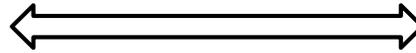


IECC – International Energy Conservation Code

- ▶ The IECC energy code is developed/offered by the International Code Council (ICC)
- ▶ ICC membership (the approval body of IECC) is primarily made up of building officials
- ▶ IECC is part of the suite of building codes supported and sold by ICC
- ▶ IECC is compiled as a unified collection of provisions from other codes and individual advocate proposals
- ▶ Currently the most widely adopted energy code in the US
- ▶ Latest available version is 2015 IECC



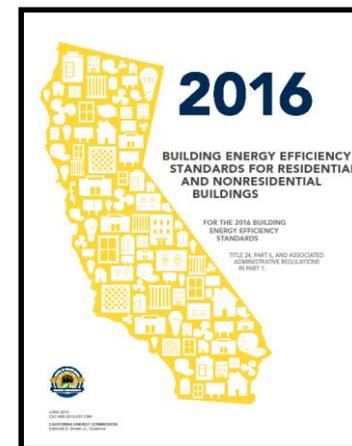
The IECC and 90.1 Connection



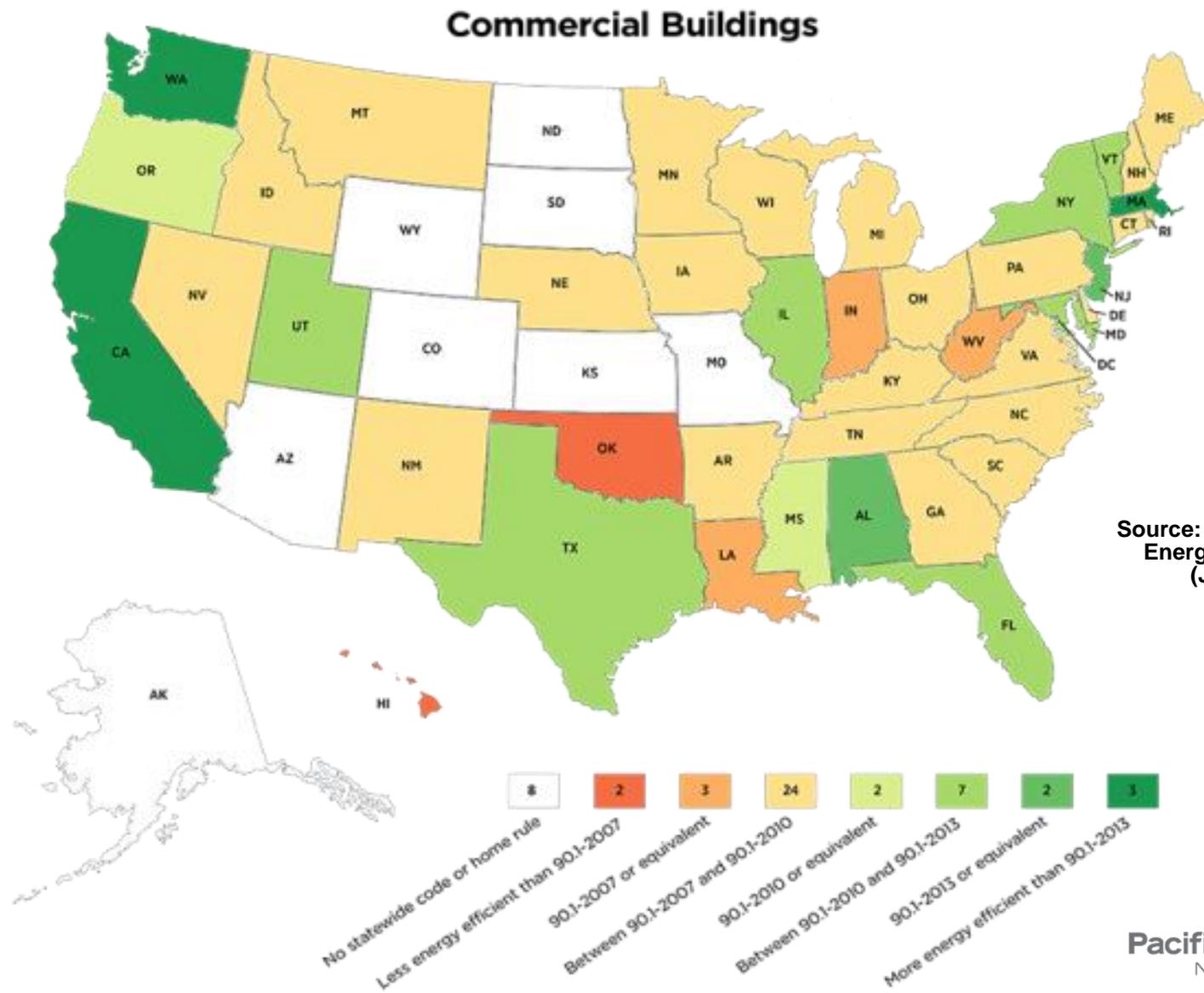
- ▶ 90.1 and IECC have many similar requirements
- ▶ IECC has historically been considered to be “simpler” than 90.1
 - ▶ Shorter and easier to apply
 - ▶ Fewer exemptions and therefore potentially more stringent
- ▶ Current IECC versions are approaching 90.1 complexity
- ▶ **ASHRAE/IES 90.1 is referenced in IECC as an equivalent compliance option (i.e. IECC 2015 references 90.1-2013)**

State Specific Energy Code

- ▶ Some states currently have an energy code that is State developed but often reference a national code with technical amendments. (Oregon, Washington, Florida, Indiana, etc.)
- ▶ California continues to have the most significant state specific energy code development program which tends to pace other national codes.



Commercial Building Energy Code Adoption



Source: DOE/PNNL Building Energy Codes Program (January 2017)

Details on Lighting Code Requirements

This presentation focuses on **ASHRAE/IES 90.1-2013** with reference to the corresponding **IECC 2015**

(Your current local lighting code requirements will mostly be less stringent....but expect requirements like this coming soon)

▶ Also covered will be:

- Differences found in **IECC 2015** (which references 90.1-2013)
- Significant changes/updates for the latest published **90.1-2016**
- Notes on significant California **Title 24** differences
- Potential future national lighting code changes (90.1, IECC)

Energy Code Lighting Scope and Coverage

Energy codes (including IECC, 90.1, Title 24) are *prescriptive* based codes.....that specify building practice to achieve energy effectiveness including:

- ▶ Interior lighting power limits
- ▶ Exterior lighting power limits
- ▶ Interior lighting controls
- ▶ Exterior lighting controls
- ▶ Allowances, exceptions, credits

Each code also offers a modeling compliance path as well as specific unique additional requirements

Lighting Power Density (LPD) AND Controls

LPD and Controls are both needed for effective and enforceable *prescriptive* code based limits on use of lighting energy

LPD = Watts per square foot or application:

- ▶ Provides a limit to power used for lighting which reduces waste (when on) as well as poor design/use
- ▶ Can reduce design flexibility and therefore requires more thoughtful design

Control = Automatically off or reduced whenever possible:

- ▶ Provides savings closely aligned with occupant needs
- ▶ Requires more thoughtful application to space function as well as maintenance to ensure most effective savings

What about a *performance* based code system that more simply specify projected or actual energy use?

90.1 Lighting Power Density (LPD) Limits

LPD limit compliance – two basic paths for interior

- ▶ Space-by-Space LPDs – Often used to maximize allowance or for buildings with specific space types that may have unique needs

Sum of spaces X allowances = total bldg LPD

- ▶ Building area LPDs – Easiest/simplest to calculate

Building area X bldg allowance = total bldg LPD

LPD Limits comparison to 90.1-2013

- ▶ IECC 2015:
 - Whole building LPDs identical to 90.1-2013
 - Space type LPDs mostly the same as 90.1-2013 with few exceptions
- ▶ Title 24
 - Similar LPD values – some higher, some lower
 - Title 24 also offers a third tailored method involving more detailed space based determination of lighting power
- ▶ 90.1-2016
 - Whole building – average 12% lower
 - Space by Space – average 26% lower

Where Do LPD Values Come From?

- ▶ Space type LPD values (90.1)
 - Developed within the ASHRAE/IESNA 90.1 Lighting subcommittee with Illuminating Engineering Society (IES) committee support.
 - Generated from building space type models with design and lighting technology inputs
- ▶ Whole building LPDs (90.1)
 - Developed from detailed room data for commercial buildings and the space type LPDs
 - Weighted average for building type

IECC tends to adopt similar or same values

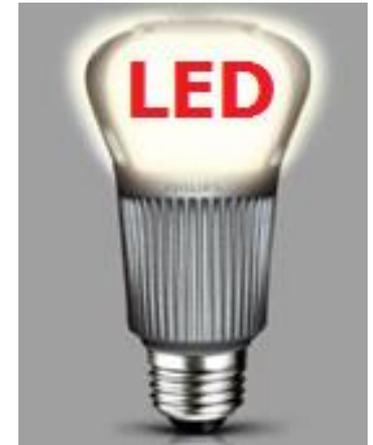
Title 24 typically considers 90.1 values and others and does some verification analysis

Energy Code LPDs and LED Lighting

- ▶ Energy codes do limit the installed lighting power for interior and exterior (LPD), but....
- ▶ Currently adopted energy codes (including 90.1-2013) typically do not:
 - specify individual technologies
 - Include LED product efficacies in determining LPD limits

However....

- ▶ The 2016 version of 90.1 will include LED technology as a driver for LPD limits because of:
 - Proven efficacy and energy savings capability
 - Continued reduced cost
 - Product maturity and reasonable applicability



Until 90.1-2016 and other newer codes are adopted..... the use of LED technology (when well applied!) can help with code compliance

LPD Exemptions

- ▶ 90.1-2013 lists 18 exemptions - interior lighting wattage you DO NOT have to count for compliance. For example:

.....

- 7. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions
- 8. Lighting in interior spaces that have been specifically designated as a registered interior historic landmark
- 9. Lighting that is an integral part of advertising or directional signage
- 10. Exit signs

.....

- ▶ Note that compliance tools may not always completely and clearly represent exemptions – review the actual code!

IECC and Title 24 will have similar sets of exemptions – review the actual code

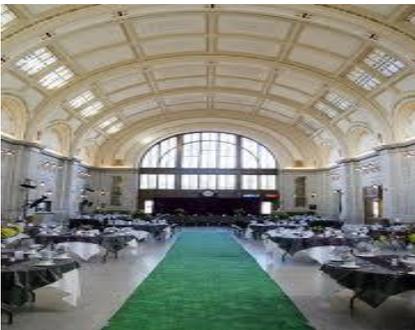
Interior LPD Adjustment

***Room Cavity Ratio Adjustment* for unusual spaces**

- ▶ Used only with the space by space method
 - Calculate *Room Cavity Ratio* (RCR) for a room
 - If greater than listed RCR threshold, a 20% increase is allowed
- ▶ For corridor/transition spaces, the increase is allowed for spaces with widths less than 8 feet

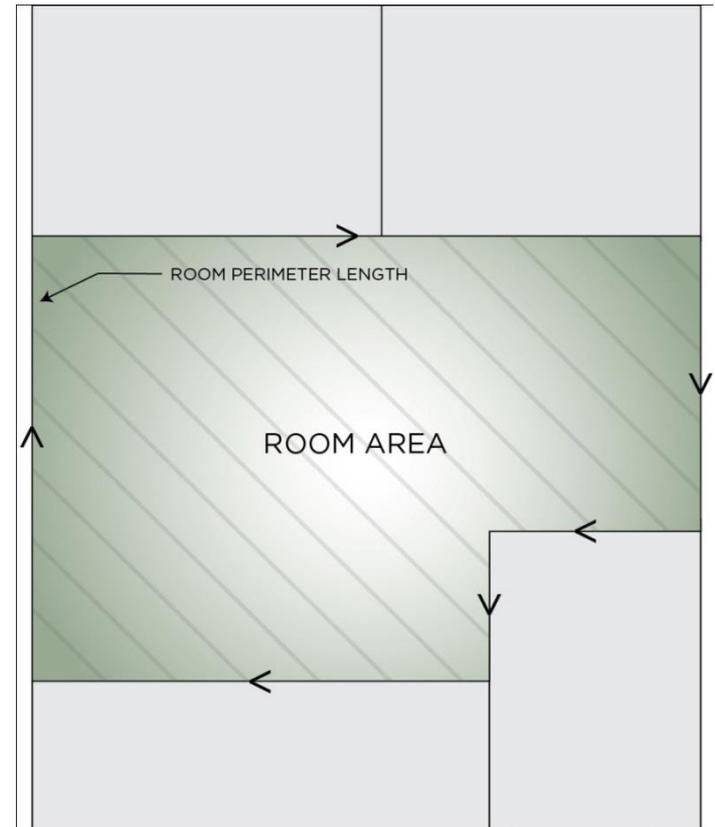
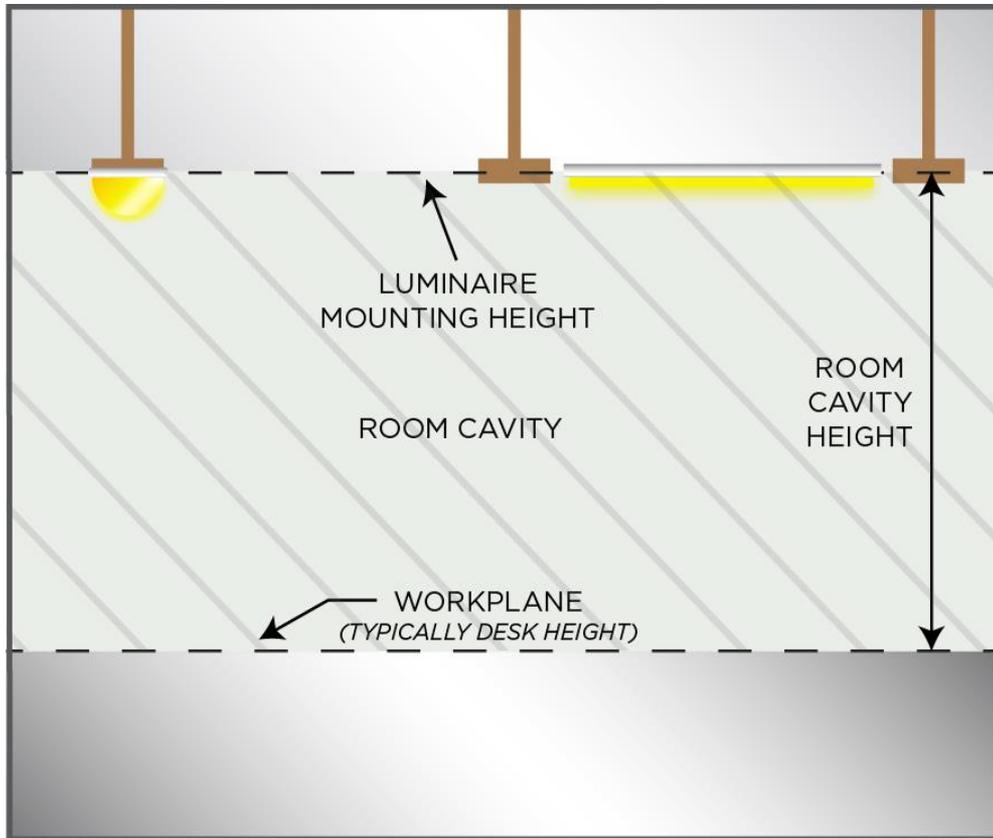
not included in IECC 2015

Title 24 applies a room RCR in the tailored method



Interior LPD Adjustment

$$\text{RCR} = 2.5 \times \text{Room Cavity Height} \times \text{Room Perimeter Length} / \text{Room Area}$$



Additional Allowances

Additional allowance for lighting specifically designed/installed to highlight merchandise

▶ Additional Lighting Power Allowance:

1000 watts

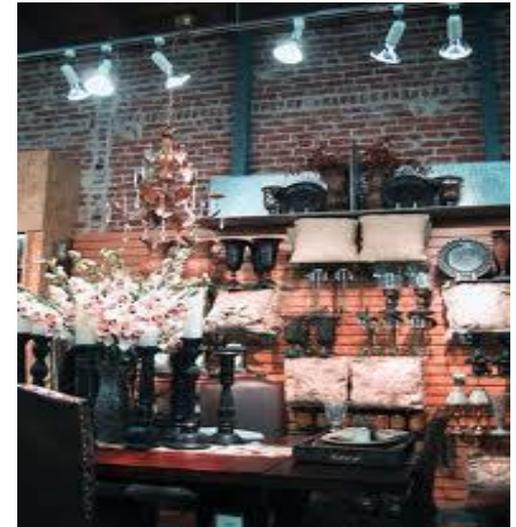
- + (Retail Area 1 × 0.6 W/ft²)
- + (Retail Area 2 × 0.6 W/ft²)
- + (Retail Area 3 × 1.4 W/ft²)
- + (Retail Area 4 × 2.5 W/ft²)

Retail Area 1 = floor area for all products not listed in Retail Areas 2, 3, or 4

Retail Area 2 = floor area for vehicles, sporting goods, and small electronics

Retail Area 3 = floor area for furniture, clothing, cosmetics, and artwork

Retail Area 4 = floor area for jewelry, crystal, and china.



IECC 2015 provides only 500W base allowance instead of 1000W

Title 24 offers a selection of additional allowances including retail

90.1-2016 reduces these allowances by 25% to recognize the use of LED

Exterior Lighting Power Limits

Tradable surfaces

Common exterior applications where wattage 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

**IECC has the same trading system
Title 24 allows trades among all
applications with specific exceptions**



Exterior Power Allowance by Zones (partial list)

		<u>Zone 1</u>	<u>Zone 2</u>	<u>Zone 3</u>	<u>Zone 4</u>
<u>Base Site Allowance</u>		<u>500 W</u>	<u>600 W</u>	<u>750 W</u>	<u>1300 W</u>
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	
Landscaping	0.04 W/ft ²	0.05 W/ft ²	0.05 W/ft ²	0.05 W/ft ²	

**IECC 2015 exterior LPDs are the same with limited exceptions
 Title 24 has similar categories with somewhat higher allowances
 90.1-2016 further reduces LPD by 30% based on LED technology**

Exterior Lighting Power Allowance Zones

The zone designations follow the current IESNA development work on Model Lighting Ordinances (MLO)



Interior Lighting Control Requirements

Interior control requirements are applied by space type (with exemptions)

- ▶ 90.1-2013 has adopted a tabular format that shows control requirements by space along with applicable LPD limits and separately defines each control type.
- ▶ IECC 2015 and Title 24 specify control requirements in sections and paragraphs with defined or listed application.
- ▶ All have similar approaches to control but with some differences in application.

Interior Lighting Control Requirements

Each space is required to have or is limited by one or more control functions:

- ▶ Local on/off control
- ▶ Manual on restriction
- ▶ Partial automatic on (occupancy/timer based)
- ▶ Partial automatic off (occupancy/timer based) - **not used in IECC 2015**
- ▶ Automatic full off (occupancy/timer based)
- ▶ Bi-level control available to occupant
- ▶ Scheduled automatic shutoff
- ▶ Daylight control (Continuous dimming or multi-step) – sidelighting or toplighting as appropriate

Title 24 has a similar set of lighting control requirements with often more detailed specifics

A few details on general control requirements.....

Occupancy Based or Timer/shutoff Control

- ▶ 90.1-2013 and Title 24 require occupancy sensor or automatic timer/scheduled shutoff control in most spaces
- ▶ IECC 2015 applies the specific occupancy sensor requirement to a more limited list
- ▶ 90.1-2013 and Title 24 also allow automatic partial off for spaces including some corridors and lobbies, stairwell, library stacks, warehouse.



Occupancy Manual-on Control Restriction

90.1 and IECC require that Automatic control devices shall not be set to Automatically turn the lighting to full on.

- ▶ This effectively requires manual-on OR 50% auto-on function for automatic controls
- ▶ Exceptions (where full automatic-on is allowed):
 - public corridors, and stairwells, restrooms,
 - primary building entrance areas and lobbies ,
 - areas where manual-on operation would endanger the safety or security of the room or building occupant(s).

Daylighting Control

Electric lighting must be controlled when daylight is available...and made available when possible

- ▶ Require the control of electric lighting when top and side daylight is presentAND....
- ▶ Require the installation of skylights when applicable (exceptions apply)

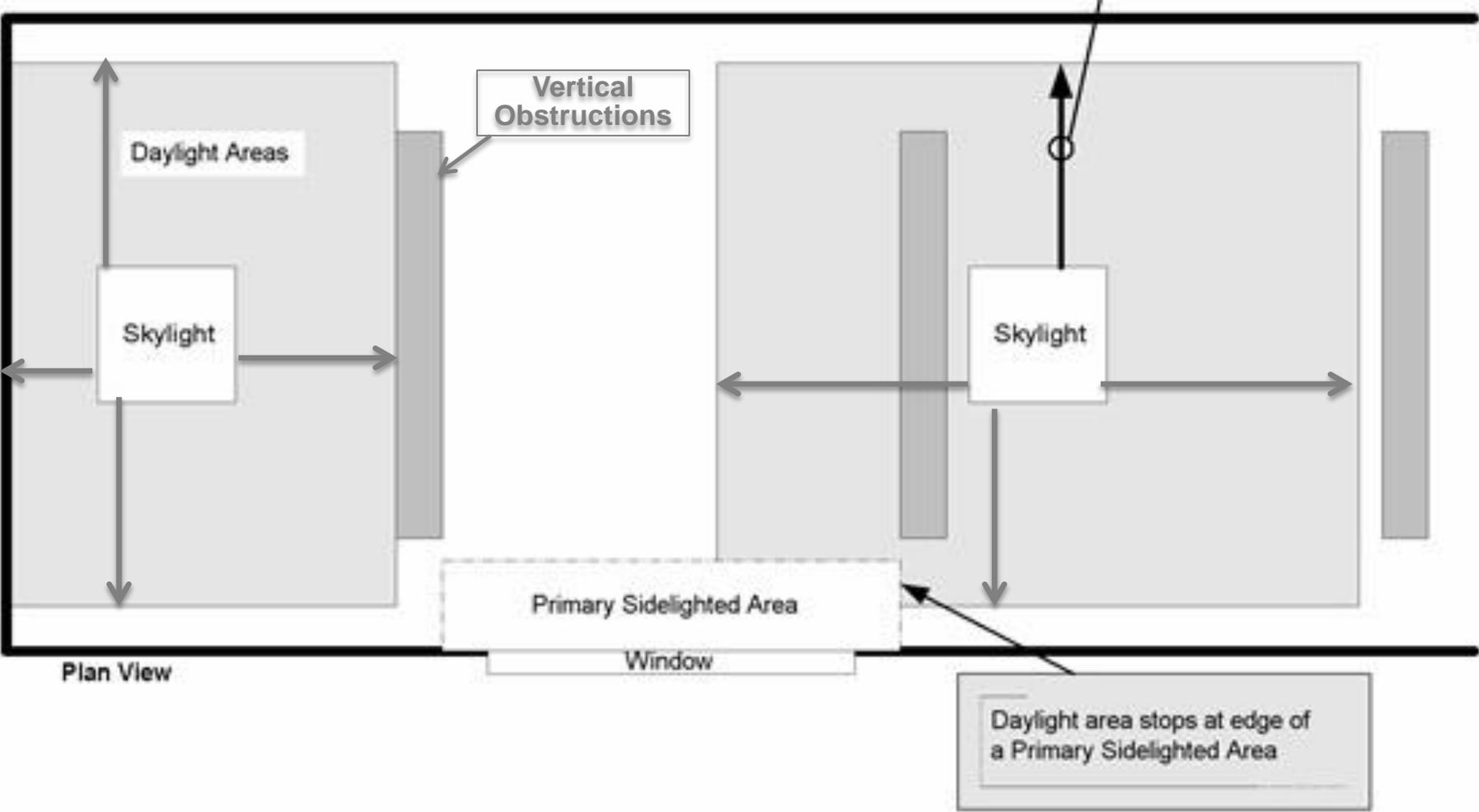


Lighting Control for Toplighting

Electric lighting must be automatically controlled if toplighting daylight is available

- ▶ Applied based on “daylight area under skylights” + “daylight area under rooftop monitors” with lighting wattage exceeding 150W
- ▶ Control is required for the general lighting over these areas – some exceptions apply
- ▶ Control must be multi-level photocontrol - at least two output levels at 0% - 35% and 50% - 70% or Continuous dimming

“Daylight Area Under Skylights” – Top View

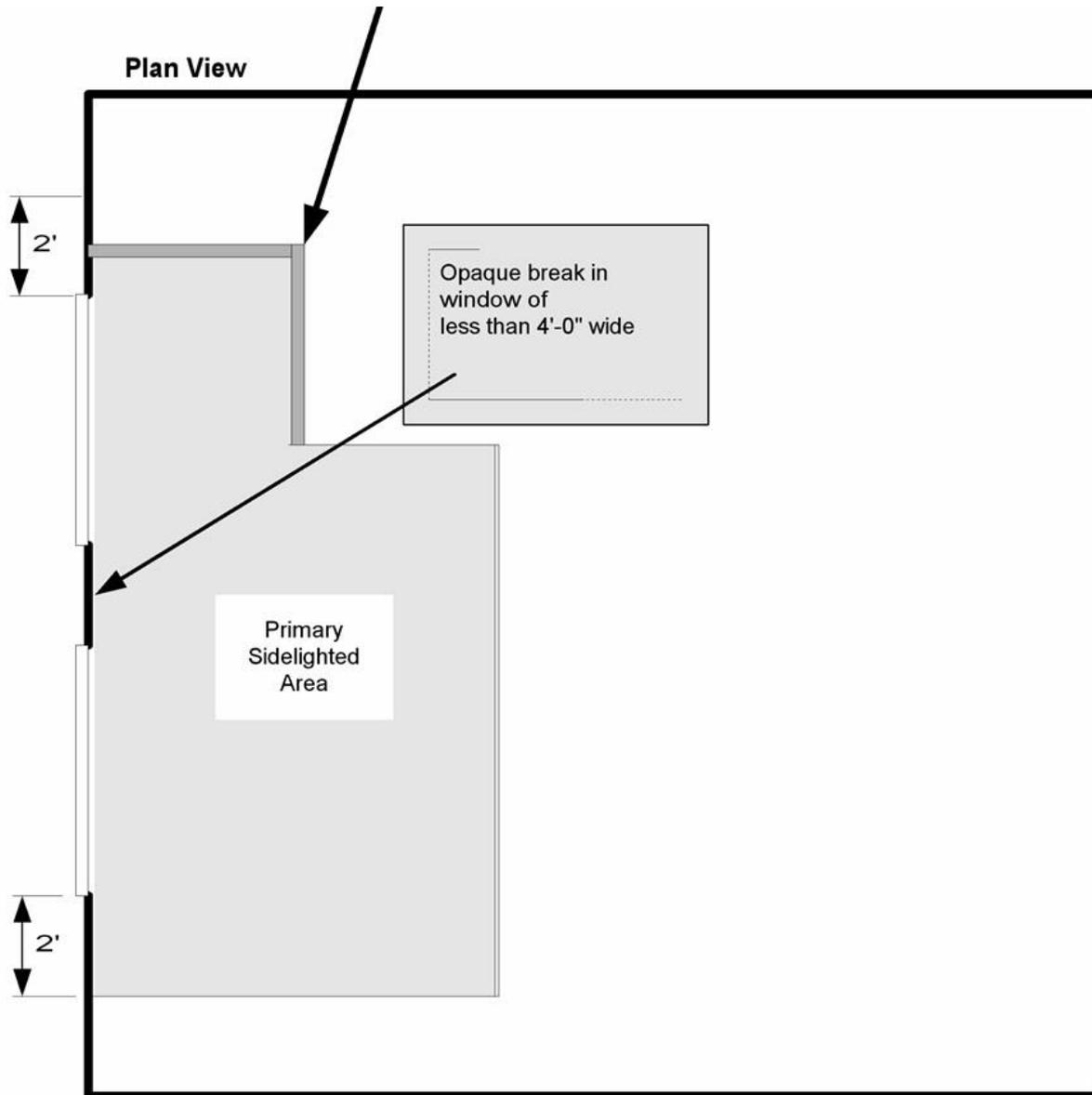


Lighting Control for Sidelighting

Electric lighting must be automatically controlled if sidelighting daylight is available

- ▶ Applied based on “primary sidelighted area” with lighting wattage exceeding 150W.
- ▶ Control is required for the general lighting over these areas – some exceptions apply
- ▶ Control must be multi-level photocontrol - at least two output levels at 0% - 35% and 50% - 70% or Continuous dimming

“Primary Sidelighted Area” – Top View



Interior Parking Garage Control

Parking garage lighting must be automatically controlled including daylighting

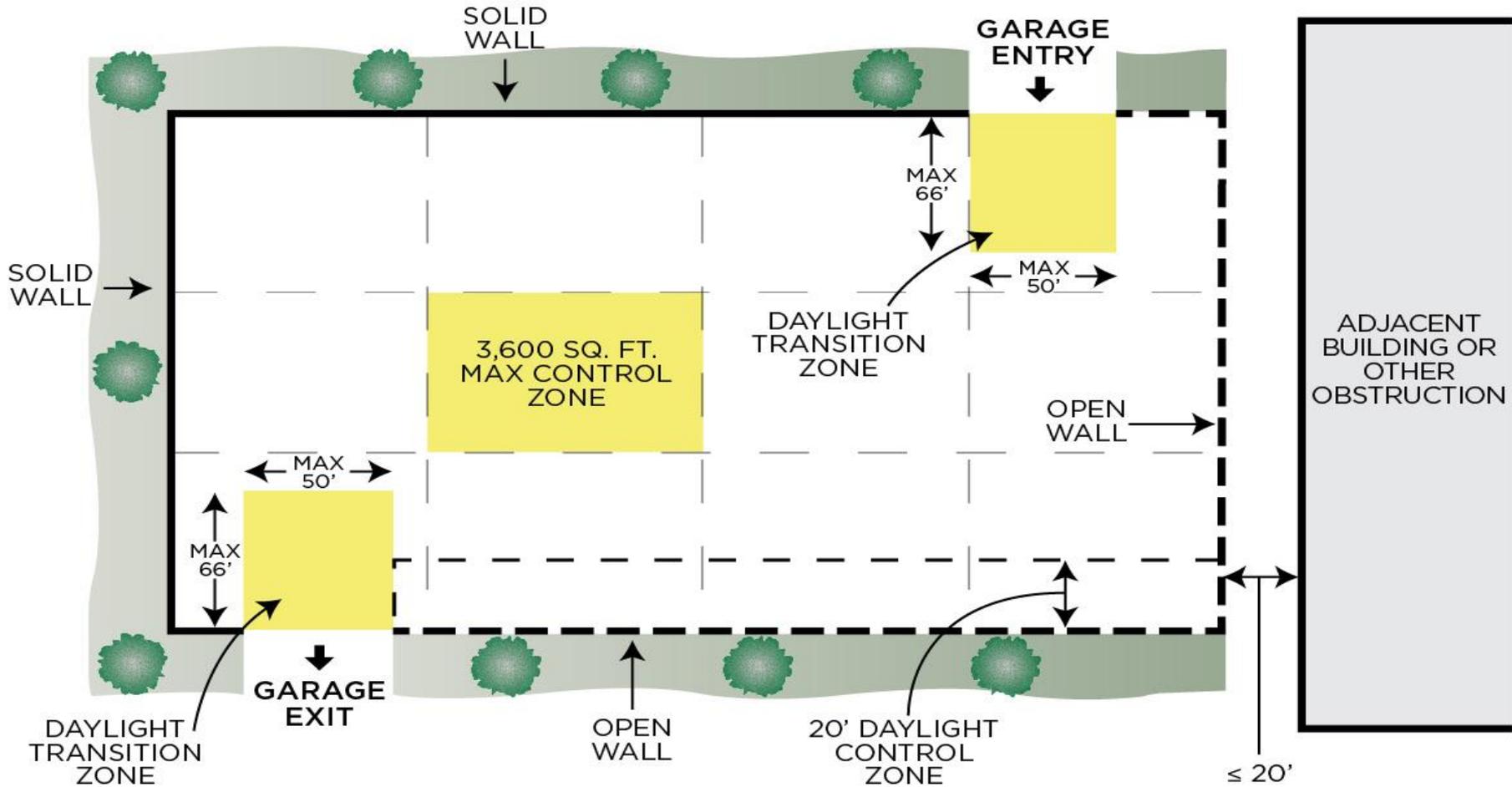
- ▶ Reduce lighting power by 30% or more when no occupancy detected in a lighting zone (< 3,600 sf)
- ▶ Daylight transition zone lighting (66 ft. wide by 50 ft.) must be separately controlled for eye adaptation.
- ▶ Daylight control required for lights within 20 feet of perimeter wall with net opening to wall ratio of 40%.
- ▶ Exceptions apply

These controls are not in IECC 2015

Title 24 has a similar set of requirements

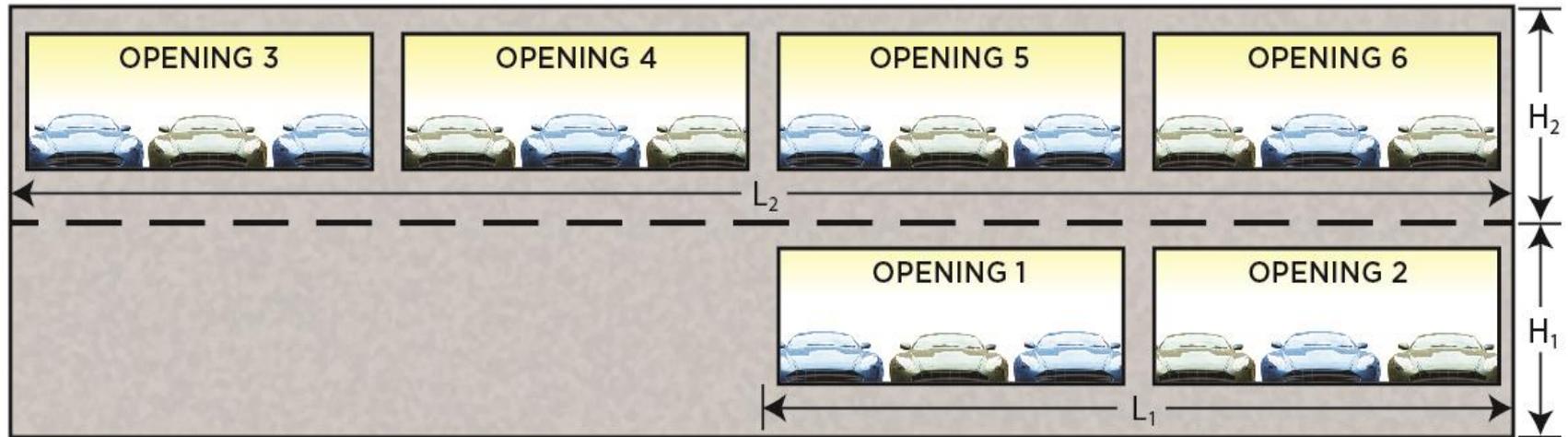


Parking Garage Control



Parking Garage Control: Opening to Wall Ratio

PARKING GARAGE SIDE VIEW (ELEVATION)



Daylighting control required if the total area of all openings in a wall section (i.e. openings 1-2) are greater than or equal to 40% of the total wall area ($H \times L$).

Example:
$$\frac{\text{Opening 1} + \text{Opening 2}}{H_1 \times L_1}$$

Example:
$$\frac{\text{Opening 3} + \text{Opening 4} + \text{Opening 5} + \text{Opening 6}}{H_2 \times L_2}$$

Exterior Lighting Control

Requires specific daylight and building operation lighting controls for exterior

- ▶ Automatic dusk-to-dawn shutoff required
- ▶ Building façade/landscape lighting must be off from latest of midnight or closing to earliest of 6am or opening
- ▶ Other lighting including ad signage, shall be auto reduced by at least 30% after-hours or when area is unoccupied

90.1-2016 and Title 24 include additional requirements for occupancy based control of lighting in parking areas



Advanced Control Incentives

If all mandatory control requirements are met AND advanced controls are installed, THEN additional limited lighting power is allowed

- ▶ Based on control of specific spaces only
- ▶ Additional power can be used anywhere in the building
- ▶ Additional Interior Lighting Power is calculated as:

Lighting Power Under Control x Control Factor

- ▶ Available options are limited and reflect very advanced systems, programmable control, or additional control in secondary spaces

Title 24 offers some similar incentives

Incentives are not provided in IECC 2015

Alterations Requirements

Lighting alterations (retrofits) must comply with interior and exterior power limits

- ▶ Includes retrofits where luminaires are added, replaced, or removed.
- ▶ Altered interior and exterior space area must also have basic auto shutoff control (IECC 2015 requires full lighting section compliance including controls as applicable)
- ▶ Alterations of less than 10% of a spaces connected lighting load are exempted
- ▶ Lamp plus ballast retrofits must also comply (not included as part of IECC 2015)



90.1-2016 adds occupancy and scheduled shut-off control
Title 24 includes similar requirements with additional detail

Functional Testing of Controls

Functional testing required for lighting controls (calibrated, adjusted, programmed)

- ▶ Must be performed by individuals NOT involved in design, manufacture, or installation **IECC 2015 only specifies that design professional verify that controls perform as designed**
- ▶ Primarily for *occupant sensors, time switches, or daylight control photosensors*
 - Verify all performance criteria is met
 - Confirm occupant sensor time-out and sensitivity settings
 - Confirm timers and programs set to turn lights off
 - Confirm photosensor controls effectively control electric lighting
- ▶ Must follow specific (step-by-step) directions

Title 24 also has an extensive set of functional testing (operation) requirements

A Few Words About Compliance Enforcement

- ▶ DOE requires adoption of codes....but....

State and local jurisdictions monitor compliance.

- ▶ Codes are not perfect!....your project may not fit the requirements....interpretation may be needed

- ▶ Most building officials are just as interested in a reasonable application of the code as the builder

- working to the intent of the requirement is the goal
- offering an energy-effective solution with reasoning may prove successful!

Future of Lighting Energy Codes

What can be expected moving forward?

- ▶ Further LPD limit reductions based on more LED technology
 - Current 90.1-2016 includes LED in the LPD models at about 75%
 - 90.1-2019 will include more – possibly close to 90+ percent
- ▶ Additional applications
 - Industrial applications?
 - Non-building-attached applications? (i.e. area parking lots)
 - More advanced control as cost and application improve?

THANK YOU!

Questions ?