TITLE 24, PART 6 | 2028 CODE CYCLE

Indoor Lighting Controls

Codes and Standards Enhancement (CASE) Proposal

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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Proposal Description

- Code Change Proposal
- Benefits
- Background Information

Proposed Code Changes

- Require nighttime dimming in parking garage daylight adaptation zones
- Require partial or full OFF occupant sensing controls in more spaces
- Reduce occupant sensing control time delay to 15 minutes
- Clarify the definition and reduce the threshold for requiring multilevel lighting controls
- Require continuous dimming for daylight responsive controls, regardless of the multilevel lighting controls exception

See Title24stakeholders.com for proposal description, justification, draft code language, and requested data

Benefits of the Proposed Change

- **Increase energy savings with effective use of electric lighting**
  All proposed changes
- **Align with the industry best practices to increase visual adaptation and occupant satisfaction**
  Require nighttime dimming in parking garage daylight adaptation zones

  Require continuous dimming for daylight responsive controls, regardless of the multilevel lighting controls exception
- **Increase harmony in the operation of different control requirements**
  Clarify the definition and reduce the threshold for requiring multilevel lighting controls

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1	Title 24, Part 6	Reference Appendices
▪ No Changes	▪ 110.9(b)4 ▪ 130.1	▪ NA7.6.1 ▪ NA7.6.2

Submeasure 1: Require Nighttime Dimming in Parking Garage Daylight Adaptation Zones

Background Information & Current Market Conditions

- **Promotes best practice and safety while saving energy**
  - IES RP-8 *Recommended Practice: Lighting Roadway and Parking Facilities*
    Provide a higher light level (~50 fc) from the garage entrance to ~66 ft deep inside the garage (a.k.a. the daylight adaptation zone) to mitigate a large change in adaptation level for human eyes transitioning **from full daylight to low interior light level**
  - The adaptation is not needed during nighttime
  - Saves energy by reducing the light level in the daylight adaptation zone during nighttime
- **The same requirements are already in the national standards (ASHRAE 90.1) and other model codes (IECC) for several code cycles**
  - Practitioners with national project exposure may already have experience

Technical Considerations

- **May be achieved in multiple ways:**
  - Dim the light in the daylight adaptation zone from sunset to sunrise (continuous dimming is commonly available for luminaires)
  - Provide a separate layer of lighting for daylight adaptation that is turned off from sunset to sunrise
  - Or some combination of the above

Poll

What percentage of your parking garage projects already automatically reduce light level in the daylight adaptation zone during nighttime?

a. <1%
b. 1-25%
c. 26-50%
d. 51-75%
e. >75%
f. Not applicable to me

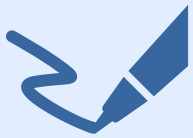
Energy and Energy Cost Savings Methodology & Assumptions

- Spreadsheet-based modeling and analysis framework
- Based on full-load hour reduction estimate and the CEC 2029 construction forecasts
- **Information needed:**
  - Garage operating hours?
    - How many are 24/7 statewide?
    - For those not 24/7, what is a reasonable assumption for the nominal business hours?
  - How big is the daylight adaptation zone?
    - What is a reasonable assumption for the percentage of daylight adaptation zones out of the entire parking structure?

Key Energy Modeling Approach and Assumptions

Standard Design

1. Lighting in the parking garage daylight adaptation zones ON at 100% during operating hours
   - 500 lux / 46 fc horizontal at the finished grade
   - 250 lux / 23 fc vertical at 5 ft above finished grade
2. Operating hours
   - 24/7 operation – **x%** of the garages in CA
   - **Nominal business hours** – **y%** of the garages in CA
3. Daylight adaptation zone accounts for **z%** of the total garage area



Proposed Design

1. Lighting in the parking garage daylight adaptation zone dimmed to the same level as the parking area between sunset and sunrise
   - 10 lux / 0.9 fc horizontal at finished grade
   - 5 lux / 0.5 fc vertical at 5 ft above finished grade
2. Operating hours
   - 24/7 operation – **x%** of the garages in CA
   - **Nominal business hours** – **y%** of the garages in CA
3. Daylight adaptation zone accounts for **z%** of the total garage area

Incremental Cost Framework

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Baseline

First Cost

1. No cost related to nighttime dimming

30-Year Maintenance Costs

1. No cost related to nighttime dimming

Proposed

First Cost

1. Sunset-sunrise controller (astronomical timer)
2. Dimming driver and related wiring
3. Installation of the controller
4. Programming and commissioning for nighttime dimming

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Key Aspects of Compliance Verification

- **Requiring daylight adaptation zones to be shown on the drawings** will help identify where they are and verify whether they meet the requirement.
- Moving the **length limitation** for daylight adaptation zones from footnotes to the main code language will **improve compliance**.
- Daylight adaptation zone nighttime controls should be **verified through acceptance testing**:
  - Acceptance test technicians (ATTs) already perform acceptance tests on parking garage lighting controls (daylight responsive controls and occupant sensing controls).
  - This would be an additional test ATTs perform in parking garages.

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. Lack of protocols to verify nighttime controls in the parking garage daylight adaptation zone without acceptance testing	1. A new acceptance test method will be created. It is expected to be simple and straightforward, but we will confirm this through cost analysis and, if necessary, field testing. 2. Change the trigger for the commissioning requirements so the nighttime controls can be verified by the commissioning providers.

Submeasure 2: Require Partial or Full OFF Occupant Sensing Controls in More Spaces

Background, Market Conditions & Technical Considerations

- **Occupant sensing controls are a well-understood and easy-to-implement control strategy in all lighting control systems**
- **A similar requirement has been added in the latest update to the national standards (ASHRAE 90.1)**
  - Addendum bd to ASHRAE 90.1-2022 required more spaces for occupant sensing controls
- **Occupant sensing controls will trigger HVAC occupied standby controls**
  - In spaces where ventilation is allowed to be reduced to zero
  - Implementing HVAC occupied standby continues to be a challenge, and this may exacerbate the current compliance issues
  - Collaborate with the HVAC CASE Team to interview system integrators and other stakeholders to better understand current implementations and challenges

Energy Modeling Assumptions

- Spreadsheet-based modeling and analysis framework for lighting energy savings
- Simulating energy savings in EnergyPlus with CBECC rulesets for occupied standby savings

Currently Required Spaces

- Classroom, lecture, training, vocational area
- Conference and meeting area
- Corridor area
- Multipurpose room < 1,000 sf
- Library stacks area
- Office area
- Parking garage area
- Restrooms
- Stairwell
- Warehouse

Considered Spaces

- Auditorium area
- Civic meeting area
- Computer room
- Exercise/fitness and gymnasium area
- Financial transaction area
- Laboratory
- Lobby, main entry
- Lounge, breakrooms, or waiting area
- Multipurpose room ≥ 1,000 sf
- Hotel function areas
- Museum exhibition/display area
- Religious worship area

Poll

Are there any space types currently considered problematic?

Are there any additional space types we should consider?

Open ended response

Considered Spaces
▪ Auditorium area ▪ Civic meeting area ▪ Computer room ▪ Exercise/fitness and gymnasium area ▪ Financial transaction area ▪ Laboratory ▪ Lobby, main entry ▪ Lounge, breakrooms, or waiting area ▪ Multipurpose room ≥ 1,000 sf ▪ Hotel function areas ▪ Museum exhibition/display area ▪ Religious worship area

Poll

What else should we know? Are there market or technical barriers we should consider?

Open ended response

Key Energy Modeling Approach and Assumptio

Slide NOT shown

- Spreadsheet-based modeling and analysis framework
- Build on the approach developed in the 2022 Indoor Lighting CASE Report

Standard Design

1. Time switch shut-off controls with fixed schedules in affected spaces
2. No occupied standby controls in affected spaces

Proposed Design

1. Occupant sensing controls in affected spaces
2. Occupied standby controls in allowed affected spaces
   - Thermostat temperature setpoint setback
   - Ventilation reduced to zero

Incremental Cost Framework

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Baseline

First Cost

1. Time switches
2. Installation of the time switches
3. Programming of the time switches

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Proposed

First Cost

1. Occupancy sensors and controllers
2. Installation of the sensors and controllers
3. Programming and commissioning for occupant sensing controls
4. Programming for occupied standby controls

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Key Aspects of Compliance Verification

- More spaces will need to undergo acceptance testing
- Compliance forms–NRCC, NRCI, and NRCA–will need to be filled out differently for the affected space types
- The change will require updates to the compliance software

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. Challenges in implementing HVAC systems for occupied standby controls. 2. Ventilation and mechanical system design need to change to implement occupied standby controls. 3. Potentially creating conflicts among different controls in spaces that already have control complexity, e.g., demand ventilation controls, film hood ventilation controls, etc. 4. Exacerbate the coordination issues between lighting design and mechanical design teams	Collaborate with the HVAC CASE team: 1. Assess and identify mechanical systems that should be exempted. 2. Evaluate if there are specific space types that should be exempted from occupied standby controls. 3. Interview control contractors to understand the challenge and determine the best way to improve and ensure compliance

Submeasure 3: Reduce Occupant Sensing Control Time Delay to 15 Minutes

Background, Market Conditions & Technical Considerations

Objective: Reduce occupant sensing time delay from the current 20 minutes to 15 minutes

- Occupant sensing controls are a well-understood and easy-to-implement control strategy in all lighting control systems
- Many occupancy sensors/controls already provide a 15-minute option for time delay setting, and some set the factory default at 15 minutes
- The same requirement has been added in the latest update to the national standards (ASHRAE 90.1) – Addendum bd to ASHRAE 90.1-2022
- Possible prevalent false-offs in specific applications and space types if occupant sensing time delay is reduced to 15 minutes
  - Survey stakeholders and practitioners to identify if any applications or space types are susceptible to false-offs

Poll

What else should we know? Are there market or technical barriers we should consider?

Open ended response

Key Energy Modeling Approach and Assumptio

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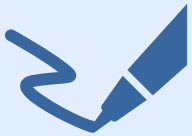
- Spreadsheet-based modeling and analysis framework for the proposed changes
- Generally based on full-load hour reduction estimate and the CEC 2029 construction forecasts

Standard Design

1. Occupant sensing controls in the required space configured with a 20-minute time delay



Proposed Design

1. Occupant sensing controls in the required space configured with a 15-minute time delay

Incremental Cost Framework

Slide NOT shown

Baseline

First Cost

1. Occupancy sensors and controllers capable of 20-minute time delay
2. Programming and commissioning of occupant sensing controls for a 20-minute time delay

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Proposed

First Cost

1. Occupancy sensors and controllers capable of 15-minute time delay
2. Programming and commissioning of occupant sensing controls for a 15-minute time delay

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Key Aspects of Compliance Verification

- Verify and confirm the 15-minute time delay, instead of the current 20-minute time delay
- NRCA form will need to be updated to reflect the new 15-minute time delay
- NRCI form will have to be filled out supporting the new 15-minute time delay
- Should the occupant sensing time delay be documented in the NRCC form?
- No updates are proposed or required for the compliance software

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. The 15-minute time delay could affect the time delays for other systems, e.g. mechanical systems, if the occupancy sensor is used to control systems that are governed by other codes, e.g., mechanical code.	1. Research and ensure occupant sensing time delay requirements in other systems are not affected by the change. 2. Investigate and confirm if there's a functional difference provided in the lighting control systems between the time delay for the system to turn off the light and the time delay for the occupant sensing controls to report or signaling vacancy (to the lighting or other systems).

Submeasure 4: Clarify the Definition and Reduce the Threshold for Requiring Multilevel Lighting Controls

Background, Market Conditions & Technical Considerations

Objective 1: Clarify the definition of multilevel lighting controls in the code language

Objective 2: Update the exception threshold to reflect LED technology

- Multilevel lighting controls and uniformity requirements for luminaires with traditional light sources were removed starting in the 2025 Energy Code cycle
  - Only requirements for LEDs and HIDs remained
  - Exception threshold (0.5 watts per square foot) was still based on the wattage of traditional light sources
- Confusing reference to multilevel lighting controls in other mandatory control requirements in the 2025 code language
  e.g., for daylight responsive controls, "*allow multilevel lighting controls to adjust the light level with continuous dimming*"
  - Is it a manual dimmer?
  - Is it a control capability that provides continuous dimming to enable other control strategies?

Poll

What else should we know? Are there market or technical barriers we should consider?

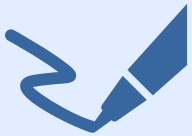
Open ended response

Key Energy Modeling Approach and Assumptions

- Spreadsheet-based modeling and analysis framework

Standard Design

1. No multilevel lighting controls not implemented in spaces with a lighting power density (LPD) 0.5 W/sf or less



Proposed Design

1. Multilevel lighting controls in spaces with an LPD 0.5 W/sf or less but greater than **0.4** W/sf
2. No multilevel lighting controls not implemented in spaces with an LPD **0.4** W/sf or less

Incremental Cost Framework

Slide NOT shown

Baseline

First Cost

1. Luminaires with non-dimmable drivers
2. Manual wall switches
3. Installation and wiring of the wall switches
4. Programming and commissioning of wall switches for on/off controls

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Proposed

First Cost

1. Luminaires with dimming drivers
2. Manual wall dimmers
3. Installation and wiring of the wall dimmers
4. Programming and commissioning of wall dimmers for continuous dimming controls

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Key Aspects of Compliance Verification

- It will ease the burden of documenting on enforcing compliance if it is possible to remove the 100 square foot exception trigger
- Compliance forms –NRCC and NRCI– will need to be updated to reflect changes in the exceptions
- No updates are proposed or required for the compliance software

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. Reducing the LPD threshold for multilevel lighting controls may cause issues in spaces where multilevel lighting is not required (and where non-dimming LEDs would be selected).	1. Engage with stakeholders to identify related situations and use cases, and devise ways to mitigate.

Submeasure 5: Require Continuous Dimming for Daylight Responsive Controls Regardless of Multilevel Lighting Controls Exception

Background, Market Conditions & Technical Considerations

- **Different triggers for multilevel lighting controls and daylight responsive controls**
  - Multilevel lighting controls based on lighting power density (0.5 W/ft^2 exception threshold)
  - Daylight responsive controls based on general lighting wattage (75 Watts exception threshold)

- **Potential to create an awkward situation for spaces if daylight responsive controls are required, but multilevel lighting controls are not**
  - Lighting behavior could confuse and likely upset occupants

- **Continuous dimming is available for most luminaires with no or minimal additional cost**

Poll

What else should we know? Are there market or technical barriers or solutions we should consider?

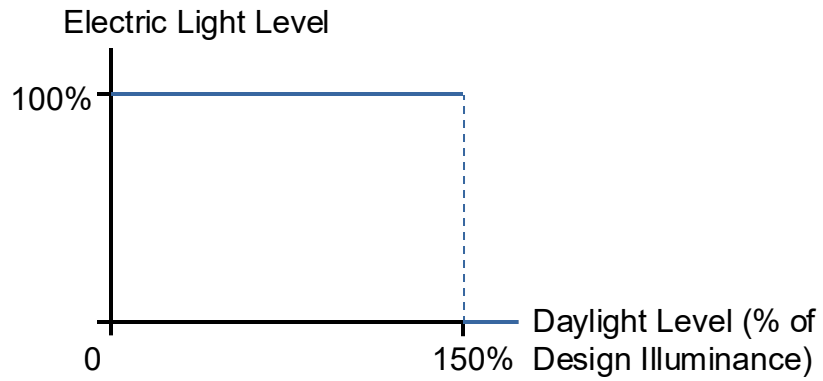
Open ended response

Key Energy Modeling Approach and Assumptions

- Spreadsheet-based modeling and analysis framework
- Build on the approach developed in the 2025 Daylighting CASE Report

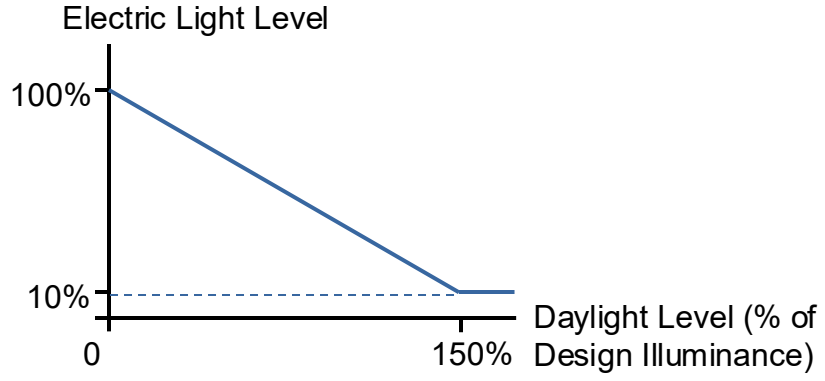
Standard Design

1. No multilevel lighting controls in daylit zones with an LPD of 0.5 W/sf or less
   - On/off for daylight responsive controls



Proposed Design

1. Multilevel lighting controls in daylit zones with an LPD of 0.5 W/sf or less
   - Continuous dimming for daylight-responsive controls



Incremental Cost Framework

Slide NOT shown

Baseline

First Cost

1. Luminaires with non-dimmable drivers
2. Wiring, programming, and commissioning of daylight responsive controls for on/off controls

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Proposed

First Cost

1. Luminaires with dimming drivers
2. Wiring, programming, and commissioning of daylight responsive controls for continuous dimming

30-Year Maintenance Costs

1. No expected routine maintenance or equipment replacement

Key Aspects of Compliance Verification

- Compliance forms–NRCC, NRCI, and NRCA–will need to be updated to reflect the requirement update
- Acceptance test method in the Reference Appendices will need to be updated to remove the test method for daylight responsive controls using step switching
- No updates are proposed or required for the compliance software

Compliance Barriers and Solutions

Compliance Verification Barriers	Potential Solutions
1. There are varying triggers in individual mandatory control requirement sections that are related. Where should the exceptions to multilevel lighting controls be placed, or should there be exceptions at all?	1. Add language to the multilevel lighting controls section to clarify that if daylight responsive controls are triggered, exceptions to multilevel lighting controls do not apply. 2. Remove multilevel lighting controls exceptions altogether if possible.

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More information on
CEC's 2028 proceeding website.

We want to hear from you!

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Energy Modeling Assumptions

Slide NOT shown

Require partial or full OFF occupant sensing controls in more spaces

- Simulating energy savings in EnergyPlus with CBECC rulesets for occupied standby savings
  - Using the following prototypical buildings and climate zones

Prototypical Buildings
▪ Large Office ▪ Medium Office ▪ Small Office ▪ Large Retail ▪ Medium Retail ▪ Mixed-use Retail ▪ Large School ▪ Small School ▪ Non-refrigerated Warehouse ▪ Hotel ▪ Assembly ▪ Hospital ▪ Laboratory ▪ Grocery ▪ Refrigerated Warehouse

Climate Zones
▪ **Simulating in 1 – 16**

Approach for Gathering Costs

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- Cost data will be separately collected and analyzed for each proposed change
- Both first cost and maintenance costs will be based on the additional materials (equipment, devices, cables/wires, etc.) required to implement and sustain the operation of each proposed change
  - Material cost data will be collected through surveys of manufacturers' sales rep agencies and distributors
- The incremental labor costs will be estimated from the extra efforts and hours needed to design, install, program, commission, test, and maintain the equipment and devices required for the proposed changes
  - Primary source will be data collected through outreach to practitioners, including lighting designers, engineers, installation contractors, commissioning providers, system integrators, and acceptance test technicians
  - Secondary/supplementary source will be RSMeans and prevailing wage published by California Department of Industrial Relations
- **Look out for a survey that we will distribute to collect relevant data!**