

Indoor Lighting Power Density



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Acronyms

Table 1 presents a list of acronyms used in this report. Title24stakeholders.com also maintains a [glossary of terms](#).

Table 1: List of Acronyms

Acronym	Definition
ACM	Alternative Calculation Method
ADA	Americans with Disabilities Act
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ATT	Acceptance Test Technician
BCR	Benefit-to-cost Ratio
Btu	British Thermal Units
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CASE	Codes and Standards Enhancement
CBSC	California Building Standards Commission
CBECC	California Building Energy Code Compliance Software
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CBO	Community-Based Organization
CPUC	California Public Utilities Commission
CZ	Climate Zone
DAC	Disadvantaged Community
DGS	California Department of General Services
DOSH	Division of Occupational Safety and Health
ECC	Energy Code Compliance
EIR	Environmental Impact Report
EPIC	Electric Program Investment Charge
ESJ	Environmental and Social Justice
FSOR	Final Statement of Reasons
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
HVAC	Heating, Ventilation, and Air Conditioning
IECC	International Energy Conservation Code
IES	Illuminating Engineering Society
IOU	Investor-Owned Utility

Acronym	Definition
ISOR	Initial Statement of Reasons
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LED	Light Emitting Diode
LPD	Lighting Power Density
LSC	Long-term System Cost
MeasureSET	CASE Measure Savings Estimation Template
MG	Million Gallons of Water
NAICS	North American Industry Classification System
NPDI	Net Private Domestic Investment
PEP	Public Engagement Plan
PV	Present Value
RCR	Room Cavity Ratio
SOC	Standard Occupational Classification
SRIA	Standardized Regulatory Impact Assessment
UL	Underwriters Laboratories
W	Watt

1. Introduction

This is a draft report. The Statewide Codes and Standards Enhancement (CASE) Team encourages readers to provide comments on the proposed code changes and supporting analyses. The CEC will evaluate proposals that the Statewide CASE Team and other stakeholders submit and may revise or reject proposals. More information about the rulemaking schedule and how to participate in the process can be found on CEC's 2028 code cycle website. Suggested revisions will be considered when refining proposals and analyses. The final CASE Report will be submitted to the CEC later in 2026.

For this report, the Statewide CASE Team is requesting input on the following:

- 1. With the advent of programmable drivers, the wattage of drivers can be adjusted not only by the manufacturer but also by other manufacturer approved representatives, such as distributors. How should the maximum wattage be documented for verification during the compliance process?
 - a. Permanent label installed by manufacturer or manufacturer approved representative (to be verified by field inspector compared to NRCI form)*
 - b. Document that certifies the maximum wattage of the luminaire as programmed (to be verified by plans examiner compared to NRCC form)*
 - c. Both label and document**
- 2. Should the revised code allow the calculated luminaire wattage of luminaires with line voltage sockets to be the total wattage of the installed lamps without requiring a luminaire wattage label?*
- 3. What fraction of lighting retrofits today end up replacing the entire luminaire because they are not allowed to get credit for lower wattage lamps based on current 130.0(c) definitions?*
- 4. Are any of the proposed lighting power densities too high or too low? Which ones and what do you recommend as better values?*
- 5. How could the calculation of installed wattage or allowed wattage to be simplified while retaining overall stringency?*
- 6. What is your estimate of LED luminaire efficacy increase over the last six years, as a percentage?*
- 7. What applications are challenging to design within the 2022 Energy Code allowed LPD?*
- 8. Which lighting system type is most impacted by the 2022 Energy Code allowed LPD requirements? i.e., general, decorative, task, etc.*

Email comments and suggestions to info@title24stakeholders.com and info@mchughenergy.com. Comments will not be attributed to their authors unless these are publicly docketed or with permission of the contributor.

1.1 Report Context

This proposal describes specific energy-efficiency code changes (referred to as “measures”) aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California’s Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in CALGreen (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost effective and technically feasible.

The CEC is the state agency authorized to adopt revisions to Title 24, Part 6. One way the Statewide CASE Team participates in the development process is by submitting code change proposals to the CEC for consideration. CEC will evaluate proposals that the Statewide CASE Team and other stakeholders submit and may revise or reject proposals. See the [CEC’s 2028 code cycle website](#) for information about the rulemaking schedule and how to participate in the process.

1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs) — Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison sponsored this effort as a group. Where the term, “Statewide CASE Team” is used in this report, it refers the authors of the CASE report and the Codes & Standards programs of the supporting California Investor-Owned Utilities.

1.3 Stakeholder Engagement to Inform Proposal

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with many industry stakeholders, including manufacturers, utility incentive program managers, and others involved in the code compliance process. The proposal incorporates feedback received during a public stakeholder workshop that the Statewide CASE Team held on

September 24, 2025. During this workshop, the Statewide CASE Team received feedback on the lifetime of drivers and Type A retrofits and answered questions regarding Lamp Lumen Depreciation (LLD) and changing switches after inspection. The Statewide CASE Team also collected information from up to 21 stakeholders through poll questions covering areas such as LLD, Total Light Loss Factor (LLF), ease of compliance, and luminaire wattage labeling. Additional discussion topics during the workshop included compliance pathways for retrofit lighting systems, approaches for verifying luminaire wattage labeling, and the treatment of selectable-output luminaires and lamps in code compliance calculations.

The Statewide CASE Team assembled a focus group of prominent senior lighting design professionals from major design firms to get meaningful insights. The Statewide CASE Team sent a designer/specifier survey document to the focus group to gather information on experiences with Title 24, Part 6, code compliance, LED performance, and the current state of LED development. In addition, the Statewide CASE Team asked the focus group to provide any specific recommendations that they thought might be important to the Statewide CASE Team's proposal.

The focus group is comprised of people from 14 design firms, 10 of which are based in California. The 10 California-based design firms are located throughout the state, mostly in the greater Los Angeles and San Francisco metropolitan areas. Two design firms are located outside California but are well versed in Title 24, Part 6. The Statewide CASE Team initially reached out to the focus group in late November 2025. As of mid-December 2025, six of the 14 designers had responded, so the Statewide CASE Team followed up with the stakeholders. The Statewide CASE Team conducted additional follow up in mid-January 2026 in the hopes of receiving additional input. As noted, the Statewide CASE Team is still engaging with the focus group but has received significant input that is summarized below:

- Compliance with the current version of Title 24 can be challenging. More complex or upscale projects often need to use additional power allowances and adjustment factors to meet code compliance.
- Designers commonly use a lumen depreciation factor of 0.90; a total light loss factor between 0.85 to 0.80 is typical across projects.
- Designers expressed mixed opinions regarding the accuracy of manufacturers' luminaire specification cut-sheet data versus actual luminaire performance.
- Designers also noted that 90 CRI luminaires typically have somewhat lower efficacy than comparable 80 CRI products, although the difference has decreased significantly with newer LED technologies. One respondent estimated the efficacy difference to be approximately 17 percent, while others indicated that the difference varies by product and has narrowed in recent luminaire generations.

- When using multi-tap (multiple wattage) lamps or luminaires, using the highest selectable wattage is fine, and projects can still comply with current LPDs. However, noting the current LPDs have not been updated since the 2022 Title 24, Part 6. If the maximum wattage of a multi-wattage luminaire is too high, projects can instead specify fixed-output luminaires with a lower output that match the required light output. Alternatively, to show code compliance, the design could include a current limiter sub-panel to govern luminaire output wattage—thus, if someone later increased luminaire wattage to a higher setting, the current limiter could shut off power to the circuit until it is within the code allowed wattage. Current limiters have been an allowed compliance path in Title 24 for several code cycles.
- UL Type B or C lamps are used most frequently as retrofit LED lamps. Type A is not typically used; however, some designers noted their clients may use Type A retrofit lamps on maintenance projects. One designer noted they only use UL Type C lamps. In their view, Type A lamps can be less reliable because the luminaire remains subject to ballast and other electrical component failures, whereas Type B presents safety concerns due to line voltage (120 V or 277 V) at lamp¹²

In addition to the focus group, the Statewide CASE Team reached out to a separate group of stakeholders between October 2025 and January 2026 to gather input on LED retrofit practices, installation costs, and operational considerations for Title 24 updates. This group consisted of one manufacturer, three manufacturer representatives, one manufacturer association, and one university. To date, the Statewide CASE Team has heard back from multiple stakeholders and incorporated their insights into the analysis:

- The three manufacturer representatives were contacted in October 2025, with one acknowledging receipt received, but no survey responses have been received to date. Follow-up outreach is planned to reach more than 50 manufacturers collectively represented by these firms.
- The university’s facilities team provided feedback between September and December 2025. Responses included:
 - Type A (plug-and-play) LED retrofits are widely used due to cost and funding flexibility, while Type B (ballast bypass) retrofits are not allowed for safety reasons.

² It is important to note that these UL Type B safety concerns reflect the opinion of an individual designer only. Any determination regarding safety would require documented evidence demonstrating that UL protections and applicable listing requirements are insufficient.

- Labor costs vary by project size, with in-house electricians for smaller projects and contractors for larger ones. Night and weekend work for minimal occupant disruption increases labor costs.
- Maintenance challenges exist with Type A systems, including shorter-than-expected driver lifetimes (3–5 years in some cases) and discontinued tracking of lamp/ballast combinations.
- UL Type C retrofits (lamp plus driver) are preferred for long life, but this facility team has experienced early driver failures compared to the warranty period.
- Policy guidance should support practical, cost-effective transitions from fluorescent to LED systems without imposing barriers that reduce adoption.
- The Statewide CASE Team had preliminary engagement with one manufacturer who provided feedback as of February 12, 2026, whose responses included:
 - The manufacturer indicated that higher-efficacy luminaires typically achieve improved performance by using more LEDs operating at lower drive currents, and in some cases additional LED boards, allowing the same lumen output at lower wattage.
 - The manufacturer noted that higher-efficacy product variants generally involve only a small incremental cost increase compared to standard-efficacy models.
 - According to the manufacturer, higher-efficacy luminaires do not introduce significant performance trade-offs, as they use the same core components with modified LED configurations.
 - The manufacturer reported no significant supply chain or lead-time constraints that would limit broader adoption of higher-efficacy luminaires if required by energy codes.
 - The manufacturer indicated that higher-efficacy luminaires currently represent a relatively small share of overall product sales, reflecting current market demand rather than technology limitations.
- A manufacturer association was contacted in December 2025, and its members were solicited for input. Themes from four respondents included:
 - **UL Type availability and use:** Respondents reported offering and supporting all UL Types (A, B, C, and hybrids), with a strong interest in maintaining plug-and-play (Type A) options for retrofit markets due to cost, installation speed, and customer preference.
 - **Performance and compliance UL Type A concerns:** Two stakeholders noted that ballast age, configuration, and rated versus actual operating

power can materially affect energy performance, creating challenges for consistent compliance and energy accounting. Two stakeholders favored rating UL Type A configurations based on the ballast's maximum wattage rating.

- **Multi-wattage product compliance:** Most respondents favored rating lamps and luminaires at the highest wattage option to preserve future flexibility and reduce fixture waste; several cautioned against break-off tabs or DIP switch handles due to risk of accidental damage and product disposal.
- **Labeling preferences:** Opinions were mixed between lamp-based labeling, field-installed luminaire labels, and flexible approaches. Multiple respondents expressed concern that labels intended for field-installation are often overlooked or discarded during installation.
- **Label confirmation timing:** There was general support for label confirmation at both plan check and inspection to address field changes and prevent higher-wattage substitutions after approval.

See Appendix F for additional details on the Statewide CASE Team's stakeholder engagement. See *Section 2.4.4 Summary of Stakeholder Comments* for a summary, for an explanation of how the stakeholder input informed the LPD analysis. See *Section 2.5.4 Summary of Stakeholder Comments on Luminaire Wattage*, for a summary of how the stakeholder feedback were used to inform luminaire classification and wattage rating.

A more detailed description of the questions asked of stakeholders and a summary of their responses are contained in Appendix F.

2. Measure Description

2.1 Proposed Code Change

This code change proposal aims to update the prescriptive requirements on lighting power density (LPD) for nonresidential indoor spaces. The LPD requirements dictate the maximum lighting power allowed in each building type or space type within a building. The LPD requirements in 2025 Title 24, Part 6, Section 140.6 will be the base case, and the proposed case has lower LPD values than the base case although this varies by building and area type. A lower LPD value means that the same maintained level of illumination in a building or an area would be provided while using less lighting power.

The proposed LPD update is based on the following four factors:

1. **Advancements in LED technology** since the 2022 code cycle have resulted in higher maintained luminous efficacies for light sources.
2. **Updated industry practices for lamp lumen depreciation.** Market information on LED products having a 90 percent lamp lumen depreciation (LLD) at an expected life of 50,000 hours is broadly being used in lighting design and is used for calculating reduced LPD requirements in the most recent national model energy codes (ASHRAE 90.1-2025 and the 2027 version IECC). Initial research by the Statewide CASE Team has supported these assumptions.
3. **Alignment with national lighting design standards.** The LPD requirements in Title 24, Part 6 are based upon meeting or exceeding the maintained illuminance recommendations of the Illuminating Engineering Society (IES) contained in either the IES Illuminance Selector or the pertinent current Recommended Practice (RP) by application type.
4. **Alignment with national energy standards.** Lighting power information developed for the national model energy efficiency codes is also compared and considered when developing the updated Title 24, part 6 LPD values. This comparison also forms part of the consideration to add new space types.

Furthermore, to ensure consistent and accurate determination of installed lighting power, the proposal includes updated guidance for luminaire classification and power in Section 130.0(c) to more closely align with national model codes and reflect changes to lighting technology. The four primary changes recommended for luminaire classification and power are:

1. Allow the wattage of a luminaire with line voltage sockets to be the combined wattage of lamps that are installed in the luminaire.

2. For multi-wattage lamps or luminaires to be the maximum field-adjustable wattage that is possible after installation, without removing the luminaire from its installed location.
3. Limit the use of LEDs that are installed downstream of a fluorescent or HID (high intensity discharge, high pressure sodium, or metal halide) ballast by treating the wattage of the ballasts and LED combination as the wattage of the ballast when it was driving the legacy fluorescent or HID light source.
4. Allow the use of current limiters for any adjustable wattage lighting technology installed wattage.

In addition, the proposal aims to simplify the indoor lighting alteration provisions by replacing the current 5,000 ft² floor-area limitation for one-to-one luminaire alterations with a cap on the total wattage of altered luminaires. Under the proposed change, the simplified alteration pathway would apply where the total wattage of altered luminaires does not exceed 3,000 watts and the alteration reduces lighting wattage by at least 40 percent relative to the pre-alteration condition. This change maintains comparable stringency while eliminating the need to determine room or tenant space floor area to demonstrate eligibility for the simplified compliance pathway.

The revised LPD requirements do not vary by climate zone and will apply to new construction, additions, and alterations. No changes to the compliance process are anticipated. While no structural or formatting change to the compliance software and documents are expected, the LPD values built into them would need to be updated to reflect the revision.

Table 2 summarizes the scope of the proposed code change.

Table 2: Scope of Proposed Code Change

A indicates the proposed code change is relevant.

Building Type(s)		Construction Type(s)		Type of Change	
<input type="checkbox"/> Single Family		<input checked="" type="checkbox"/> New Construction		<input checked="" type="checkbox"/> Mandatory	
<input type="checkbox"/> Multifamily		<input checked="" type="checkbox"/> Additions		<input checked="" type="checkbox"/> Prescriptive	
<input checked="" type="checkbox"/> Nonresidential (Not Group R uses)		<input checked="" type="checkbox"/> Alterations		<input checked="" type="checkbox"/> Performance	
Application Climate Zones	Energy Code Sections	Compliance Forms		Sections of ACM Reference Manuals	
Climate Zones 1-16	Part 6, Section 130.0(c), 140.6, 141.0	NRCC-LTI-E, LMCC-LTI-E and NRCC/LMCC-PRF-E		Prescriptive	

Third Party Verification)	Updates to Compliance Software
<input checked="" type="checkbox"/> No changes to third party verification	<input type="checkbox"/> No updates
<input type="checkbox"/> Update existing verification requirements	<input checked="" type="checkbox"/> Update existing feature
<input type="checkbox"/> Add new verification requirements	<input type="checkbox"/> Add new feature

2.2 Benefits of Proposed Change

High-efficiency light sources are now widespread, and updating LPD requirements in Title 24, Part 6 ensures that new and altered buildings reflect these advancements. By revising LPDs to reflect the latest recommended practices from the Illuminating Engineering Society (IES) and appropriate illumination levels, this code change maximizes energy savings while supporting the continued effectiveness and modernization of California’s lighting market (Illuminating Engineering Society 2025).

These updates are grounded in multiple improvements:

1. Adoption of updated IES standards,
2. Refined mappings of primary function areas to task requirements,
3. Updated luminaire zonal lumen distributions added to the Inverse Lumen Method model, and
4. Updated luminaire data reflecting current design practice and higher maintained efficacy.

Updating LPDs directly impacts energy savings and maintains the efficient design features of compliant lighting designs while using high-efficacy light sources. The Nonresidential ACM Reference Manual relies on LPDs as a baseline for energy modeling. If lighting efficacy increases but LPDs remain fixed, designs may install less power than allowed, potentially shifting inefficiencies to other building systems such as HVAC or envelope components. Revising LPDs would ensure that lighting designs continue to meet recommended illuminances with current commercially available efficacies, maintaining the stringency and effectiveness of Title 24, Part 6 over time.

These updates would also support broader market and policy goals. Efficient, well-designed lighting reduces building energy use and occupant energy bills, simplifies compliance for designers and code officials, and drives market transformation toward higher-performing luminaires.

By integrating current technologies, good design practices, and updated standards, this code change would reinforce California’s leadership in energy efficiency and ensure future building designs maximize performance, sustainability, and affordability.

2.3 Background Information

2.3.1 Lighting Power Density

Over the past three decades, lighting technology has advanced significantly, particularly with the widespread adoption of light-emitting diodes (LEDs). These high-efficiency light sources have steadily increased in maintained efficacy, producing more light for the same amount of electricity. As a result, the LPD values in Title 24, Part 6 have been updated in previous code cycles to reflect these improvements. Prior to the 2019 code cycle, the allowable LPDs in Section 140.6 were based on a mix of older technologies, including fluorescent, metal halide, and infrared-reflecting halogen lamps. These traditional sources had lower efficacy and limited control over light distribution, which restricted energy savings potential.

The 2019 update of indoor LPD requirements represented a significant shift in approach. The standards moved from legacy lighting technologies to LEDs as the baseline. LEDs not only offer higher efficacy but are also typically dimmable, and have more controllable light distribution. These characteristics allow for higher optical efficiency, directing light precisely where it is needed. As a result, the 2019 revision of Title 24, Part 6 significantly reduced allowable LPDs, ensuring energy savings while maintaining appropriate illumination levels for building occupants. Updates in the 2022 revision of Title 24, Part 6, continued to reduce allowable LPDs in appropriate space types. The Title 24 Standard; however, the tailored lighting method was removed, and its LPD values were incorporated into the area category method.

The Statewide CASE Team's review of LPD requirements in national standards (2025 ASHRAE 90.1) and other model codes (2024 IECC) shows that for certain space types, the LPD values in these national and model codes are already lower than the values in the 2025 Title 24, Part 6. The IECC proposed general lighting values are identical to those adopted in ASHRAE 90.1-2025 for the Space-by-Space Method and for the Building Area Method.

The lighting designers on the lighting and power subcommittee to ASHRAE 90.1 agreed that they use a lamp lumen depreciation factor of 90 percent for designing lighting systems. This higher lamp lumen depreciation (less light loss) resulted in lower LPDs in the ASHRAE 90.1 lighting model and resulted in lower LPDs in the Space-by-Space Method and the Building Area Method. A lighting designer on the Statewide CASE Team interviewed lighting manufacturers and their representatives and confirmed that a 90 percent lamp lumen depreciation at 50,000 hours is a reasonable value and that the equipment cut-sheets do not always represent the lamp lumen depreciation of latest products. In prior technical models for ASHRAE 90.1 and Title 24, manufacturers' reported data were used, resulting in LPDs that were 6.4 percent higher due to this factor alone.

California is experiencing a rapid growth of data center construction to support cloud computing and artificial intelligence. Current Title 24 requirements do not explicitly address LPDs for data centers and their spaces. Updating LPDs for these building types will help ensure that illumination services are delivered efficiently while supporting broader energy-savings goals.

2.3.2 Luminaire Classification

Indoor lighting compliance under Title 24 is determined by comparing the Adjusted Indoor Lighting Power, calculated according to Section 140.6(a), to the Allowed Indoor Lighting Power in Section 140.6(b) and 140.6(c). The Allowed Indoor Lighting Power is based on LPD values in Table 140.6-B (Complete Building Method) and Table 140.6-C (Area Category Method). The Adjusted Indoor Lighting Power is derived from the total installed wattage of luminaires as defined in Section 130.0(c) (“Luminaire classification and power”) and modified by various exclusions and adjustments.

While this proposal would not change Section 140.6(a), it does propose updates to Section 130.0(c) to better align with recent guidance on defining installed wattage, including methods adopted in ASHRAE 90.1-2022 Addendum (ASHRAE 2025). These changes would ensure that installed lighting power is accurately described and increase flexibility to comply with the Title 24 lighting standards with the latest lighting technologies.

The proposed updates to Section 130.0(c) include:

- **New requirements for field-adjustable solid-state lighting (SSL) luminaires**

Wattage must now reflect the highest output setting available from the manufacturer or manufacturer approved representative. The chosen maximum wattage must be marked on a permanent label installed by the manufacturer or their authorized representative. This ensures that installed wattage accounts for the full operational capability of field-adjustable products.

- **Revised wattage determination for luminaires with line-voltage lamp holders**

Instead of defaulting to the luminaire’s maximum relamping wattage, wattage is now based on the installed lamp or SSL light engine. This aligns the rules with ASHRAE practices and provides a more accurate reflection of actual installed power.

- **Clarification on wattage determination for SSL luminaires using legacy ballasts**

The proposed language explicitly addresses luminaires in which SSL is powered by high-intensity discharge (HID) or fluorescent ballasts. If adopted, the proposed language would establish that the reported wattage must be based on the

maximum rated wattage of the ballast. This ensures a conservative and consistent method for power calculations when legacy ballasts remain in place.

These proposed updates have implications for linear LED lamps, including UL Type A, Type B, and Type C architectures.

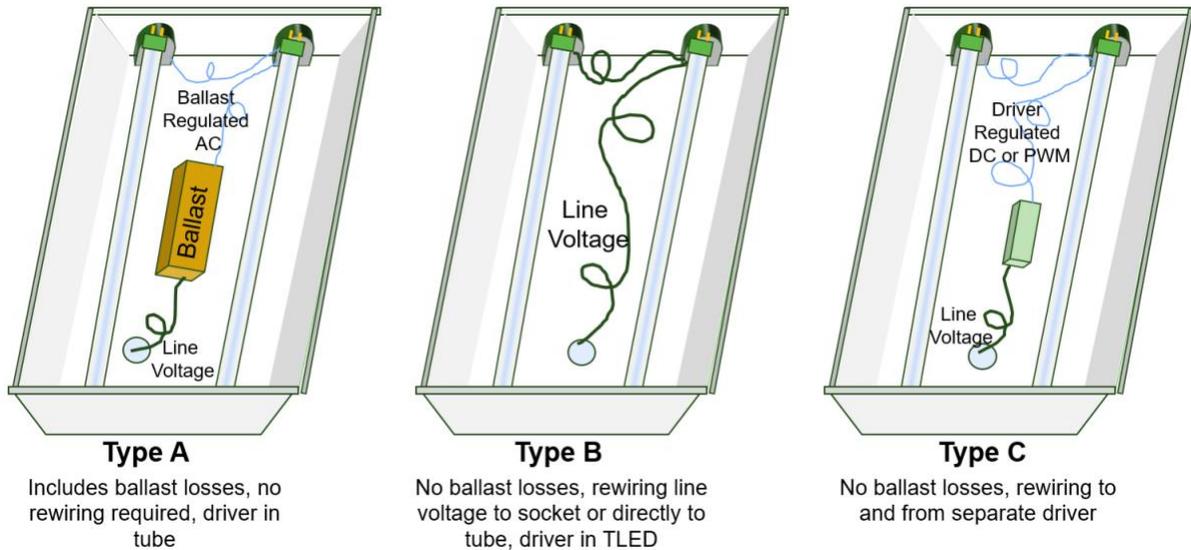


Figure 1: Three types of linear LED lamps

- **UL Type A (fluorescent ballast-compatible lamps):**
UL Type A products rely on an existing fluorescent ballast. Under the proposed language, these systems are explicitly covered by Section 130.0c(3). Installed wattage for compliance purposes must be based on the maximum rated wattage of the ballast, regardless of the lower rated wattage of the SSL lamp itself. This may result in higher reported installed wattage compared to SSL-only systems.
- **UL Type B (ballast-bypass, line-voltage lamps):**
Under the current Energy Code and proposed updates, UL Type B lamps fall under the line-voltage lamp-holder provisions. Installed wattage will be based directly on the lamp's labeled wattage or driver-integrated SSL light engine rating, rather than any historical fluorescent lamp rating.
- **UL Type C (remote-driver systems):**
UL Type C systems operate the same as SSL luminaires with dedicated drivers. Under the current and proposed Section 130.0(c), UL Type C systems must use the maximum rated input wattage of the driver/lamp combination and may be subject to the expanded SSL labeling requirements.

2.3.3 Simplification of One-to-One Luminaire Alteration Pathway

Under the current requirement in Section 141.0(b)2I, the one-to-one luminaire alteration pathway is limited to alterations within spaces of 5,000 ft² or less. Determining eligibility therefore requires calculating the floor area of the affected space or tenant area, which can require additional documentation or drawings and therefore increase compliance complexity for relatively small retrofit projects.

To maintain comparable stringency while simplifying compliance, the proposed language replaces the floor-area limit with a cap on the total wattage of altered luminaires. The simplified pathway would apply only where the total wattage of all altered luminaires do not exceed 3,000 watts and where the alteration reduces lighting wattage by at least 40 percent compared to the pre-alteration condition.

The 3,000-watt threshold is derived from typical legacy lighting conditions. Assuming a legacy lighting power density of approximately one watt per square foot, a 5,000-ft² space would have approximately 5,000 watts of installed lighting. A 40 percent reduction results in approximately 3,000 watts of post-alteration lighting load. Anecdotally, this corresponds roughly to a retrofit involving about 100 luminaires at 30 watts each, representing a substantial lighting upgrade while remaining consistent with the scale of projects intended for the simplified pathway.

By using a wattage threshold rather than a floor-area limit, the proposed change preserves the intended scope of the simplified alteration pathway while eliminating the need to calculate room size or provide supporting plans, thereby reducing compliance burden without materially reducing energy savings.

2.4 Technical Basis of Lighting Power Densities

The maximum allowed lighting power densities are developed based on multiple layers of analysis, comparison and review. These can be summarized as follows.

- **Technical model.** This model uses a lumen method calculation to approximate the required lighting power density to light prototypical spaces to maintained light levels recommended by the Illuminating Engineering Society in their Lighting Selector or appropriate Recommended Practice. These models contain assumptions about geometry, reflectances, and types of lighting systems to generate a calculated W/sf.
- **Interviews with market participants on current design features and current lighting power densities.** This also includes feedback from stakeholders, and solicited comments from recognized experts in the lighting design community.

- **Comparison with Title 24, compliance documentation databases.** These databases summarize the lighting power density for different building types and space types.

2.4.1 Technical Model for Calculating LPDs

Most LPDs in previous iterations of ASHRAE standards and Title 24, Part 6 iterations were based on versions of the Inverse Lumen Method calculation, a simplified lighting calculation that’s been used since the early 1900s, and is documented in the IES Handbook and other publications. An advantage of the Inverse Lumen Method is its simplicity and transparency; all the inputs can be entered into a spreadsheet, simplifying review. The Inverse Lumen Method is based on a simplified model that calculates the allowable lighting power needed to deliver a targeted design illuminance. This works well based on far-field photometric measurements of luminaires and in rooms that are open rectangular boxes without too much intervening furniture, partitions, or stacks. As spaces deviate from these assumptions, one can use more exacting models that use the radiosity calculation approach. The radiosity calculation approach was used³in the prior code cycle for large offices with systems furniture, library stacks, and warehouse areas with racks.^[OBJ] For this proposal, new detailed models were not conducted. Instead, the Statewide CASE Team utilized the previously calculated radiosity calculation models and scaled those using luminaire efficacy.

The updates to LPDs proposed for the 2028 Title 24, Part 6 Standards are based on this same method. The Statewide CASE Team reviewed and refined these calculation results, drawing on their professional experience to ensure accuracy and relevance.

2.4.1.1 Derivation of Inverse Lumen Method

The average maintained illuminance (luminous flux density), $\dot{E}_{\text{maintained}}$, (in units of FC or lux in SI units) in a space is calculated by the following Lumen Method equation:⁴

$$\dot{E}_{\text{maintained}} = \frac{(\text{no. luminaires}) \left(\frac{\text{lamps}}{\text{luminaire}} \right) (\text{lamp lumens})(CU)(LLF)}{\text{workplane area}}$$

Where,

CU = coefficient of utilization, or fraction of lumens from light sources that reaches the work plane directly or via interreflections. This is a function of luminance distribution of the luminaire, the geometry of the space (as described by the Room Cavity Ratio (RCR)), and the reflectance of the ceiling, walls, and floor of

³ <https://title24stakeholders.com/measures/cycle-2022/nonresidential-indoor-lighting/>

⁴ Illumination Engineering Society (IES).2011. The Lighting Handbook 10th edition. Equation 10.30.

the space. CUs are commonly provided by luminaire manufacturers in a table format with respect to the RCR, for standard room surface reflectances.

Historically, the Statewide CASE Team relied on lookup tables for CU values. Beginning with the 2022 version, however, the LPD model has used an Excel User-Defined Function to calculate directly from the space geometry, surface reflectances, and the zonal lumen distribution of the luminaires. The Excel User – Define Function enables the State CASE Team to create a custom Visual Basic function in Excel that performs these calculations directly, eliminating the need for lookup tables. This approach results in a more efficient and lightweight spreadsheet. The Statewide CASE Team collected IES photometric files for all luminaires of interest and extracted the zonal lumens for each file using the Lighting Analysts Photometric Toolbox software.

LLF = the product of recoverable and non-recoverable light loss factors. Recoverable light loss factors are the product of lamp lumen depreciation or reduced light source output due to aging; luminaire dirt depreciation, or reduced optical efficiency due to dirt buildup on the luminaire and its elements; and room surface dirt depreciation, or the decrease of reflected light in the space due to dirt reducing the reflectances of surfaces. Non-recoverable light-loss factors include ballast, thermal, and equipment operating factors (such as lamp operating position).

For integral LED luminaires, this equation differs slightly. The LED’s light output is significantly impacted by its temperature, which, in turn, is a function of the thermal performance of the luminaire in rejecting heat. As a result, the IES LM-79 test method for measuring the light output of solid-state lighting products measures the entire luminaire’s output. The equation for integral LED luminaires can more accurately be described as follows:

$$\dot{E}_{maintained,LED} = \frac{(no. luminaires)(luminaire lumens)(CU)(LLF)}{workplane area}$$

Where luminaire lumens represent the lumens leaving the luminaire and account for both the thermal effects of a luminaire and its optical efficiency. As a result, the same luminaire tested with an integral LED would have a higher CU than one with fluorescent lamps. This is because the CU for LEDs represents the fraction of light leaving the luminaire (after luminaire optical losses) that reaches the work plane, whereas the CU for the same fixture fitted with fluorescent lamps represents the light leaving the lamps that reaches the work plane.

The total maintained lumens (luminous flux) delivered to the space, $\Phi_{\text{maint, delivered}}$, is found by multiplying the maintained illuminance, $\dot{E}_{\text{maintained}}$, by the areas of the work plane.

$$\Phi_{\text{maint,delivered}} = \dot{E}_{\text{maintained}} \times \text{workplane area}[\text{Lumens}]$$

$$\Phi_{\text{maint,delivered LED}} = (\text{no. luminaires})(\text{luminaire lumens})(CU)(LLF) [\text{Lumens}]$$

The maintained delivered luminous efficacy, $K_{\text{maint,delivered}}$, of a given lighting system in a given space having a particular geometry (RCR) and surface reflectances is as follows:

$$K_{\text{Maint,delivered}} = \frac{\Phi_{\text{maint,delivered}}}{\text{Total Input Watt}} [\text{Lumens/Watt}]$$

For the 2022 Title 24, Part 6 update, the Statewide CASE Team developed a database of 68 luminaires based on the averaged results of 488 source luminaires. This database includes:

- Appendix A: Luminaire description
- Appendix B:** Luminaire lumens
- Appendix C: Input watts (from which luminous efficacy can be calculated)
- Appendix D: Zonal lumens for each 10-degree increment vertical angle, normalized to 1,000 lumens per luminaire to allow averaging across luminaires with different total lumen output
- Appendix E: CIE Classification (Direct to Indirect) calculated from zonal lumen description

Lumen depreciation will be estimated per luminaire type based on multiple interviews and comparisons between product literature to best estimate the actual lamp lumen depreciation. It will build on the ASHRAE 90.1 precedent of using the 90 percent lamp-lumen depreciation, unless a more robust estimate is found.

From these components, maintained, delivered luminous efficacies, and $K_{\text{maint,delivered}}$ are calculated. This proposal added higher-performing luminaires to this database and modified the light loss factors to best represent the performance of the equipment’s performance over its expected life and maintenance schedule.

For a space having a design illuminance, E_{design} , with a given RCR, and being illuminated by a lighting system with a maintained delivered luminous efficacy, $K_{\text{maint,delivered}}$, the LPD for the space is:

$$LPD_{design} [W/ft^2] = \frac{E_{Design} [lm/ft^2]}{K_{Maint,delivered} [lm/W]} \times Space\ Fraction [no\ units]$$

Where the space fraction indicates what fraction of the space area is being illuminated to a given design illuminance (FC) value.

A given space can have an area-weighted LPD where part of the space is illuminated by one lighting system type and other parts are illuminated by other system types with different efficacies.

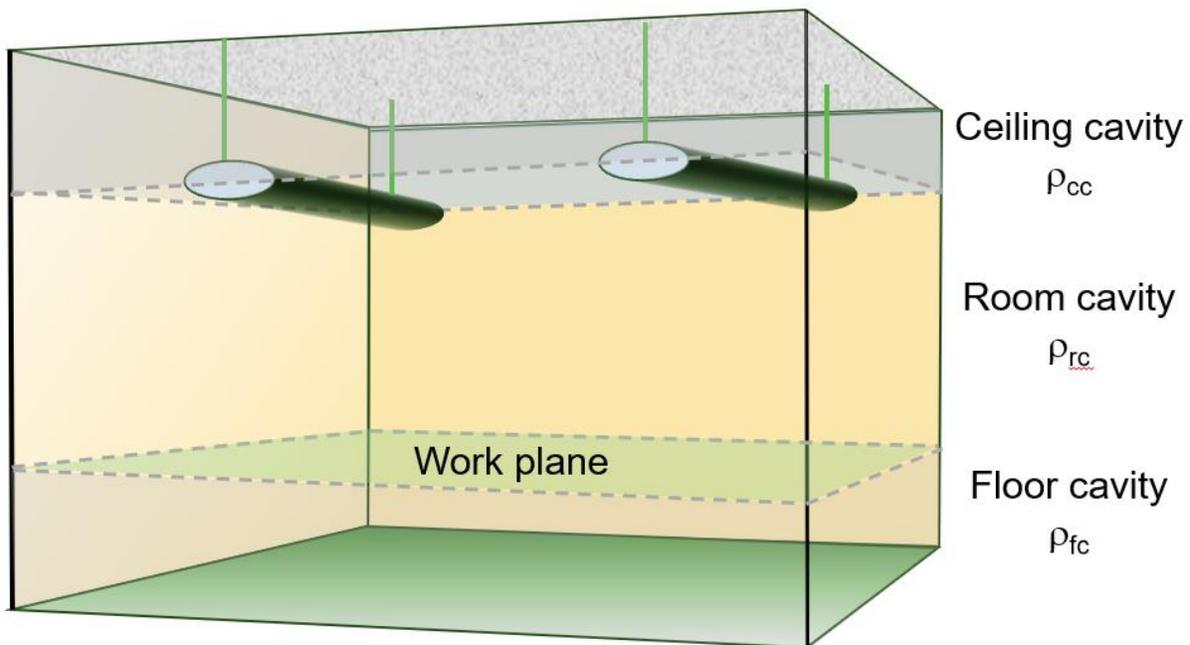


Figure 2: Schematic of sample space light transfer simulated using the Inverse Lumen Method

In the past, CUs were provided for each luminaire type at various room cavity ratios in increments of factors of 2 from 2 to 10. Typically, this was for one set of reflectances 70 percent ceiling, 50 percent wall, and 20 percent floor for most fixtures but for industrial fixtures it was 50 percent ceiling, 30 percent wall, and 20 percent floor reflectances. Starting with the CASE proposal for LPD for the 2022 standards, a spreadsheet user-defined function calculates the coefficient of utilization for any room cavity ratio (any orthogonal geometry) and any reflectances of the ceiling, walls or floor cavities.

This allows a more accurate estimate of the luminaire lumens needed to illuminate the space to a given design illuminance, regardless of room geometry or surface reflectances.

2.4.1.2 Wall Wash Calculation Method

Wall wash luminaires are asymmetric or directional luminaires designed to light wall surfaces, increasing the brightness rather than providing horizontal illuminance on the work plane. As a result, the power required for wall washing to achieve a given average illuminance is not directly calculable using the Lumen Method. Starting in the 2019 Indoor Lighting Power Densities report, the Statewide CASE Team developed an approach to calculate wall-washing power densities per square foot of floor area. This approach requires detailed radiosity simulation of prototypical spaces and normalizing the results for special application of the Inverse Lumen Method. There are two primary outputs for this method:

1. The amount of power required to illuminate the wall areas of the space to a given average vertical illuminance and normalized to an LPD per square foot of floor area.
2. The amount of general lighting power displaced from reflected or “spill” light from the illuminated walls, normalized to negative LPD per square foot of floor area.

The calculations below make use of more complex radiosity calculations (in this case the Statewide CASE Team used the AGi32 software) to quantify these specific lighting and power characteristics of each wall washing luminaire modeled:

P_{WallWash} = Wall wash lighting power, in watts

$\text{Area}_{\text{wall}}$ = Area of vertical wall being illuminated, ft²

$E_{\text{v,wall}}$ = Average illuminance of vertical wall, foot candles

WHF = Fraction of wall height inward from wall for horizontal floor illuminance measurements, dimensionless

$E_{\text{H,floor}}$ = Average horizontal illuminance of floor plane within the fraction of wall height inward from the wall illuminated by wall wash luminaires, foot candles

The sample spaces are modeled with only the wall illuminated by evenly spaced wall-wash luminaires. The luminaire models include light-loss factors so that calculated footcandles represent maintained illuminance values. Rooms with walls heights of 12 feet or less have a WHF of 50 percent, whereas spaces with taller walls have a WHF of either 25 percent or 33 percent. Horizontal illuminances is calculated at floor levels because wall-wash lighting displaces circulation lighting, which typically has its design illuminance defined at the floor level. Wall reflectances are varied so that one can accurately model the amount of reflected light, reducing the need for separate general lighting.

For each room type modeled in the Title 24, Part 6 Lumen Method spreadsheet, a geometry is specified. For the purposes of the wall washing calculation the RCR of the

space is defined as the full height RCR where the mounting height is at the ceiling levels and the horizontal work plane is at floor level.

$$RCR = \frac{5 \times height \times (Width + Length)}{Width \times Length} = \frac{2.5 \times Perimeter\ Wall\ Area}{Floor\ Area}$$

$$\frac{Area_{Wall}}{Area_{Floor}} = \frac{RCR}{2.5} = 0.4 \times RCR$$

Where,

AreaWall = area of all the walls of the room (ft²)

AreaFloor = floor area of the room (ft²)

The RCR is directly proportional to the ratio of wall area to floor area. This is a simple conversion of wall washing W/ft² of wall area to W/ft² of floor area. It should be noted that the heights used for RCR in the wall washing calculation are the heights of the room from the floor to luminaires (these were all mounted at ceiling level) and not the heights of the cavity between the mounting height of the luminaires and the work plane. As a result, there is a separate RCR calculated for use in the wall washing calculation.

LPDs (W/ft² of floor area) can be calculated using the RCR of a given space to convert the W/ft² of wall areas needed to wall wash all the perimeter walls in a room to given illuminance level. An LPD_{Wall Wash} adder accounts for wall washing all the walls in a given room.

$$LPD_{Wall\ Wash}[W/sf\ floor\ area] = \frac{P_{WallWash}}{Area_{Floor}} = \frac{P_{WallWash}}{Area_{Wall}} \times \frac{Area_{Wall}}{Area_{Floor}}$$

$$LPD_{Wall\ Wash}[W/sf\ floor\ area] = \frac{P_{WallWash}}{Area_{Wall}} \times 0.4 \times RCR$$

Where,

P_{WallWash} = Power for wall washing, Watts

This approach assumes that the wall washing watts needed would be linearly proportional to wall illuminance levels and wall area. Some adjustment is needed for tall wall heights, because wall washing luminaires for these applications are typically higher output and may have different efficacies. In addition, the ratio of average illuminance to total lumens may differ for tall walls. Thus, specific luminaires are specified for tall wall heights.

The required power for wall washing, P_{WallWash}, and the area of the wall, A_{Wall}, are inputs for a given detailed (radiosity) simulation. Additionally, a light loss factor is applied to the radiosity simulation so that the luminous flux output of the simulated luminaires is

reduced to represent their maintained light output at the end of the 15-year period of analysis. The results from AGI simulations of the average vertical illuminance on the wall, $E_{v,wall}$, are multiplied by the area of the wall to yield the total maintained lumens (luminous flux) delivered to the wall, $\Phi_{main,v,wall}$. Dividing the maintained lumens delivered to the wall by the power for wall washing yields the maintained delivered luminous efficacy of the wall washing luminaires, $K_{maint,wall}$. This luminous efficacy value is significantly less than the luminous efficacy of the luminaire itself because some of the light emitted from the luminaire is lost to spill, interreflections, and other surfaces other than the wall.

The maintained delivered luminous efficacy, $K_{maint,wall}$, of a given lighting system located in a space with a particular geometry (RCR) and surface reflectances is represented by the following:

$$K_{Maint,Wall} = \frac{\Phi_{maint,v,Wall}}{P_{WallWash}} = \frac{E_{v,wall} \times A_{Wall}}{P_{WallWash}} [\text{Lumens/Watt}]$$

LPD per square foot of wall area required to light the wall to target average illuminance can be calculated by rearranging the formula:

$$\frac{P_{WallWash}}{A_{Wall}} = \frac{E_{v,wall}}{K_{Maint,Wall}}$$

As described earlier, the LPD to wall wash all perimeter wall areas in units of Watts per square foot of wall area, can be converted to a LPD unit of Watts per square foot of floor area, by multiplying the wall wash LPD by 0.4 times RCR. Combining the equation for calculating the wall LPD from design vertical illuminance and delivered, maintained efficacy and the equation to convert from a wall power density to a floor power density is given below.

$$LPD_{Wall Wash} = \frac{E_{v,wall}}{K_{Maint,Wall}} \times 0.4 \times RCR [\text{W/ft}^2 \text{ of floor area}]$$

Often wall washing is conducted on a portion of the walls; the following equation proportionately reduces the LPD for wall washing in units of watts per square foot of floor area.

$$LPD_{Wall Wash} = WallFraction \times \frac{E_{v,wall}}{K_{Maint,Wall}} \times 0.4 \times RCR [\text{W/ft}^2 \text{ of floor area}]$$

Where,

WallFraction = fraction of the wall that is illuminated with wall washing luminaires.

This is a variable (selected by the user), and is similar to the SpaceFraction variable- which is the fraction of the floor area illuminated by the other lighting systems (see prior section on Inverse Lumen Method).

In addition to wall washing increasing the LPD for illuminating walls, the presence of wall washing luminaires provides spill light that displaces some of the luminaires needed for general lighting. This is commonly seen in many designs, where the last row of luminaires for general lighting are replaced with wall washing luminaires that provide both wall washing and general lighting.

As previously mentioned, the average horizontal FC on the work plane at the finish floor level was extracted for the room area that is within a defined distance from the wall illuminated by the simulated wall washer. This defined distance is the wall height multiplied by the wall height fraction, WHF. The ratio of average horizontal illuminance on the work plane to the average vertical illuminance on the wall, $R_{HtoV,L}$, was calculated for each detailed prototype space simulation and averaged for each luminaire type evaluated. This becomes a characteristic of the luminaire type, which varies more between luminaires than within the simulation of the same luminaire type for different space geometries.

The average horizontal illuminance within the defined fraction of the wall-height distance from the wall, E_H , can be calculated for a wall washing system that has a target design average vertical illuminance on the wall, $E_{Wall,Design}$, as follows:

$$E_H = E_{Wall,Design} \times R_{HtoV,L}$$

The fraction of general lighting illuminance (and wattage) that is displaced by spill light from wall washing, the wall height fraction in from walls, FGI_{Spill} , is given by the following equation:

$$FGI_{Spill} = \min \left[1, \frac{(E_{Wall,Design} \times R_{HtoV,L})}{E_{Floor,Design}} \right]$$

Where,

$E_{Wall,Design}$ = Design (target) illuminance for wall washing (FC)

$E_{Floor,Design}$ = Design (target) general lighting floor illuminance (FC)

The equation is capped at 1 so that no more light or power than is used for providing general lighting for the floor is displaced.

As described earlier, the ratio of total perimeter wall area to floor area is given by the following:

$$\frac{Area_{Wall}}{Area_{Floor}} = \frac{RCR}{2.5} = 0.4 \times RCR$$

However, the floor area simulated for receiving horizontal spill light from the wall washers is: the wall height fraction multiplied by the wall height (inwards, from the base of the walls). When all walls are illuminated by wall washing, the fraction of floor area where horizontal general lighting is displaced, FFA_{Spill} , is given by the following:

$$FFA_{Spill} = WHF \times 0.4 \times RCR$$

WHF is the fraction of wall height inward from wall for horizontal floor illuminance measurements and is 50 percent of the wall height for most walls. However, for walls taller than 12 feet WHF is 25 percent. For evaluating corridor wall washers that can illuminate a corridor without additional lighting, the WHF was 80 percent for a forward-throw wall washer illuminating the entire 8-foot width of a corridor with a 10-foot ceiling height.

In most cases, not all the walls in the space are illuminated by wall-washing luminaires. The more general equation that accounts for the portion of floor area adjacent to the fraction of walls being illuminated is given below.

$$FFA_{Spill} = WallFraction \times WHF \times 0.4 \times RCR$$

Combining this with the ratio of wall area to floor area yields the General Lighting Reduction Fraction, GLRF:

$$GLRF = FGI_{Spill} \times FFA_{Spill}$$

The General Lighting Power Density Reduction, $LPD_{Gen,Red}$, is given by the following:

$$LPD_{Gen,Red} = LPD_{Gen} \times GLRF, \text{ or}$$

$$LPD_{Gen,Red} = LPD_{Gen} \times \min \left[1, \frac{(E_{Wall,Design} \times R_{HtoV,L})}{E_{Floor,Design}} \right] \times Wall\ Fraction \times WHF \times 0.4 \times RCR$$

In 2019 Title 24, Part 6 wall wash model, the wall height factor was fixed and from the 2022 code cycle onwards, models the wall height factors are a variable that is attached to the different precalculated radiosity modes that are normalized using this approach. The wall wash model has different precalculated models that vary the reflectance of the wall. This does not affect the vertical FCs impinging on the wall, but it does reduce the amount of horizontal illuminance received by work plane near the wall. Thus, reflectance of the wall impacts the General Lighting Power Density Reduction, $LPD_{Gen,Red}$. Thus, for different reflectance walls the amount of displaced general lighting

power can be more accurately calculated and less LPD “safety factor” associated with loss of accuracy is needed for the LPD targets. Unless otherwise published, high CRI(90 CRI and above) wall washers have their efficacy derated by 20 percent by the authors.

2.4.2 Luminaire Efficacy

When comparing the 2022 Inverse Lumen Method model to the 2028 Inverse Lumen Method model, “luminaire efficacy” is the variable with the greatest difference. As shown in Table 3, luminaire efficacy increased significantly, with most luminaires exhibiting efficacy gains of at least 15 percent. Theoretically the LPDs should decrease proportionally; however, this technical inverse lumen method spreadsheet model informs changes to LPDs but is not the sole input. Nonetheless, identifying these changes in efficacy demonstrates the need to revisit the allowed lighting power allowances. It is clear that over the last six years, luminaire efficacy has increased significantly and updating the 2028 code to keep up with the market would yield significant energy savings.

Table 3: Comparison of Luminaire Efficacies from 2022 and 2028 LPD models

Luminaire Description	Average 2028 Efficacy (lm/W)	Average 2022 Efficacy (lm/W)	Ratio 2028 Efficacy to 2022 Efficacy
Cove light asymmetric 80CRI	117	91	128%
Cove light asymmetric 90CRI	117	N/A - new	128%
Downlight large 6"+ 80CRI	97	82	118%
Downlight large 6"+ 80CRI Hi Output	100	90	111%
Downlight large 6"+ 90CRI	92	78	117%
Downlight large 6"+ 90CRI Hi Output	93	81	116%
Downlight large 6"+ 90CRI Warm	92	66	139%
Downlight large 6"+ 90CRI Warm Hi Output	93	70	133%
Downlight 4" and less 80CRI	100	76	132%
Downlight 4" and less 80CRI Lo Output	97	62	156%
Downlight 4" and less 90CRI	94	83	113%
Downlight 4" and less 90CRI Warm	94	69	136%
High Bay 80CRI	153	128	119%
Low bay 80CRI	152	145	105%

Luminaire Description	Average 2028 Efficacy (lm/W)	Average 2022 Efficacy (lm/W)	Ratio 2028 Efficacy to 2022 Efficacy
Pend bowl direct/indirect 80CRI	107	81	131%
Pendant direct/indirect 80CRI	126	97	130%
Pendant direct/indirect 90CRI	110	N/A - new	114%
Parking garage luminaire 70CRI	127	111	115%
Parking garage luminaire 80CRI	139	104	134%
Parking garage luminaire 80CRI Hi Output	139	104	134%
Linear light slot 4" or more 80CRI	115	104	110%
Linear light slot 4" or less 80CRI	123	94	131%
Strip Under cabinet 80CRI	108	63	170%
Strip Under cabinet 80CRI Hi Output	116	76	152%
Strip Under cabinet 90CRI	90	46	198%
Industrial strip 80CRI	141	135	105%
Industrial strip 80CRI Hi Output	139	122	114%
Industrial strip 80CRI Lo Output	141	121	116%
Troffer Basket 80CRI	132	116	114%
Troffer Basket 80CRI Hi Output	132	112	118%
Troffer Basket 80CRI Lo Output	128	95	134%
Troffer Basket 90CRI	125	101	124%
Troffer Lensed 80CRI	125	110	114%
Troffer Lensed 80CRI Hi Output	125	115	109%
Troffer Lensed 80CRI Lo Output	125	111	113%
Parking garage luminaire 70CRI Hi Output	128	112	114%

2.4.3 Proposed Title 24, Part 6 LPDs Compared with LPDs in Other Energy Codes

The ratios of the 2028 Title 24 base power allowance to the ASHRAE 90.1-2025 general power allowance in the Space-by-Space Methe describe the relatively stringency as compared to the minimum national model energy code. Additionally, ASHRAE 90.1 exempts display lighting in museums, thus the lighting power allowance for museums is very low. The percentage comparisons are for the base LPDs only. Additionally, allowances in Title 24 and ASHRAE 90.1 are use-it-or-lose-it allowances. One cannot use left over allowances from one room and apply it to another room. The

base allowances may be traded off between rooms so one can install less than the allowed LPD in one room and apply the left over base allowance to another room and install additional lighting power in the other room.

In the primary function area column, several of these areas are in blue font. They represent new function areas or represent 2025 single primary function areas that were split up into multiple areas. New function areas include the elevator lobby, performing arts lobby, performance arts dressing room, and data centers. Concourse and Atria Area from 2025 Title 24 was split into: Atria of different heights (to match height bins in ASHRAE 90.1), convention center concourse, retail concourse, and transportation concourse. Convention, Conference, Multipurpose and Meeting Area from 2025 Title 24 was split into: Convention Center - Ballroom; Exhibit Space, Meeting Room; Educational, civic - Multipurpose room; Office - Conference Room.

The benefit of separating a broad multi-space primary functional area LPD into more targeted primary function area LPDs is that each LPD is more closely linked to the illumination needs of these individual space types. In the past, the LPD was targeted to the highest lighting power for all space types listed in the multiple space primary function area. As a result, for most of the space types in these groupings, the LPDs were unnecessarily high. By splitting of multiple space types into single space types, the LPD is targeted to the specific needs of each space type. The result from these more targeted LPDs is fairly significant for the wattage reductions. For the remaining areas where the applications and design illuminances are not changing, the wattage reductions are modest, often less than the 15 percent reduction expected from luminaire efficacy alone.

The healthcare primary function area “Patient Room” was split into Patient Room - Critical Care and Patient Room – General. This change resulted from comparing sample LPDs with other standards, including ANSI/ASHRAE/ASHE Standard 189.3: Standard for the Design, Construction, and Operation of Sustainable High-Performance Health Care Facilities. The pre-existing patient room LPD was appropriate for general patient rooms, and the recommended LPD value of 0.90 W/sf from ASHRAE 189.3 for critical care patient rooms was applied to the newly added Patient rooms – critical care primary function area in the proposal.

To simplify the standard, a single value per ATM is proposed in parking garages whereas in the past the ATM allowance was 100 Watts per first ATM and an additional 50 Watts for additional ATMs. This modification removes the ambiguity of whether the ATMs were close together (the original intention) or any additional ATMs in the entire parking garage had the reduced allowance. The wattage needed to illuminate ATMs has decreased with higher efficacy LED sources, so the level of complexity is no longer needed. The California statutory requirements for illumination ATMs⁽⁰⁰⁾ require at least 10 footcandles on the face of the ATM and at least 10 fc on the ground up to 5 feet in

front of the machine even when only one machine is present. Additionally at least 2 fc “in that portion of the defined parking area within 60 feet of the automated teller machine,” is required. In parking garages, the 2 fc requirement is already met by the general lighting LPD for parking garages which is sufficient to provide 5 fc average maintained illuminance.

Table 4 compares the allowed lighting power densities of this proposal with the lighting power densities of the current 2025 version of Title 24, Part 6 and with the LPDs in the national nonresidential model energy code ASHRAE 90.1-2025. It is anticipated that the 2027 version of the IECC will have the base LPD values as in ASHRAE 90.1. The first additional lighting power allowance is shown for the proposed 2028 Title 24 Area Category Method, and for ASHRAE 90.1-2025 the additional lighting power allowance is 0.50 Watts per square foot across all primary function areas and a separate section of 90.1-2025 has retail display lighting allowances that vary by type of product sold.

The ratios of the proposed 2028 Title 24 allowed base LPD allowance and the 2025 Title 24 allowed general lighting LPD indicated the increase in stringency. These range between 58% and 110% with most around 85% reflecting the change in luminous efficacy of products. The 8% ratio for the parking garage daylight adaptation zone reflects that the transition zone lighting is treated as a specialized task additional lighting power allowance that is tied to daylight adaptation controls.

The ratios of the 2028 Title 24 base power allowance to the ASHRAE 90.1-2025 general power allowance in the Space-by-Space Method describe the relatively stringency as compared to the minimum national model energy code. Additionally, ASHRAE 90.1 exempts display lighting in museums, thus the lighting power allowance for museums is very low. The percentage comparisons are for the base LPDs only. Additionally, allowances in Title 24 and ASHRAE 90.1 are use-it-or-lose-it allowances. One cannot use left over allowances from one room and apply it to another room. The base allowances may be traded off between rooms so one can install less than the allowed LPD in one room and apply the left over base allowance to another room and install additional lighting power in the other room.

In the primary function area column, several of these areas are in blue font. They represent new function areas or represent 2025 single primary function areas that were split up into multiple areas. New function areas include the elevator lobby, performing arts lobby, performance arts dressing room, and data centers. Concourse and Atria Area from 2025 Title 24 was split into: Atria of different heights (to match height bins in ASHRAE 90.1), convention center concourse, retail concourse, and transportation concourse. Convention, Conference, Multipurpose and Meeting Area from 2025 Title 24 was split into: Convention Center - Ballroom; Exhibit Space, Meeting Room; Educational, civic - Multipurpose room; Office - Conference Room.

The benefit of separating a broad multi-space primary functional area LPD into more targeted primary function area LPDs is that each LPD is more closely linked to the illumination needs of these individual space types. In the past, the LPD was targeted to the highest lighting power for all space types listed in the multiple space primary function area. As a result, for most of the space types in these groupings, the LPDs were unnecessarily high. By splitting of multiple space types into single space types, the

LPD is targeted to the specific needs of each space type. The result from these more targeted LPDs is fairly significant for the wattage reductions. For the remaining areas where the applications and design illuminances are not changing, the wattage reductions are modest, often less than the 15 percent reduction expected from luminaire efficacy alone.

The healthcare primary function area “Patient Room” was split into Patient Room - Critical Care and Patient Room – General. This change resulted from comparing sample LPDs with other standards, including ANSI/ASHRAE/ASHE Standard 189.3: Standard for the Design, Construction, and Operation of Sustainable High-Performance Health Care Facilities. The pre-existing patient room LPD was appropriate for general patient rooms, and the recommended LPD value of 0.90 W/sf from ASHRAE 189.3 for critical care patient rooms was applied to the newly added Patient rooms – critical care primary function area in the proposal.

To simplify the standard, a single value per ATM is proposed in parking garages whereas in the past the ATM allowance was 100 Watts per first ATM and an additional 50 Watts for additional ATMs. This modification removes the ambiguity of whether the ATMs were close together (the original intention) or any additional ATMs in the entire parking garage had the reduced allowance. The wattage needed to illuminate ATMs has decreased with higher efficacy LED sources, so the level of complexity is no longer needed. The California statutory requirements for illumination ⁵ATMs_[OBJ] require at least 10 footcandles on the face of the ATM and at least 10 fc on the ground up to 5 feet in front of the machine even when only one machine is present. Additionally at least 2 fc “in that portion of the defined parking area within 60 feet of the automated teller machine,” is required. In parking garages, the 2 fc requirement is already met by the general lighting LPD for parking garages which is sufficient to provide 5 fc average maintained illuminance.

⁵ California Financial Code - Division 4. Automated teller machines: user safety Section 13041.
https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=FIN§ionNum=13041.

Table 4: Comparison of Proposed Title 24 LPDs with 2025 Title 24 and ASHRAE 90.1-2025

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed General LPD (W/sf)	Ratio Base 2028 / 2025 Title 24	ASHRAE 90.1-2025 General Lighting	Ratio Base Allowance 2028 Title 24 / 90.1-25
Aging Eye/Low-vision: Corridor Area	0.60	0.30	0.70	86%	0.60	100%
Aging Eye/Low-vision: Dining	0.80	0.40	0.80	100%	1.08	74%
Aging Eye/Low-vision: Main Entry Lobby	0.80	1.10	0.85	94%	1.27	63%
Aging Eye/Low-vision: Lounge/Waiting Area	0.80	0.40	0.80	100%	1.06	75%
Aging Eye/Low-vision: Multipurpose Room	0.80	0.40	0.85	94%	1.06	75%
Aging Eye/Low-vision: Religious Worship Area	0.80	0.50	1.00	80%	0.62	129%
Aging Eye/Low-vision: Restroom	0.90	0.30	1.00	90%	0.90	100%
Aging Eye/Low-vision: Stairwell	0.80	0.30	0.80	100%	N/A	N/A
Atria < 20 ft tall	0.30	0.20	0.60	50%	0.29	103%
Atria 20 to < 40 ft	0.40	0.25	0.60	67%	0.37	108%
Atria > 40 ft	0.50	0.30	0.60	83%	0.49	102%
Audience Seating Area	0.30	0.35	0.50	60%	0.23	130%
Auditorium Area	0.50	0.45	0.70	71%	0.56	89%
Auto Repair / Maintenance Area	0.55	0.20	0.55	100%	0.56	98%
Barber, Beauty Salon and Spa Area	0.65	0.50	0.70	93%	0.61	107%
Civic Meeting Room	0.70	0.30	0.90	78%	0.96	73%
Convention Center: Ballroom	0.45	0.40	0.75	N/A	N/A	N/A
Convention: Concourse	0.45	0.25	0.60	75%	0.51	88%
Convention: Exhibit Space	0.45	0.30	0.75	60%	0.83	54%
Convention: Meeting Room	0.65	0.25	0.75	87%	0.83	78%
Control room	0.60	0.00	N/A	N/A	0.65	92%
Copy Room	0.45	0.00	0.50	90%	0.52	87%
Corridor Area	0.35	0.30	0.40	88%	0.43	81%

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed General LPD (W/sf)	Ratio Base 2028 / 2025 Title 24	ASHRAE 90.1-2025 General Lighting	Ratio Base Allowance 2028 Title 24 / 90.1-25
Data center: Computer room	0.45	0.25	N/A	N/A	0.70	64%
Dining Area: Bar/Lounge and Fine Dining	0.30	0.45	0.45	67%	0.69	43%
Dining Area: Cafeteria/Fast Food	0.40	0.25	0.45	89%	0.35	114%
Dining Area: Family and Leisure	0.35	0.25	0.40	88%	0.50	70%
Kitchen/Food Preparation Area	0.85	0.00	0.95	89%	0.93	91%
Education/Business: Classroom, Training,	0.56		0.60	93%	0.68	82%
Educational, civic: Multipurpose room (art, music etc)	0.65	0.30	0.75	87%	0.83	78%
Electrical, Mechanical, Telephone Rooms	0.40	0.20	0.40	100%	0.67	60%
Exercise/Fitness Center and Gymnasium Area	0.55	0.00	0.50	110%	0.78	71%
Financial Transaction Area	0.53	0.30	0.70	76%	0.53	100%
Healthcare: Corridor	0.55	0.25	N/A	N/A	0.60	92%
Healthcare: Exam/Treatment Room	1.10	0.00	1.15	96%	1.26	87%
Healthcare: Imaging Room	0.55	0.35	0.60	92%	0.88	63%
Healthcare: Medical Supply Room	0.50	0.00	0.55	91%	0.52	96%
Healthcare: Nursery	0.80	0.20	0.80	100%	0.84	95%
Healthcare: Nurse's Station	0.80	0.30	0.85	94%	0.93	86%
Healthcare: Operating Room	1.80	0.00	1.90	95%	1.99	90%
Healthcare: Patient Room - Critical care	0.90	0.35	N/A			
Healthcare: Patient Room - General	0.65	0.35	0.70	93%	0.73	89%
Healthcare: Physical Therapy Room	0.65	0.10	0.75	86%	0.86	75%
Healthcare: Recovery Room	0.85	0.20	0.90	94%	1.13	75%
Laboratory: Scientific and Teaching	0.80	0.35	0.90	89%	1.18	68%
Laundry Area	0.43	0.00	0.45	96%	0.48	90%
Library : Reading Area	0.70	0.25	0.80	88%	0.80	88%

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed General LPD (W/sf)	Ratio Base 2028 / 2025 Title 24	ASHRAE 90.1-2025 General Lighting	Ratio Base Allowance 2028 Title 24 / 90.1-25
Library : Stacks Area	0.91	0.00	1.00	91%	1.15	79%
Lobby: Elevator	0.50	0.40	N/A	N/A	0.56	89%
Lobby: Main entry	0.60	0.40	0.70	86%	0.74	81%
Lobby: Performing Arts	0.60	0.40	0.70	86%	1.13	53%
Locker Room	0.40	0.00	0.45	88%	0.40	99%
Lounge, Breakroom, or Waiting Area	0.45	0.25	0.55	82%	0.50	90%
Manufacturing & Commercial Work Area: Low Bay	0.63	0.20	0.60	105%	0.81	77%
Manufacturing & Commercial Work Area: High Bay	0.65	0.20	0.65	100%	1.15	57%
Manufacturing & Commercial Work Area: Precision	0.80	0.70	0.85	94%	0.71	113%
Motion picture: Theater area	0.32	0.25	0.50	65%	0.20	162%
Museum: Exhibition/Display	0.60	0.50	0.80	75%	0.27	222%
Museum Area: Restoration Room	0.65	0.35	0.70	93%	1.17	56%
Office Area: ≤ 250 square feet	0.55	0.25	0.65	84%	0.69	79%
Office Area: > 250 square feet	0.50	0.25	0.60	83%	0.52	96%
Office: Conference Room	0.60	0.25	0.75	80%	0.83	72%
Parking Garage Area: Parking Zone and Ramps	0.08	0.00	0.10	80%	0.08	100%
Parking Garage Area: Daylight Adaptation Zones	0.08	0.70	1.00	8%	0.79	10%
Performance : Theater area	0.50	0.40	0.80	63%	0.97	52%
Performance : Dressing room	0.47		N/A	N/A	0.37	126%
Pharmacy Area	1.00	0.35	1.00	100%	1.49	67%
Retail: Concourse	0.35	0.35	0.60	58%	0.51	69%
Retail: Grocery Sales	0.85	0.35	1.00	85%	0.79	108%

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed General LPD (W/sf)	Ratio Base 2028 / 2025 Title 24	ASHRAE 90.1-2025 General Lighting	Ratio Base Allowance 2028 Title 24 / 90.1-25
Retail: Merchandise Sales	0.91	0.35	0.95	95%	0.79	115%
Retail: Fitting Room	0.50		0.60	83%	0.42	119%
Religious Worship Area	0.75	0.25	0.95	79%	0.64	117%
Restrooms	0.60	0.35	0.65	92%	0.73	82%
Stairwell	0.57	0.35	0.60	95%	0.44	130%
Sports Arena – Playing Area: Class I Facility	2.25	0.00	2.25	100%	2.65	85%
Sports Arena – Playing Area: Class II Facility	1.45	0.00	1.45	100%	1.87	78%
Sports Arena – Playing Area: Class III Facility	1.05	0.00	1.1	95%	1.21	86%
Sports Arena – Playing Area: Class IV Facility	0.71	0.00	0.75	95%	0.81	88%
Transportation: Baggage Area	0.30	0.10	0.40	75%	0.29	103%
Transportation: Concourse	0.35	0.35	0.60	58%	0.46	76%
Transportation : Ticketing Area	0.40	0.20	0.45	89%	0.37	108%
Transportation: Waiting area	0.45	0.20	0.60	75%	0.71	63%
Videoconferencing Studio	0.73	1.00	0.90	81%	1.11	66%
Warehouse: Storage	0.40	0.00	0.40	100%	0.41	98%
Warehouse: Shipping and Handling	0.60	0.00	0.60	100%	0.83	72%

2.4.4 Summary of Stakeholder Comments

The Statewide CASE Team conducted preliminary outreach to lighting manufacturers, lighting designers, and other stakeholders to solicit input on proposed Title 24 updates related to luminaire classification, wattage determination, and indoor lighting power density (LPD). Feedback collected during the Utility-Sponsored Stakeholder Meeting on September 24, 2025, as well as through follow-up discussions with manufacturers and designers, provided insights into current design practices, luminaire performance assumptions, and compliance considerations associated with the proposed updates.

The Statewide CASE Team assembled a focus group of senior lighting design professionals from major design firms, along with stakeholders representing manufacturers and a university facilities team, as part of these outreach and research efforts. See Section 1.3 for a summary of the input received from these stakeholders, and Appendix F for a detailed list of input. Through this engagement, the Statewide CASE Team has incorporated stakeholder feedback into the proposal and supporting analysis.

Specifically, stakeholder input helped evaluate and confirm several key modeling and design assumptions used in the LPD analysis. Lighting designers indicated that lumen depreciation factors around 0.90 are commonly used in lighting calculations for modern LED luminaires, consistent with manufacturer documentation and current industry practice. A higher lumen depreciation factor reflects improved lumen maintenance performance over time and allows designers to assume higher maintained light output, which can result in lower installed wattages needed to meet illuminance targets.

Feedback from both designers and manufacturers also informed the evaluation of compliance approaches for selectable-output luminaires and multi-wattage products, which are becoming increasingly common in the market. Stakeholders indicated that using the highest wattage setting for compliance calculations for wattage-selectable luminaires provides a clear and conservative approach that is generally acceptable in practice. Designers noted that if this approach creates compliance challenges in specific applications, fixed-output luminaires can be specified or alternative compliance approaches, such as current limiters, can be used.

Designers also noted that while 90 CRI luminaires typically have lower efficacy than comparable 80 CRI products, the difference has narrowed significantly in recent LED product generations. In addition, stakeholders indicated that manufacturer cut-sheet performance data and photometric files are generally reliable for recently introduced luminaires, though updates to documentation may not always occur when incremental product improvements are made.

Organizations and individuals contacted for additional feedback through the Manufacturer Survey are listed in Appendix F. The Statewide CASE Team will continue

to solicit feedback from relevant organizations that have not yet responded at the time of this report to ensure that the final proposal reflects current market conditions, product availability, and design practices.

2.4.5 Summary of Compliance Database Lighting Power Densities

The Statewide CASE Team received data from NORESCO's compliance database. The compliance database contains compliance information used to generate Certificates of Compliance (CC) and Certificates of Installation (CI) for permitting Non-residential (NR) and Low-rise Multifamily (LM) projects in California. This data is from the EnergyPro building simulation performance approach software and the prescriptive approach Virtual Compliance Assistant (VCA) form-filling software, and, for the purposes of this report, is provided data from NRCC documents specific to the LTI (Indoor Lighting) category. The Statewide CASE Team is still analyzing this data and the results will be provided in the Final CASE Report.

2.5 Technical Basis Luminaire Classification and Wattage Rating

This proposal includes updates to Section 130.0(c) to better align with recent guidance on defining installed wattage, including the methods adopted in ASHRAE 90.1-2022 Addendum ck (ASHRAE 2025). These changes are not expected to directly affect luminaire energy use; rather, they are intended to increase flexibility in allowable equipment combinations and in how wattages are rated.

The proposed updates focus on three key areas:

- Luminaires with line-voltage lamp holders
- Field-adjustable solid-state lighting (SSL) luminaires
- Clarification on wattage determination for SSL luminaires using legacy ballasts

These revisions aim to provide more accurate and verifiable wattage reporting while supporting compliance with both code and industry-standard testing practices

2.5.1 Luminaires with Line Voltage Lamp Holders

The proposal would define the wattage of luminaires with line-voltage lamp holders as the sum of the wattages of the installed lamps, rather than relying on the luminaire's factory-applied maximum relamping label. Under the current code, anyone wishing to reuse a luminaire with lower-wattage lamps must remove the luminaire, ship it back to the manufacturer, and obtain a new label. This process is impractical, costly, and often leads to unnecessary luminaire replacement and material waste without providing additional energy savings.

Historically, there has also been concern that high-efficacy lamps installed for inspection could be swapped out afterward. This concern stemmed from the limitations of earlier high-efficacy lamp technologies, which were frequently replaced because of:

1. High upfront cost
2. Poor color quality
3. Limited optical control
4. Lack of dimming capability
5. Longevity that often fell short of expectations

With today's LED market, these incentives for post-inspection lamp replacement are significantly reduced. Modern LED lamps offer high color quality (CRI 90–97), dimming capability, long life, and reasonable pricing. Because each lamp is individually labeled, inspectors can easily verify installed wattage—often with greater accuracy than relying on a luminaire's maximum relamping label.

Rationale and accuracy considerations include:

- **More accurate reflection of installed power**
Using the actual lamp wattage eliminates systematic overestimates caused by defaulting to a luminaire's maximum-rated wattage.
- **Clear, verifiable documentation**
Lamp wattage labeling is standardized and consistently applied across products, making field verification straightforward.
- **Alignment with industry practices**
The proposed approach aligns with ASHRAE and other national model code practices that base luminaire wattage on installed lamp wattage.

Based on current product characteristics and market data, totaling the wattage of the installed lamps would provide an accurate and representative wattage value for line-voltage luminaires. The proposal would reduce waste, simplify compliance, and maintain confidence in the accuracy of connected-load calculations.

2.5.2 Accommodating Field-adjustable solid-state lighting (SSL) luminaires

The proposal would require that luminaires with multiple wattage or output settings use the highest output setting available from the manufacturer or manufacturer approved representative. The chosen maximum wattage must be marked on a permanent label installed by the manufacturer or their authorized representative. This approach is intended to ensure that code calculations account for the full operational capability of field-adjustable products.

Rationale and accuracy considerations include:

- **More accurate representation of potential power use**
Multi-wattage and field-adjustable products can vary in power draw across their settings. If compliance were based on a lower setting, connected load could be underestimated. Using the highest accessible setting would provide a conservative and more accurate basis for wattage calculations.
- **Alignment with industry testing and listings**
Many products are evaluated and listed (e.g., UL or DLC) across their full output range. Using the highest accessible setting for compliance would better align with how these luminaires are tested, ensuring that wattage assumptions correspond to certified performance.
- **Consistency across different adjustment mechanisms**
Treating all adjustable luminaires uniformly—whether their settings are changed mechanically or through programmable drivers—would prevent gaps where certain adjustment types could inadvertently allow lower reported wattage than the product is capable of delivering.

2.5.3 Clarification on Wattage Determination for SSL Luminaires using Legacy Ballasts

The proposal would clarify how installed wattage is determined for luminaires in which SSL components are powered by existing—or legacy—HID or fluorescent ballasts. Under the proposed language, the wattage of these luminaires would be defined as the maximum rated wattage of the ballast.

This approach recognizes that, in ballast-powered configurations, the ballast remains the primary electrical power-regulating component of the system. The SSL lamp or light engine may have a lower nominal input rating, but the connected load seen by the electrical system is governed by the ballast’s rated operating characteristics and losses. As a result, relying solely on the SSL product’s labeled wattage can underrepresent the actual installed power and compromise the accuracy of connected-load calculations.

Rationale and accuracy considerations include:

- **Accurate representation of connected load**
Ballasts introduce fixed and variable losses that are not captured in the labeled wattage of the SSL lamp or module. Using the maximum rated ballast wattage provides a conservative and more representative estimate of the power draw associated with the installed luminaire.
- **Consistency with legacy system treatment**
Existing code provisions for HID and fluorescent luminaires base wattage on ballast ratings rather than lamp ratings. Applying the same principle to SSL

retrofits that retain legacy ballasts maintains continuity across technologies and avoids creating parallel compliance pathways for functionally similar systems.

- **Reduced risk of underreporting installed power**

Because SSL lamps compatible with ballasts are often marketed with low nominal wattage values, basing compliance on lamp labeling alone could systematically underestimate connected load in retrofit scenarios. The proposed method limits this risk by anchoring calculations to the controlling electrical component.

- **Alignment with industry testing and listing practices**

Ballasts are evaluated and listed as complete power-regulating devices, including their electrical losses and operating ranges. Using the ballast's maximum-rated wattage aligns code reporting with how these components are tested and certified.

By defining installed wattage based on the maximum-rated ballast wattage, the proposal provides a clear, enforceable, and technology-neutral method for accounting for SSL luminaires that retain legacy ballasts. This clarification improves the accuracy of connected-load reporting, supports consistent inspection practices, and maintains parity with established treatment of non-SSL luminaires, without restricting allowable equipment combinations.

2.5.4 Summary of Stakeholder Comments on Luminaire Wattage

The Statewide CASE Team conducted preliminary outreach to lighting manufacturers, lighting designers, and other stakeholders to solicit input on proposed updates to Title 24 related to luminaire classification, wattage determination, and indoor LPD. Feedback collected during the Utility-Sponsored Stakeholder Meeting on September 24, 2025, and through follow-up outreach activities provided insights into current lighting design practices, retrofit approaches, and compliance considerations associated with the proposed updates.

Stakeholders generally expressed support for allowing the continued reuse of existing luminaires with replaceable lamps where appropriate, particularly in retrofit situations where full luminaire replacement may not be feasible due to cost, access limitations, or architectural constraints. Several stakeholders emphasized that flexible retrofit pathways can help facilitate incremental upgrades from legacy fluorescent systems to LED technologies while minimizing material waste and project costs.

Stakeholders also raised questions and concerns regarding compliance treatment for certain retrofit configurations and emerging luminaire technologies. In particular, discussions focused on the treatment of UL Type A LED retrofit lamps, the treatment of selectable-output SSL luminaires, and approaches for determining installed wattage for products with adjustable lumen or wattage settings. Stakeholders highlighted the

importance of clearly defining how these products should be treated in compliance calculations to ensure consistent interpretation by designers, manufacturers, and enforcement agencies.

Additional input was provided regarding multi-wattage luminaires, multi-wattage LED retrofit lamps, and the role of luminaire labeling and field verification in supporting compliance. Manufacturers and designers indicated that selectable-output luminaires and lamps are increasingly common in the market because they allow flexibility during installation and simplify product stocking and specification. At the same time, stakeholders emphasized the need for compliance approaches that are straightforward to document and verify in the field.

To supplement feedback gathered during the stakeholder meeting, the Statewide CASE Team also conducted targeted outreach with a small focus group of senior lighting design professionals from major design firms, as well as stakeholders representing manufacturers and a university facilities team. These discussions provided additional insights into real-world retrofit practices, product performance considerations, and compliance documentation responsibilities. Lighting designers reported that installed lighting power in typical projects frequently falls near the allowable power levels, although the need for performance trade-offs or additional power allowances varies depending on project type and design features. Designers also noted that projects incorporating advanced lighting features (such as tunable white or color-changing lighting) can sometimes face greater challenges complying with lighting power limits.

Through these interactions, the Statewide CASE Team began incorporating stakeholder feedback where appropriate and continues outreach to ensure that proposed updates reflect current market conditions and design practices. In general, stakeholders indicated that using the highest wattage setting for compliance calculations for selectable-output luminaires provides a clear and conservative approach that can simplify compliance documentation. Designers also indicated that when necessary, fixed-output luminaires or other compliance strategies can be specified to address projects that approach lighting power limits.

With respect to retrofit lamp technologies, feedback indicated that UL Type A, B, and C LED retrofit lamps are all used in practice, with project conditions, safety considerations, and cost constraints influencing product selection. While some stakeholders indicated a preference for Type B or Type C retrofit approaches due to efficiency and performance considerations, others emphasized that Type A products remain an important option for certain retrofit projects where ballast compatibility, installation simplicity, or budget limitations are factors. Based on this feedback, along with input from university facilities staff and broader policy considerations, the Statewide CASE Team determined that limiting the use of UL Type A retrofit lamps would not be pursued as part of this proposal.

Overall, the feedback highlighted the importance of providing clear guidance regarding the eligibility of Type A retrofit lamps, the treatment of selectable-output luminaires and lamps in compliance calculations, and the use of consistent labeling and verification approaches to support accurate compliance determination. A detailed summary of survey responses and stakeholder comments is provided in Appendix F.

2.6 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 7: Proposed Language of this report for detailed revisions to code language.

2.6.1 Energy Code Change Summary

The primary updates to the code will focus on the LPD values in Table 140.6-B and Table 140.6-C of Section 140.6, Title 24, Part 6. Updates to the Luminaire Classification and Power section will be made in Section 130.0(c).

2.6.2 Reference Appendices Change Summary

No changes are proposed to the Reference Appendices for this proposed measure.

2.6.3 Compliance Manuals Change Summary

Compliance manuals will be updated to describe the changes in how lighting wattage is calculated and how allowed wattage is calculated, especially for retail occupancies. The mechanics of most of the applications stay the same only as the values change but any example that makes use of the allowed wattage would be updated. Additionally, the manual would be updated to describe the additional specificity of building type since nonresidential buildings would be more narrowly defined.

2.6.4 Alternative Calculation Method Reference Manual Change Summary

If adopted, the current LPD values in Appendix 5.4A of the ACM Reference Manual will be updated to reflect the proposed code change. For more details see 7.6 ACM Reference Manual.

2.6.5 Compliance Forms Change Summary

If adopted, the compliance forms will differentiate between two building categories: (1) Nonresidential Buildings excluding *Group R Occupancies and Common or Public Use Areas*, and (2) buildings and their *Group R Occupancies and Common or Public Use Areas*.

For Group R buildings, that wattage calculations would remain unchanged. For Nonresidential Buildings, excluding *Group R*, the LPD values in the NRCC-LTI-E form would be updated to reflect the proposed code change. The final implementation may involve two separate forms or tables within the same form.

2.7 Measure Context

2.7.1 Comparable Model Codes or Standards

The proposed updates to LPD values in Title 24, Part 6, Section 140.6 are informed by recent and relevant national model codes and industry standards. The primary reference is ASHRAE 90.1-2025, which includes updated LPD requirements for nonresidential indoor spaces and reflects contemporary LED lighting technology, optical efficiency, and luminaire design practices. The proposal also considers the draft version of IECC 2027, which is based upon the updates in ASHRAE 90.1-2025 for Space-by-Space Method LPDs and Building Area Method LPDs. These references provide a benchmark that indicate that California's standards are slightly more efficient than the national minimum energy efficiency model codes.

Overall, the proposed Title 24 updates are more stringent than current 2025 Title 24 values for certain space types, primarily based on updates to efficacies of LED luminaires and updates to assumptions of maintained efficacy. The proposed updates also address areas not explicitly covered by national standards, such as data center lighting, ensuring high energy efficiency in rapidly growing building sectors. Overall, this proposal ensures that California's lighting standards remain aligned with industry best practices, maintain technical accuracy, and continue to support energy savings.

2.7.2 Interactions with Other Regulations

State Law AB130 prohibits modifications to residential dwellings until 2031. This has been interpreted to include GROUP R OCCUPANCIES AND COMMON OR PUBLIC USE AREAS. This is newly defined in the definition section as follows: *GROUP R OCCUPANCIES AND COMMON OR PUBLIC USE AREAS. Group R occupancy as defined by the California Building Code and spaces ancillary to the occupancy that are not part of individual dwelling or sleeping units and are intended for shared, common, or public use, including areas that support occupant use or building operations.*

As a result, there are two area category method tables:

1. A revised Lighting Power Density table for nonresidential buildings not including *Group R occupancies and common use areas* and
2. An unchanged Lighting Power Density table for *Group R occupancies and common use areas*.

The common-use areas of Hotel/Motel buildings were historically combined with nonresidential requirements as many space types in nonresidential buildings are found in the common areas of hotel/motel buildings such as exercise spaces, offices, lounges, parking garages, and more. For the 2028 code cycle, the same application may have different lighting power allowances depending on the type of building in which the space is located.

Besides the consideration above, there are no known federal, state, or local regulations that directly duplicate or conflict with the proposed updates to LPD requirements in Title 24, Part 6. The measure does not require the use of lighting equipment that exceeds federally mandated minimum efficiency standards, ensuring full compliance with applicable federal appliance regulations. At the state level, there are no conflicting requirements related to energy efficiency, occupational safety, or health. The proposed LPD updates are consistent with the California Building Code and do not necessitate changes to other building code sections, such as mechanical, plumbing, or electrical codes. While some local jurisdictions have adopted reach codes with more stringent lighting requirements, these complement the proposed measure and would not pose a conflict. Overall, the proposal is designed to harmonize with existing regulatory frameworks while advancing statewide energy efficiency goals.

3. Compliance and Enforcement

3.1 Compliance Considerations

The proposed updates to LPD values in Tables 140.6-B and 140.6-C, along with the refinements to Section 130.0(c) regarding luminaire classification and installed wattage, are designed to be feasible for compliance and enforcement without imposing significant new burdens. Compliance with the measure will continue to rely on the standard calculation of Adjusted Indoor Lighting Power under Section 140.6(a), ensuring that installed wattages do not exceed the Allowed Indoor Lighting Power. The updates clarify how installed wattage should be determined for multi-wattage luminaires, linear LED lamps, and line-voltage luminaires, aligning Title 24, Part 6 with recent guidance from ASHRAE 90.1-2025. This harmonization reduces ambiguity for designers, inspectors, and code compliance staff, supporting accurate and consistent application of the standards.

Field verification or diagnostic testing is not expected to be required beyond standard lighting inspections. Compliance professionals, including building inspectors and plan checkers, will rely on modified existing procedures for reviewing luminaire schedules, lighting layouts, and calculated power densities. No specialized training beyond familiarization with the updated wattage definitions in Section 130.0(c) is anticipated, though inspection staff may benefit from brief guidance on identifying multi-wattage luminaires and LED configurations in accordance with the updated code language.

The proposed measure is expected to streamline compliance rather than increase burden. By clarifying how installed wattage should be reported and how LPDs are applied across different luminaires, the measure reduces the risk of errors or misinterpretations during plan review or field inspections. The language has been adjusted to improve clarity, reduce ambiguity, and ensure consistent application across project types. For example, updates to definitions in Section 130.0(c) are harmonized with existing Title 24 terminology, avoiding conflicts or confusion with other code sections.

3.2 Impact on Market Actors

Table 5: Impacts on Market Actors and Suggested Training and Education Opportunities summarizes impacts on market actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

Table 5: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Builders ^a	Verify luminaire selections match updated LPD values.	Additional outreach likely unnecessary.
Design Professionals ^b	Must ensure lighting designs comply with updated LPDs and account for updated installed wattage calculations.	Offer webinars or reference guides explaining the revised LPD tables and luminaire classification rules. Include calculation examples for multi-wattage and linear LED luminaires.
Construction Team ^c	Limited impact: primary responsibility is verifying that specified luminaires are installed. Contractors may propose substitutions and need to understand what constitutes a code-compliant equivalent.	Training on what can be a valid substitution and what needs to be in place to support the requirements documented in the compliance forms as part of the submittal process..
Building Departments ^d	Plan review and inspection procedures are unchanged but require understanding of updated Section 130.0(c) and LPD tables.	Provide checklist updates and brief training on new wattage calculation methods to streamline review and inspection.
Verification Testers ^e	Not applicable, ATTs do not verify wattage. They verify correct operation of controls.	Not applicable
Building Owners, Managers, and Occupants	Reduced energy bills due to lower allowed LPDs and more efficient lighting installations.	Additional outreach unnecessary.
Manufacturers and Distributors	Must label products or provide documentation reflecting lumen output and multi-wattage configurations in alignment with updated Section 130.0(c).	Educational outreach explaining new classification requirements, including examples of compliant labeling and luminaire documentation.

a. Builders include builders and developers.

b. Design professionals include architects, interior designers, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.

c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.

- d. Building departments include plan reviewers, building inspectors, specialty inspectors, permit counter technicians and sustainability department staff.
- e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers and energy consultants, and building owners and occupants. The analysis in the methodology report is not specific to the code change presented in this report. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

Builders. The proposed change would affect commercial builders; however, it would not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the residential and commercial building industries equally; instead, it would primarily affect specific subsectors within the industry. Table 6 shows the commercial building subsectors the Statewide CASE Team expects will be impacted by the changes proposed in this report.

The subsectors that are most relevant include general commercial building construction firms, nonresidential electrical contractors, and finishing trades that frequently coordinate fixture installation, lighting controls, and interior system integration. These trades will interact with the revised LPD values and updated installed-wattage rules, but the changes represent modest adjustments to design documentation rather than shifts in construction practices.

Table 6: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions \$)
Commercial Building Construction	5,491	87,450	\$10.6
Nonresidential Electrical Contractors	3,245	72,794	\$7.8
Other Nonresidential Finishing Contractors	492	7,241	\$0.6

Source: Analysis by the Title 24 CASE Team of QCEW data from the California Employment Development Department <https://labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry>

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. <https://www.bls.gov/opub/hom/cew/concepts.htm> (State of California n.d.).

Manufacturers. Manufacturers of luminaires and lighting components are impacted market actors, as the proposal clarifies installed-wattage definitions and updates LPD values that inform product specification and documentation. Most major luminaire and LED manufacturers serving the California market are national or global companies, though several maintain sales, distribution, or product configuration facilities in California. The proposed updates are not expected to impose significant new manufacturing burdens; rather, they may encourage clearer labeling and documentation for multi-wattage luminaires and LED lamp types, which aligns with existing national practices. Any potential effects on California-based operations or jobs are expected to be minimal. Additional discussion of statewide economic impacts is provided in Section 4.4.

3.3 Compliance Software Updates

If this proposal is adopted, CBECC would require updates, but only minor adjustments to existing rulesets. The primary change to incorporate the revised LPD values in Tables 140.6-B and 140.6-C into NRACM Appendix 5.4A, for nonresidential buildings, excluding the defined building types—*Group R Occupancies and Common or Public Use Areas*. The rulesets do not change; only the values in Appendix 5.4A change. However, consideration of LPDs will be based on both building type and space type, so there will be a slight modification to the ACM to reflect the prescriptive wattage allowances. With the change to the NRACM, this not only affects CBECC but also third-party software designed to meet the specification in the NRACM. These updates do not require new EnergyPlus functionality; existing objects and modeling approaches already support lighting power calculations and luminaire wattage inputs.

If the CEC determines that more substantial changes are required during rulemaking, the Statewide CASE Team will provide detailed recommendations for any needed software enhancements in summer 2026.

3.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

The Statewide CASE Team expects minimal additional costs to state or local governments associated with the enforcement of the proposed measure. The current enforcement framework already accounts for LPD requirements, and the proposed measure only decreases the values being enforced. This incremental adjustment does not require the development of new programs or significant changes to existing

enforcement protocols. Training is required to stay current with all codes updated during the triennial cycle, and the changes associated with this proposal are small.

No new training programs for enforcement officials are anticipated, as the existing training infrastructure is sufficient to support the minor increase in enforcement activity. Similarly, no additional workforce training is expected for the construction industry, as the proposed measure does not introduce new design or installation practices beyond those already covered under current guidelines.

As such, the state will incur relatively small additional costs for compliance assurance, enforcement, or training associated with this proposal as compared to the ongoing training required to stay current with the remainder of the triennial code changes and the development of new building officials.

4. Market and Economic Analysis

4.1 Market Structure and Availability

4.1.1 Current Market Structure and Availability

The principal manufacturers that supply luminaires and LED light engines to the California commercial market include Signify (Philips Lighting), Acuity Brands (including Lithonia Lighting), Hubbell, Cree, Osram Green Creative, and several European/global players such as Zumtobel. Nationally, Signify, Acuity Brands, Hubbell, Cree Lighting, and Osram combined share in the percentages of the mid-40s of the commercial lighting market.⁶ These firms produce the vast majority of commercial luminaires, fixture families, and LED modules that designers specify and contractors install; Signify, Acuity Brands and Current (including Columbia, Prescolite, and GE lamps) are particularly prominent in North American commercial projects.

Major electrical and lighting distributors that serve California projects — and that routinely stock and deliver these manufacturers' products to contractors and building owners — include All-Phase, Graybar, Platt, Rexel, among others (and their regional branches). These distributors maintain warehouses and sales/service centers throughout California, which support timely local availability and logistics for commercial construction schedules.

Manufacture, supply, and installation of the affected products can be provided by multiple parties. Luminaires and LED replacement lamps are commodity products available from many competing manufacturers and distributed through multiple national and regional distributors, providing strong redundancy in the supply chain and minimal risk of single-vendor bottlenecks. Where corporate consolidation has occurred (for example, Signify's acquisition of Cooper Lighting), product lines continue to be supplied under familiar brands and remain widely available through distributors.

Because this proposal focuses on updating LPD tables and clarifying how installed wattage is determined, it does not require manufacturers to introduce new luminaire technologies or retool production lines. The manufacturer impact is administrative: clearer labeling, cut-sheet documentation, and field marking for multi-wattage luminaires, linear LED lamp configurations, and inseparable SSL modules to align with the revised definitions. Those adjustments are within the scope of normal product documentation updates and are already familiar to major suppliers.

There are no known patents or exclusive-supply restrictions that would limit multiple vendors from providing compliant luminaires or LED modules for the California market.

⁶ <https://www.mordorintelligence.com/industry-reports/north-america-commercial-led-lighting-market>

The commercial LED and luminaire markets are mature and competitive; key product types (linear LED lamps, recessed troffers, high-bay fixtures, downlights, and integrated SSL fixtures) are produced by many manufacturers, so the measure will not create a single-source dependency.

Emerging trends in the lighting market — connected lighting controls, tunable-white systems, power-over-Ethernet (PoE) solutions, and integrated sensor networks — are complementary to this proposal. By tightening LPD allowances and clarifying how installed wattage is counted, the measure incentivizes use of optically efficient luminaires and encourages integrated control strategies that reduce installed power while preserving (or improving) illuminance quality. Where the design strategy requires greater use of controls or optically efficient fixtures, Section 3.2 recommends targeted outreach to designers and controls contractors. No negative impacts on innovation are anticipated; on the contrary, clearer wattage accounting rewards product innovations that deliver more lumens per input watt and better optical performance. (See Section 3.2 for workforce training recommendations.)

The required design strategies for compliance — selecting luminaires with documented installed wattages that meet the revised Section 130.0(c) definitions and designing to the updated LPD tables — are already common practice among experienced commercial lighting designers and electrical contractors. Typical commercial design-build teams regularly specify fixture wattages, submit luminaire schedules, and coordinate with distributors for product submittals; the proposal tightens how those wattages are defined and reported. For less experienced teams, the training and outreach described in Section 3.2 (webinars, sample luminaire schedules, calculation examples) will be sufficient to close any knowledge gaps.

High-efficacy luminaires are the de facto standard in the California commercial market today, so compliant products are already widely available from multiple manufacturers and stocked by major distributors. Absent regulations, the industry would continue moving toward higher efficacy and better optical performance; however, the code change accelerates uniform market adoption and eliminates ambiguity in wattage reporting.

For statewide energy savings estimates, the CASE analysis conservatively discounts free-market adoption rates—assumes some portion of the market would have adopted higher performance in the absence of the code—and counts only the incremental savings attributable to the code change. Given the complexity of evaluating the impact of lower LPDs on future behavior, this proposal relies on prior CPUC evaluations of measured savings from changes in stringency of lighting efficiency standards and applies a methodology for projecting market-wide changes in distribution of installed power.

4.1.2 Market Challenges and Solutions

The greatest market challenges are the wide range of efficacy and lamp lumen depreciation (LLD) stated on specification cut-sheets for similar products from different manufacturers—and, in some cases, from the same manufacturer.

In the analysis of luminaires (refer to Appendix G), luminaire efficacy differences between similar luminaires in any given category are as much as 150 percent to 200 percent.

Also, the LLD stated on specification cut-sheets from the manufacturers varied significantly. Some manufacturers stated the IES L70 at 50,000 hours, while others stated lumen maintenance as high as at 60,000 hours with estimated extended LLD at L70 to L90 at 100,000+ hours.

The ideal solution would be the industry standardization of documented luminaire specifications on product cut-sheets. The practical solution is for specifiers to review and analyze luminaire specifications (especially efficacy and LLD) and to validate the accuracy of the specifications with the manufacturer and/or manufacturers' representatives.

4.2 Design and Construction Practices

4.2.1 Current Design and Construction Practices

Currently, lighting designers select LED luminaires that balance lumen output, optical distribution, and dimmability to optimize energy efficiency while maintaining occupant comfort. Designers also consider lamp lumen depreciation (LLD) assumptions when calculating LPDs, ensuring installed wattages remain within code limits throughout the expected life of the system.

The proposed updates to LPD values and the clarifications to luminaire classification will reinforce these practices by aligning allowable lighting power with modern LED performance, task-based lighting strategies, and industry-standard luminaire classification methods. Designers will continue to specify luminaires according to the intended application, but updated Table 140.6-B and 140.6-C values may encourage more widespread use of higher-efficacy luminaires or improved optical efficiency to meet stricter power allowances. This may slightly shift design decisions, such as fixture spacing or selection of integrated LED systems versus traditional lamp-and-ballast configurations, but it does not fundamentally alter electrical service requirements, space planning, or aesthetic considerations.

4.2.2 Health and Safety Considerations

The proposed updates to LPDs and luminaire classification do not introduce any changes to structural or seismic design, indoor air quality, moisture management, fire-resistance ratings, or other health and safety factors. The measure continues to rely on existing luminaire installation practices, electrical safety standards, and manufacturer guidance.

All current federal, state, and local safety regulations, including rules enforced by the California Division of Occupational Safety and Health, remain fully applicable.

Compliance with the updated LPDs and luminaire classification is not anticipated to create any adverse impacts on the health or safety of building occupants, installers, or maintenance personnel.

A potential benefit of the measure is improved lighting quality and consistency, which may enhance visual comfort and reduce the risk of eye strain or accidents in poorly illuminated spaces. No stakeholder feedback raised health or safety concerns specific to this proposal.

4.2.3 Design and Construction Challenges and Solutions

A major design and construction challenge is the discrepancies found between cut-sheets of what are essentially the same product. The Statewide CASE Team hypothesize that luminaire cut-sheets are not updated as quickly as products are changing. The same product with a 90 CRI is sometimes listed as having a higher efficacy than the same luminaire with an 80 CRI. Historically, an 80 CRI product will have a higher efficacy than a 90 CRI product which contain spectra with lower photopic efficiencies. It is hypothesized that the 90 CRI product is a new release and the data for the 80 CRI product has not been updated.

Thus to meet more demanding LPDs while providing sufficient illumination, specifiers must confirm that the luminaire selection process is conducted with the latest and accurate data. Given our findings of increased efficacies over the last 6 years, this challenge may turn into an opportunity to expand the range of luminaires that are available to provide enhanced lighting quantity and quality with reduced wattages.

Furthermore, this due diligence must also apply when bid alternate and substitute luminaires are submitted to insurer luminaire performance, quality and efficacy, meet or exceed the specified luminaire.

Additionally, Table 5 in Section 3.2 *Impact on Market Actors* has recommendations for a description of workforce trainings that could support effective design, installation, and commissioning.

4.3 Energy Equity and Environmental Justice

The Statewide CASE Team evaluated the potential impact on environmental and social justice (ESJ) communities,⁷ including impacts related to race, class, and gender via research and stakeholder input. including impacts related to race, class, and gender.

Based on a preliminary review, this proposed code change is unlikely to have significant negative or positive impacts on the ESJ communities. The Statewide CASE Team does expect impacts on cost from the proposed code change. However, the costs are expected to be modest and outweighed by the benefits. Specifically, energy costs would decrease, which would result in lower utility bills for the ESJ communities.

The Statewide CASE Team does not expect any impact on the health and safety of ESJ communities or on their disaster preparedness. The comfort of ESJ communities is unlikely to be impacted by the proposed code change.

Recognizing the importance of engaging ESJ communities and gathering their input to inform the code change process and proposed measures, the Statewide CASE Team is working to build relationships with CBOs to facilitate meaningful engagement. Please reach out to Yao-Jung Wen (ywen@energy-solution.com) if you have input on how this proposal may impact ESJ communities or if you would like to offer your perspective.

4.4 Impacts on Jobs and Businesses

This section will be completed for the Final CASE Report.

4.5 Economic and Fiscal Impacts

This section will be completed for the Final CASE Report.

⁷ The CPUC refers to ESJ communities as “low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities” (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises “(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

5. Cost Effectiveness

5.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The 2028 CASE Methodology Report and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

5.2 Energy and Energy Cost Savings Results

Energy and energy cost savings results are developed from differences in allowed installed wattage as follows:

- Annual energy savings per square foot are calculated by taking the difference in lighting power density between the 2025 LPDs and the proposed 2028 LPD and multiplying this by the annual full load hours of lighting system operation for space type.
- The decreased cooling loads and increased heating loads associated with reduced lighting electrical consumption is not calculated due to its small impact, relative to the primary impact of less lighting load. Nonresidential buildings are primarily cooling load dominated, each unit of reduction in lighting internal gains save an additional 15 percent in electricity savings but also result in an increase of around 7 percent in gas consumption. The net effect of heating and cooling interaction effects are small and, in most applications, increases savings. For more details and references see Appendix A.

- Full load hours are calculated from the lighting power fractions in the lighting schedules in Appendix 5.4A of the Nonresidential Alternative Calculation Method (NR ACM) manual which describes the whole building simulation calculation methods used in the performance approach. These lighting power fractions are for hour 1 through 23 during weekdays, Saturdays and Sundays. The day-of-week values line up with the assumptions embedded in the economic factors, and the lighting profiles are aligned to be formatted to the 2009 calendar year, where January 3 and 4 are the first weekend of the year. This reference year assures that the day of week in the computer simulations align with the day of week used for the development of the hourly metrics for life cycle systemwide cost (LSC), energy demand, source energy, and carbon emissions.
- When the LPD reduction (W/sf) is multiplied by the lighting schedule and divided by 1,000 Watts/kW conversion factor, this results in a kWh/sf reduction for each hour. The sum of the value results in the kWh/sf-yr savings.
- When these hourly energy savings are multiplied by the hourly demand factors, this yields the kW of demand for each W/sf reduction in the LPD.
- When these hourly energy savings are multiplied by the hourly LSC values and summed this results in the present value dollars over 30 years per square foot of systemwide life cycle savings. The units are present valued dollars.
- The same approach of multiplying hourly factors by the hourly energy savings values results in similar calculations of nominal undiscounted 30 year energy cost savings in units of 30 year dollars, annual Greenhouse Gas Emission reductions in tonnes of CO₂ equivalent, and source energy reductions in kBtu/yr

Since the base case and proposed systems have identical load shapes and HVAC interaction effects are ignored, there is no climate zone dependency for demand, GHG emission, and source energy reductions. For LSC and nominal energy cost savings over 30 years, the variability of maximum to minimum value divided by the average was less than 5 percent for all the ACM lighting load profiles. Thus, the average LSC and Nominal savings values with little loss in accuracy across all climate zones.

Negative savings values (shown in red and enclosed in parentheses) indicate cases where the proposed allowance for general lighting power, combined with any additional lighting power, results in an overall increase in lighting energy use relative to the current requirements.

Table 7: Reduction in Allowed Power

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed Proposed General LPD (W/sf)	2025 Additional Lighting Power (W/sf)	2028 LPD Reduction (W/sf)	2028 % Power Red.
Aging Eye/Low-vision:1 Corridor Area	0.60	0.30	0.70	0.40	0.20	18%
Aging Eye/Low-vision:1 Dining	0.80	0.40	0.80	0.40	0.00	0%
Aging Eye/Low-vision:1 Main Entry Lobby	0.80	1.10	0.85	1.30	0.25	12%
Aging Eye/Low-vision:1 Lounge/Waiting Area	0.80	0.40	0.80	0.40	0.00	0%
Aging Eye/Low-vision:1 Multipurpose Room	0.80	0.40	0.85	0.40	0.05	4%
Aging Eye/Low-vision:1 Religious Worship Area	0.80	0.50	1.00	0.40	0.10	7%
Aging Eye/Low-vision:1 Restroom	0.90	0.30	1.00	0.20	0.00	0%
Aging Eye/Low-vision:1 Stairwell	0.80	0.30	0.80	0.30	0.00	0%
Atria < 20 ft tall	0.30	0.20	0.60	0.25	0.35	41%
Atria 20 to < 40 ft	0.40	0.25	0.60	0.25	0.20	24%
Atria > 40 ft	0.50	0.30	0.60	0.25	0.05	6%
Audience Seating Area	0.30	0.35	0.50	0.25	0.10	13%
Auditorium Area	0.50	0.45	0.70	0.45	0.20	17%
Auto Repair / Maintenance Area	0.55	0.20	0.55	0.20	0.00	0%
Barber, Beauty Salon and Spa Area	0.65	0.50	0.70	0.55	0.10	8%
Civic Meeting Room	0.70	0.30	0.90	0.25	0.15	13%
Convention Center: Ballroom	0.45	0.40	0.75	0.25	0.15	15%
Convention: Concourse	0.45	0.25	0.60	0.25	0.15	18%
Convention: Exhibit Space	0.45	0.30	0.75	0.25	0.25	25%
Convention: Meeting Room	0.65	0.25	0.75	0.25	0.10	10%
Control room	0.60	0.00	N/A	N/A	0.00	
Copy Room	0.45	0.00	0.50	0.00	0.05	10%
Corridor Area	0.35	0.30	0.40	0.25	0.00	0%
Data center: Computer room	0.45	0.25	N/A	N/A	0.00	
Dining Area: Bar/Lounge and Fine Dining	0.30	0.45	0.45	0.35	0.05	6%
Dining Area: Cafeteria/Fast Food	0.40	0.25	0.45	0.25	0.05	7%
Dining Area: Family and Leisure	0.35	0.25	0.40	0.25	0.05	8%
Kitchen/Food Preparation Area	0.85	0.00	0.95		0.10	11%
Education/Business: Classroom, Training,	0.56		0.60		0.04	7%

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed Proposed General LPD (W/sf)	2025 Additional Lighting Power (W/sf)	2028 LPD Reduction (W/sf)	2028 % Power Red.
Educational, civic: Multipurpose room (art, music etc)	0.65	0.30	0.75	0.25	0.05	5%
Electrical, Mechanical, Telephone Rooms	0.40	0.20	0.40	0.20	0.00	0%
Exercise/Fitness Center and Gymnasium Area	0.55	0.00	0.50	0.00	(0.05)	(10%)
Financial Transaction Area	0.53	0.30	0.70	0.25	0.12	13%
Healthcare: Corridor	0.55	0.25	N/A	N/A	0.00	
Healthcare: Exam/Treatment Room	1.10	0.00	1.15	0.00	0.05	4%
Healthcare: Imaging Room	0.55	0.35	0.60	0.30	0.00	0%
Healthcare: Medical Supply Room	0.50	0.00	0.55	0.00	0.05	9%
Healthcare: Nursery	0.80	0.20	0.80	0.10	(0.10)	(11%)
Healthcare: Nurse's Station	0.80	0.30	0.85	0.30	0.05	4%
Healthcare: Operating Room	1.80	0.00	1.90	0.00	0.10	5%
Healthcare: Patient Room - Critical care	0.90	0.35	N/A	N/A	0.00	
Healthcare: Patient Room - General	0.65	0.35	0.70	0.25	(0.05)	(5%)
Healthcare: Physical Therapy Room	0.65	0.10	0.75	0.10	0.10	12%
Healthcare: Recovery Room	0.85	0.20	0.90	0.10	(0.05)	(5%)
Laboratory: Scientific and Teaching	0.80	0.35	0.90	0.35	0.10	8%
Laundry Area	0.43	0.00	0.45	0.00	0.02	4%
Library : Reading Area	0.70	0.25	0.80	0.25	0.10	9%
Library : Stacks Area	0.91	0.00	1.00	0.00	0.09	9%
Lobby: Elevator	0.50	0.40	N/A	N/A	0.00	
Lobby: Main entry	0.60	0.40	0.70	0.25	(0.05)	(5%)
Lobby: Performing Arts	0.60	0.40	0.70	0.25	(0.05)	(5%)
Locker Room	0.40	0.00	0.45	0.00	0.05	12%
Lounge, Breakroom, or Waiting Area	0.45	0.25	0.55	0.25	0.10	12%
Manufacturing & Commercial Work Area: Low Bay	0.63	0.20	0.60	0.20	(0.03)	(3%)
Manufacturing & Commercial Work Area: High Bay	0.65	0.20	0.65	0.20	0.00	0%
Manufacturing & Commercial Work Area: Precision	0.80	0.70	0.85	0.70	0.05	3%

Primary Function Areas	2028 Allowed Proposed Base LPD (W/sf)	2028 Additional Lighting Power (W/sf)	2025 Allowed Proposed General LPD (W/sf)	2025 Additional Lighting Power (W/sf)	2028 LPD Reduction (W/sf)	2028 % Power Red.
Motion picture: Theater area	0.32	0.25	0.50	0.25	0.18	23%
Museum: Exhibition/Display	0.60	0.50	0.80	0.45	0.15	12%
Museum Area: Restoration Room	0.65	0.35	0.70	0.35	0.05	5%
Office Area: ≤ 250 square feet	0.55	0.25	0.65	0.20	0.05	6%
Office Area: > 250 square feet	0.50	0.25	0.60	0.20	0.05	6%
Office: Conference Room	0.60	0.25	0.75	0.25	0.15	15%
Parking Garage Area: Parking Zone and Ramps	0.08	0.00	0.10	0.00	0.02	20%
Parking Garage Area: Daylight Adaptation Zones ⁸	0.08	0.70	1.00	0.00	0.22	22%
Performance : Theater area	0.50	0.40	0.80	0.25	0.15	14%
Performance : Dressing room	0.47		N/A	N/A	0.00	
Pharmacy Area	1.00	0.35	1.00	0.35	0.00	0%
Retail: Concourse	0.35	0.35	0.60	0.25	0.15	18%
Retail: Grocery Sales	0.85	0.35	1.00	0.35	0.15	11%
Retail: Merchandise Sales	0.91	0.35	0.95	0.35	0.04	3%
Retail: Fitting Room	0.50		0.60		0.10	17%
Religious Worship Area	0.75	0.25	0.95	0.25	0.20	17%
Restrooms	0.60	0.35	0.65	0.35	0.05	5%
Stairwell	0.57	0.35	0.60	0.35	0.03	3%
Sports Arena – Playing Area: Class I Facility ¹¹	2.25	0.00	2.25	0.00	0.00	0%
Sports Arena – Playing Area: Class II Facility ¹¹	1.45	0.00	1.45	0.00	0.00	0%
Sports Arena – Playing Area: Class III Facility ¹¹	1.05	0.00	1.10	0.00	0.05	5%
Sports Arena – Playing Area: Class IV Facility ¹¹	0.71	0.00	0.75	0.00	0.04	5%
Transportation: Baggage Area	0.30	0.10	0.40	0.00	0.00	0%
Transportation: Concourse	0.35	0.35	0.60	0.25	0.15	18%
Transportation : Ticketing Area	0.40	0.20	0.45	0.20	0.05	8%
Transportation: Waiting area	0.45	0.20	0.60	0.25	0.20	24%
Videoconferencing Studio ¹²	0.73	1.00	0.90	1.00	0.17	9%
Warehouse: Storage	0.40	0.00	0.40	0.00	0.00	0%
Warehouse: Shipping and Handling	0.60	0.00	0.60	0.00	0.00	0%

Table 8 reports the savings per prototypical space for each primary function area that minimally complies with the proposed lighting power allowances relative to minimal compliance with the 2025 Title 24, part 6 lighting power densities (LPDs). The savings per prototypical space are proved for electrical energy (kWh/yr), peak electrical demand in Watts, 30 year life cycle systemwide energy cost (LSC) in 30 years present valued 2029 dollars, and source energy savings in kBtu per year. The GHG emissions reductions associated with energy savings are presented in units of metric tonnes of carbon dioxide equivalent per year.

Table 8: Unit Savings per Prototype Space: Electricity, Demand, LSC, Source Energy and GHG Emissions

Primary Function Area	Prototype Area (sf)	Prototype Annual Energy Savings (kWh/yr)	Prototype Demand Savings (W)	Prototype Energy Cost Savings (PV\$)	Prototype Source Energy Savings (kBtu/yr)	GHG Savings Tonnes CO2e/yr
Aging Eye/Low-vision:1 Corridor Area	640	297	24.8	\$2,182	301	0.016
Aging Eye/Low-vision:1 Dining	1,600	0	0.0	\$0	0	0.000
Aging Eye/Low-vision:1 Main Entry Lobby	600	505	49.0	\$4,058	662	0.035
Aging Eye/Low-vision:1 Lounge/Waiting Area	900	0	0.0	\$0	0	0.000
Aging Eye/Low-vision:1 Multipurpose Room	900	152	14.7	\$1,217	199	0.011
Aging Eye/Low-vision:1 Religious Worship Area	504	170	16.5	\$1,363	222	0.012
Aging Eye/Low-vision:1 Restroom	216	0	0.0	\$0	0	0.000
Aging Eye/Low-vision:1 Stairwell	160	0	0.0	\$0	0	0.000
Atria < 20 ft tall	6,000	7,382	608.2	\$53,700	7262	0.384
Atria 20 to < 40 ft	10,000	7,031	579.2	\$51,143	6916	0.366
Atria > 40 ft	7,776	1,367	112.6	\$9,942	1345	0.071
Audience Seating Area	3,200	1,077	104.5	\$8,657	1412	0.075
Auditorium Area	5,400	3,636	352.6	\$29,216	4764	0.252
Auto Repair / Maintenance Area	4,800	0	0.0	\$0	0	0.000
Barber, Beauty Salon and Spa Area	1,440	506	41.7	\$3,682	498	0.026
Civic Meeting Room	540	273	26.4	\$2,191	357	0.019
Convention Center: Ballroom	5,625	2,841	275.4	\$22,825	3722	0.197
Convention: Concourse	6,000	3,030	293.8	\$24,346	3970	0.210
Convention: Exhibit Space	10,000	8,417	816.1	\$67,629	11028	0.583
Convention: Meeting Room	520	175	17.0	\$1,407	229	0.012

Primary Function Area	Prototype Area (sf)	Prototype Annual Energy Savings (kWh/yr)	Prototype Demand Savings (W)	Prototype Energy Cost Savings (PV\$)	Prototype Source Energy Savings (kBtu/yr)	GHG Savings Tonnes CO2e/yr
Control room	600	0	0.0	\$0	0	0.000
Copy Room	200	23	1.9	\$170	23	0.001
Corridor Area	480	0	0.0	\$0	0	0.000
Data center: Computer room	350	0	0.0	\$0	0	0.000
Dining Area: Bar/Lounge and Fine Dining	1,800	431	43.5	\$3,533	601	0.032
Dining Area: Cafeteria/Fast Food	1,200	287	29.0	\$2,356	401	0.021
Dining Area: Family and Leisure	2,400	574	58.0	\$4,711	801	0.042
Kitchen/Food Preparation Area	450	215	21.7	\$1,767	300	0.016
Education/Business: Classroom, Training,	1,064	101	9.0	\$764	110	0.006
Educational, civic: Multipurpose room (art, music etc)	1,064	112	10.0	\$850	123	0.006
Electrical, Mechanical, Telephone Rooms	1,200	0	0.0	\$0	0	0.000
Exercise/Fitness Center and Gymnasium Area	2,400	(422)	(34.8)	(\$3,069)	(415)	(0.022)
Financial Transaction Area	720	201	16.7	\$1,473	203	0.011
Healthcare: Corridor	1,000	0	0.0	\$0	0	0.000
Healthcare: Exam/Treatment Room	120	17	1.5	\$130	18	0.001
Healthcare: Imaging Room	224	0	0.0	\$0	0	0.000
Healthcare: Medical Supply Room	1,200	173	14.8	\$1,296	183	0.010
Healthcare: Nursery	800	(231)	(19.7)	(\$1,728)	(245)	(0.013)
Healthcare: Nurse's Station	200	29	2.5	\$216	31	0.002
Healthcare: Operating Room	900	260	22.2	\$1,944	275	0.015
Healthcare: Patient Room - Critical care	192	0	0.0	\$0	0	0.000
Healthcare: Patient Room - General	192	(28)	(2.4)	(\$207)	(29)	(0.002)
Healthcare: Physical Therapy Room	1,200	351	29.9	\$2,625	372	0.020
Healthcare: Recovery Room	192	(28)	(2.4)	(\$207)	(29)	(0.002)
Laboratory: Scientific and Teaching	672	255	23.6	\$1,949	298	0.016
Laundry Area	1,200	84	7.0	\$614	83	0.004
Library : Reading Area	720	162	13.5	\$1,190	164	0.009

Primary Function Area	Prototype Area (sf)	Prototype Annual Energy Savings (kWh/yr)	Prototype Demand Savings (W)	Prototype Energy Cost Savings (PV\$)	Prototype Source Energy Savings (kBtu/yr)	GHG Savings Tonnes CO2e/yr
Library : Stacks Area	360	78	6.5	\$570	79	0.004
Lobby: Elevator	640	0	0.0	\$0	0	0.000
Lobby: Main entry	1,800	(303)	(29.4)	(\$2,435)	(397)	(0.021)
Lobby: Performing Arts	2,400	(404)	(39.2)	(\$3,246)	(529)	(0.028)
Locker Room	200	39	3.2	\$281	38	0.002
Lounge, Breakroom, or Waiting Area	480	159	15.4	\$1,277	208	0.011
Manufacturing & Commercial Work Area: Low Bay	4,800	(376)	(29.9)	(\$2,694)	(351)	(0.019)
Manufacturing & Commercial Work Area: High Bay	12,000	0	0.0	\$0	0	0.000
Manufacturing & Commercial Work Area: Precision	4,800	679	54.1	\$4,866	635	0.034
Motion picture: Theater area	1,560	924	89.6	\$7,423	1210	0.064
Museum: Exhibition/Display	2,184	1,103	106.9	\$8,862	1445	0.076
Museum Area: Restoration Room	2,400	404	39.2	\$3,246	529	0.028
Office Area: ≤ 250 square feet	140	18	1.5	\$130	18	0.001
Office Area: > 250 square feet	600	70	5.8	\$511	70	0.004
Office: Conference Room	600	209	17.4	\$1,534	211	0.011
Parking Garage Area: Parking Zone and Ramps	7,200	977	105.5	\$8,214	1494	0.079
Parking Garage Area: Daylight Adaptation Zones ⁸	1,980	2,943	318.0	\$24,751	4502	0.238
Performance : Theater area	16,000	8,080	783.4	\$64,924	10587	0.560
Performance : Dressing room	80	0	0.0	\$0	0	0.000
Pharmacy Area	480	0	0.0	\$0	0	0.000
Retail: Concourse	12,000	6,328	521.3	\$46,029	6225	0.329
Retail: Grocery Sales	4,800	2,449	201.8	\$17,815	2409	0.127
Retail: Merchandise Sales	4,800	750	61.8	\$5,458	738	0.039
Retail: Fitting Room	60	21	1.7	\$153	21	0.001
Religious Worship Area	8,000	5,394	523.0	\$43,343	7068	0.374
Restrooms	200	23	1.9	\$170	23	0.001
Stairwell	360	23	1.9	\$172	24	0.001
Sports Arena – Playing Area: Class I Facility ¹¹	5,000	0	0.0	\$0	0	0.000
Sports Arena – Playing Area: Class II Facility ¹¹	5,000	0	0.0	\$0	0	0.000

Primary Function Area	Prototype Area (sf)	Prototype Annual Energy Savings (kWh/yr)	Prototype Demand Savings (W)	Prototype Energy Cost Savings (PV\$)	Prototype Source Energy Savings (kBtu/yr)	GHG Savings Tonnes CO2e/yr
Sports Arena – Playing Area: Class III Facility ¹¹	5,000	946	78.0	\$6,884	931	0.049
Sports Arena – Playing Area: Class IV Facility ¹¹	5,000	645	53.2	\$4,694	635	0.034
Transportation: Baggage Area	5,400	0	0.0	\$0	0	0.000
Transportation: Concourse	12,000	6,060	587.6	\$48,693	7940	0.420
Transportation : Ticketing Area	2,000	337	32.6	\$2,705	441	0.023
Transportation: Waiting area	4,000	2,693	261.1	\$21,641	3529	0.187
Videoconferencing Studio ¹²	828	331	27.6	\$2,429	335	0.018
Warehouse: Storage	800	0	0.0	\$0	0	0.000
Warehouse: Shipping and Handling	1,800	0	0.0	\$0	0	0.000

5.3 Incremental First Cost

Incremental first cost represents the difference in upfront cost between the proposed code requirement and an equivalent baseline design. Because incremental cost is a key input to overall cost-effectiveness, the Statewide CASE Team relied on cost data collected at a defined point in time and did not speculate about future market shifts, including potential tariff impacts. All costs cited in this analysis reflect prices collected in 2025.

These costs reflect the costs in the 2028 Title 24 model for the base lighting power allowance and does not include the evaluation of decorative and display lighting which will be presented in the final report. This model informs the LPDs selected for the base lighting power allowance

To determine equipment cost, luminaire pricing was collected from a distributor with a broad range of manufactures they were serving. Sample project sizes were used to obtain consistent pricing across luminaires selected. To ensure consistent comparison between the baseline and the proposed design, the analysis used the same grade of luminaire for both cases. All prices are presented in 2025 dollars to maintain internal consistency and avoid mixing cost assumptions from different periods.

Incremental first cost is based only on cost differences in luminaires and does not include installation costs as the installation costs are essentially the same for the base case and the proposed case. The proposed case is using a higher efficacy luminaire which in some cases is less expensive than a lower efficacy luminaire representative of the efficacies available when the 2022 standards were developed.

In Table 9, the descriptive average efficacy, luminous flux, and input wattage reflect simple averages of the multiple luminaires sampled within each prototype luminaire category. Average efficacy is the mean of individual product efficacy, rather than being calculated by dividing average lumens by average watts.

Table 9: Luminaire Costs

Representative Year Luminaire Type	Size	Avg Watts	Avg Lumens	Avg Efficacy (Lm/W)	Avg Luminaire Cost (\$)
2022 - Basket Troffer	2X2	32	3,523	110	\$305.54
2028 - Basket Troffer	2X2	26	3,374	130	\$146.06
2022 - Basket Troffer	2X4	63	6,897	110	\$329.44
2028 - Basket Troffer	2X4	49	6,638	135	\$127.42
2022 - Lensed panel troffers	2X2	31	3,487	114	\$51.31
2028 - Lensed panel troffers	2X2	29	3,608	125	\$65.00
2022 - Lensed panel troffers	2X4	54	5,864	108	\$89.86
2028 - Lensed panel troffers	2X4	53	6,890	129	\$105.67
2022 - Linear Light Slots	4-inch	23	2,233	94	\$340.44
2028 - Linear Light Slots	4-inch	14	1,679	123	\$391.88
2022 - Linear Light Slots	6-inch	36	4,004	110	\$421.21
2028 - Linear Light Slots	6-inch	50	5,803	116	\$401.25
2022 - Linear Cove Lights	4-ft Section	39	4,124	105	\$676.25
2028 - Linear Cove Lights	4-ft Section	26	3,075	118	\$381.96
2022 - Linear Indirect/Direct Pendants	4-ft Section	49	5,665	116	\$506.05
2028 - Linear Indirect/Direct Pendants	4-ft Section	26	3,429	131	\$550.00
2022 - Indirect/Direct Pendant Bowl Luminaire	36" to 60" dia.	140	11,705	85	\$3,488.75
2028 - Indirect/Direct Pendant Bowl Luminaire	36" to 60" dia.	131	16,370	122	\$4,715.13
2022 - Downlight	4-inch (low)	22	1,622	75	\$239.75
2028 - Downlight	4-inch (low)	25	2,520	98	\$228.60
2022 - Downlight	4-inch (med)	32	2,458	77	\$249.75
2028 - Downlight	4-inch (med)	27	2,706	100	\$231.90
2022 - Downlight	6-inch (med)	15	1,238	81	\$200.92
2028 - Downlight	6-inch (med)	35	3,235	94	\$285.94
2022 - Downlight	6-inch (high)	54	4,785	89	\$161.44
2028 - Downlight	6-inch (high)	56	5,836	104	\$244.56
2022 - Under counter strip	4ft Standard	17	1,224	73	\$168.98
2028 - Under counter strip	4ft Standard	15	1,671	109	\$221.49
2022 - Under counter strip	4ft High Output	29	2,856	100	\$310.50
2028 - Under counter strip	4ft High Output	20	2,308	113	\$258.52
2022 - Low bay		88	12,870	146	\$276.38
2028 - Low bay		101	15,353	151	\$251.83

Representative Year Luminaire Type	Size	Avg Watts	Avg Lumens	Avg Efficacy (Lm/W)	Avg Luminaire Cost (\$)
2022 - High Bay		242	35,600	147	\$161.75
2028 - High Bay		220	33,059	151	\$178.03
2022 - Strip Luminaires	Low output 4ft	41	4,458	114	\$218.27
2028 - Strip Luminaires	Low output 4ft	32	4,678	148	\$164.65
2022 - Strip Luminaires	High output 8ft	107	12,582	119	\$274.63
2028 - Strip Luminaires	High output 8ft	76	11,047	146	\$240.97
2022 - Parking garage	Low output	32	3,454	111	\$585.35
2028 - Parking garage	Low output	31	4,222	136	\$484.06
2022 - Parking garage	High Output	62	6,866	112	\$632.57
2028 - Parking garage	High Output	54	7,406	137	\$519.90

5.4 Incremental Maintenance and Replacement Costs

The incremental cost of materials reflects the price of luminaires capable of meeting the proposed LPD requirements while still achieving the intended illumination levels. No incremental labor cost is anticipated because installation practices are the same as those under current code. Based on industry publications and practitioner input, LED luminaires have an estimated useful life (EUL) of 50,000 hours. Replacement costs are calculated as the discounted value at a 3% real discount rate on the year 50,000 hour full load hours are achieved.

For the purposes of this assessment, the Statewide CASE Team compared LED products collected in 2025 by the Statewide CASE Team with those evaluated for the 2022 cycle. Because both the baseline and proposed conditions rely on long-life LED technologies, the expected maintenance profiles are fundamentally similar. As a result, differences in relamping, repair, or other scheduled maintenance are negligible, and no incremental maintenance cost is assigned.

Persistence of energy savings is expected to remain stable through the analysis period. Performance verification at turnover and adherence to typical facility-management practices are sufficient to maintain performance.

5.5 Cost Effectiveness

Results of the cost-effectiveness analyses for each space type are presented in Table 10.

All incremental equipment cost values are presented in 2026 present value dollars while the systemwide energy cost savings benefit is provided in 2026 present value dollars. Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current

maintenance costs, and incremental residual value if the proposed residual value is greater than the current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero or negative, the benefit-cost ratio (BCR) is considered infinite. In a few cases energy consumption increases. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate.

Table 10: 30-Year Cost-Effectiveness Summary Per Space Type

Primary Function Areas	Wattage Reduction (W)	30 Year PV Savings LSC (2029 PV\$)	Incremental Cost Including Replacements (\$)	B/C ratio
Aging Eye/Low-vision:1 Corridor Area	54	\$912	-\$777	Infinite
Aging Eye/Low-vision:1 Dining	157	\$6,155	-\$4,057	Infinite
Aging Eye/Low-vision:1 Main Entry Lobby	171	\$4,622	-\$4,873	Infinite
Aging Eye/Low-vision:1 Lounge/Waiting Area	108	\$2,920	-\$2,036	Infinite
Aging Eye/Low-vision:1 Multipurpose Room	93	\$2,520	-\$1,337	Infinite
Aging Eye/Low-vision:1 Religious Worship Area	44	\$1,202	-\$1,268	Infinite
Aging Eye/Low-vision:1 Restroom	34	\$576	-\$733	Infinite
Aging Eye/Low-vision:1 Stairwell	18	\$302	-\$359	Infinite
Atria < 20 ft tall (used to be atria concourse)	427	\$10,911	\$849	12.85
Atria 20 to < 40 ft (used to be atria concourse)	450	\$11,505	\$7,479	1.54
Atria > 40 ft (used to be atria concourse)	-481	-\$12,294	\$25,466	Increased Energy
Audience Seating Area	141	\$3,805	-\$688	Infinite
Auditorium Area	875	\$23,677	-\$4,282	Infinite
Auto Repair / Maintenance Area	1,355	\$27,476	-\$10,920	Infinite
Barber, Beauty Salon and Spa Area	343	\$8,773	-\$4,464	Infinite
Civic Meeting Room	37	\$1,014	-\$780	Infinite
Convention Center: Ballroom (used to be multipurpose)	462	\$12,498	-\$4,575	Infinite
Convention: Concourse (used to be atria concourse)	25	\$668	\$2,008	0.33
Convention: Exhibit Space (used to be multipurpose)	2,417	\$65,377	-\$13,996	Infinite
Convention: Meeting Room (used to be multipurpose)	-92	-\$2,478	\$2,019	Increased Energy
Control room (new)	37	\$748	\$1,540	0.49
Copy Room	-6	-\$108	\$143	Increased Energy
Corridor Area	-9	-\$155	\$161	Increased Energy

Primary Function Areas	Wattage Reduction (W)	30 Year PV Savings LSC (2029 PV\$)	Incremental Cost Including Replacements (\$)	B/C ratio
Data center: Computer room (new)		\$0	\$2,736	0.00
Dining Area: Bar/Lounge and Fine Dining	317	\$12,426	-\$7,845	Infinite
Dining Area: Cafeteria/Fast Food	87	\$3,422	-\$1,816	Infinite
Dining Area: Family and Leisure	63	\$2,462	-\$1,571	Infinite
Kitchen/Food Preparation Area	39	\$1,523	-\$146	Infinite
Education/Business: Classroom, Training,	29	\$466	-\$414	Infinite
Educational, civic: Multipurpose room (art, music etc)	125	\$1,991	-\$2,419	Infinite
Electrical, Mechanical, Telephone Rooms	35	\$419	-\$186	Infinite
Exercise/Fitness Center and Gymnasium Area	-187	-\$4,791	\$513	Increased Energy
Financial Transaction Area	81	\$1,378	-\$1,446	Infinite
Healthcare: Corridor (new)		\$0	\$9,846	0.00
Healthcare: Exam/Treatment Room	24	\$519	-\$434	Infinite
Healthcare: Imaging Room	14	\$308	-\$279	Infinite
Healthcare: Medical Supply Room	108	\$2,325	-\$1,634	Infinite
Healthcare: Nursery	-20	-\$422	\$175	Increased Energy
Healthcare: Nurse's Station	18	\$380	-\$253	Infinite
Healthcare: Operating Room	319	\$6,895	-\$4,846	Infinite
Healthcare: Patient Room - Critical care (new)		\$0	\$436	0.00
Healthcare: Patient Room - General	44	\$957	-\$771	Infinite
Healthcare: Physical Therapy Room	59	\$1,279	-\$1,075	Infinite
Healthcare: Recovery Room	49	\$1,050	-\$668	Infinite
Laboratory: Scientific and Teaching	41	\$1,190	-\$145	Infinite
Laundry Area	-26	-\$660	\$406	Increased Energy
Library : Reading Area	58	\$996	-\$848	Infinite
Library : Stacks Area	40	\$687	-\$714	Infinite
Lobby: Elevator	33	\$889	-\$866	Infinite
Lobby: Main entry	166	\$4,483	-\$2,690	Infinite
Lobby: Performing Arts	156	\$4,227	-\$1,218	Infinite
Locker Room	17	\$431	-\$47	Infinite
Lounge, Breakroom, or Waiting Area	17	\$458	-\$289	Infinite
Manufacturing & Commercial Work Area: Low Bay	137	\$2,768	-\$966	Infinite
Manufacturing & Commercial Work Area: High Bay	828	\$16,795	-\$6,650	Infinite

Primary Function Areas	Wattage Reduction (W)	30 Year PV Savings LSC (2029 PV\$)	Incremental Cost Including Replacements (\$)	B/C ratio
Manufacturing & Commercial Work Area: Precision	749	\$15,183	-\$3,808	Infinite
Motion picture: Theater area	215	\$5,828	-\$3,233	Infinite
Museum: Exhibition/Display	-22	-\$602	\$286	Increased Energy
Museum Area: Restoration Room	334	\$9,028	-\$5,063	Infinite
Office Area: ≤ 250 square feet	10	\$174	-\$192	Infinite
Office Area: > 250 square feet	46	\$784	-\$668	Infinite
Office: Conference Room	70	\$1,198	-\$1,094	Infinite
Parking Garage Area: Parking Zone and Ramps	105	\$5,949	-\$5,776	Infinite
Parking Garage Area: Daylight Adaptation Zones ⁸	176	\$9,970	-\$5,315	Infinite
Performance : Theater area	1,727	\$46,707	-\$22,186	Infinite
Performance : Dressing room	5	\$135	-\$64	Infinite
Pharmacy Area	54	\$1,378	-\$623	Infinite
Retail: Concourse	297	\$7,601	-\$3,682	Infinite
Retail: Grocery Sales	715	\$18,283	-\$15,597	Infinite
Retail: Merchandise Sales	146	\$3,735	-\$1,188	Infinite
Retail: Fitting Room	10	\$245	-\$124	Infinite
Religious Worship Area	1,486	\$40,201	-\$9,168	Infinite
Restrooms	-63	-\$1,070	\$1,452	Increased Energy
Stairwell	10	\$169	-\$82	Infinite
Sports Arena – Playing Area: Class I Facility ¹¹	2,359	\$60,314	-\$2,612	Infinite
Sports Arena – Playing Area: Class II Facility ¹¹	1,572	\$40,209	-\$1,741	Infinite
Sports Arena – Playing Area: Class III Facility ¹¹	279	\$7,137	-\$1,451	Infinite
Sports Arena – Playing Area: Class IV Facility ¹¹	186	\$4,758	-\$967	Infinite
Transportation: Baggage Area	162	\$4,373	-\$8,073	Infinite
Transportation: Concourse (used to be atria concourse)	221	\$5,971	-\$890	Infinite
Transportation : Ticketing Area	-175	-\$4,727	\$2,810	Increased Energy
Transportation: Waiting area (used to be atria concourse)	17	\$455	\$5,139	0.09
Videoconferencing Studio ¹²	136	\$2,310	-\$1,966	Infinite
Warehouse: Storage	63	\$766	-\$199	Infinite
Warehouse: Shipping and Handling	57	\$695	-\$191	Infinite

The ratio of proposed (2028 design) equipment costs to the base case (2022 design) equipment costs ranged from 42% to 250% (where task criteria changed) with an average cost ratio of 92%. Thus achieving base lighting (non-decorative) levels with luminaires that are of the average efficacy found in the 2028 market cost 8% less than complying with lower efficacy luminaires that were representative of the market in 2022, but which can still be specified today.

It is worth noting that there are several space types which originally were combined in the building use type "Convention, Conference, Multipurpose and Meeting Area" these now have specific prototypes and design illuminance tailored to their application. These include: Convention Center: ballroom, exhibit space, meeting room, Educational and Civic: Multipurpose room (music, art etc), and Office: conference room. Some of these spaces have greater lighting needs and thus increased energy others had lower needs and not only saved energy but also saved on first costs. This same pattern is seen for reallocating the model from a single "concourse/atria" primary function areas to separate function areas for: atria < 20 ft, atria 20 to 40 ft and atria > 40 ft. The shorter atria required less lighting power and save both energy and first costs whereas the taller atria used more energy and had a higher first cost.

6. Statewide Impacts

6.1 Statewide Energy and Energy Cost Savings

The 2028 CASE Methodology Report contains details on how statewide savings are calculated. Appendix C presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

The tables below present the technical potential of the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 11) and alterations (Table 12).

Table 11: Technical Potential of First Year Statewide Energy and LSC Impacts – New Construction and Additions

Primary Function Area	Statewide New Construction & Additions (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Aging Eye/Low-vision:1 Corridor Area	0.03	0.01	1.0	0.0	\$0.09
Aging Eye/Low-vision:1 Dining	0.03	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Main Entry Lobby	0.03	0.02	2.0	0.0	\$0.17
Aging Eye/Low-vision:1 Lounge/Waiting Area	0.03	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Multipurpose Room	0.03	0.00	0.4	0.0	\$0.03
Aging Eye/Low-vision:1 Religious Worship Area	0.03	0.01	0.8	0.0	\$0.07
Aging Eye/Low-vision:1 Restroom	0.03	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Stairwell	0.03	0.00	0.0	0.0	\$0.00
Atria < 20 ft tall	0.33	0.41	33.8	0.4	\$2.98
Atria 20 to < 40 ft	0.14	0.10	8.1	0.1	\$0.71
Atria > 40 ft	0.02	0.00	0.4	0.0	\$0.03
Audience Seating Area	1.58	0.53	51.7	0.7	\$4.28
Auditorium Area	0.98	0.66	64.0	0.9	\$5.31
Auto Repair / Maintenance Area	3.22	0.00	0.0	0.0	\$0.00
Barber, Beauty Salon and Spa Area	0.36	0.13	10.5	0.1	\$0.93
Civic Meeting Room	0.07	0.04	3.5	0.0	\$0.29
Convention Center: Ballroom	0.05	0.02	2.2	0.0	\$0.18
Convention: Concourse	0.17	0.09	8.6	0.1	\$0.71
Convention: Exhibit Space	0.17	0.15	14.3	0.2	\$1.18
Convention: Meeting Room	0.17	0.06	5.7	0.1	\$0.47
Control room	0.08	0.00	0.0	0.0	\$0.00
Copy Room	1.13	0.13	10.9	0.1	\$0.96

Primary Function Area	Statewide New Construction & Additions (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Corridor Area	5.35	0.00	0.0	0.0	\$0.00
Data center: Computer room	2.13	0.00	0.0	0.0	\$0.00
Dining Area: Bar/Lounge and Fine Dining	0.28	0.07	6.7	0.1	\$0.55
Dining Area: Cafeteria/Fast Food	1.79	0.43	43.3	0.6	\$3.52
Dining Area: Family and Leisure	0.64	0.15	15.3	0.2	\$1.25
Kitchen/Food Preparation Area	1.98	0.95	95.7	1.3	\$7.78
Education/Business: Classroom, Training,	5.05	0.48	42.5	0.5	\$3.62
Educational, civic: Multipurpose room (art, music etc)	0.71	0.07	6.6	0.1	\$0.56
Electrical, Mechanical, Telephone Rooms	2.44	0.00	0.0	0.0	\$0.00
Exercise/Fitness Center and Gymnasium Area	1.99	(0.35)	(28.7)	(0.3)	(\$2.54)
Financial Transaction Area	1.45	0.40	33.7	0.4	\$2.97
Healthcare: Corridor	0.59	0.00	0.0	0.0	\$0.00
Healthcare: Exam/Treatment Room	1.56	0.23	19.2	0.2	\$1.69
Healthcare: Imaging Room	0.09	0.00	0.0	0.0	\$0.00
Healthcare: Medical Supply Room	0.06	0.01	0.7	0.0	\$0.07
Healthcare: Nursery	0.07	(0.02)	(1.7)	(0.0)	(\$0.15)
Healthcare: Nurse's Station	0.11	0.02	1.4	0.0	\$0.12
Healthcare: Operating Room	0.07	0.02	1.7	0.0	\$0.15
Healthcare: Patient Room - Critical care	0.10	0.00	0.0	0.0	\$0.00
Healthcare: Patient Room - General	0.24	(0.04)	(3.0)	(0.0)	(\$0.26)
Healthcare: Physical Therapy Room	0.14	0.04	3.5	0.0	\$0.30
Healthcare: Recovery Room	0.07	(0.01)	(0.9)	(0.0)	(\$0.08)
Laboratory: Scientific and Teaching	0.41	0.15	14.3	0.2	\$1.18
Laundry Area	0.34	0.02	2.0	0.0	\$0.17
Library : Reading Area	0.19	0.04	3.5	0.0	\$0.31
Library : Stacks Area	0.16	0.03	2.8	0.0	\$0.25
Lobby: Elevator	0.29	0.00	0.0	0.0	\$0.00
Lobby: Main entry	4.10	(0.69)	(66.9)	(0.9)	(\$5.54)
Lobby: Performing Arts	0.31	(0.05)	(5.1)	(0.1)	(\$0.42)
Locker Room	0.80	0.16	12.8	0.2	\$1.13
Lounge, Breakroom, or Waiting Area	2.32	0.77	74.4	1.0	\$6.16
Manufacturing & Commercial Work Area: Low Bay	3.09	(0.24)	(19.3)	(0.2)	(\$1.74)
Manufacturing & Commercial Work Area: High Bay	1.00	0.00	0.0	0.0	\$0.00

Primary Function Area	Statewide New Construction & Additions (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Manufacturing & Commercial Work Area: Precision	0.20	0.03	2.3	0.0	\$0.20
Motion picture: Theater area	0.59	0.35	33.8	0.5	\$2.80
Museum: Exhibition/Display	0.25	0.13	12.3	0.2	\$1.02
Museum Area: Restoration Room	0.04	0.01	0.7	0.0	\$0.06
Office Area: ≤ 250 square feet	10.88	1.38	114.7	1.4	\$10.10
Office Area: > 250 square feet	12.35	1.43	119.6	1.5	\$10.52
Office: Conference Room	1.41	0.49	41.1	0.5	\$3.61
Parking Garage Area: Parking Zone and Ramps	16.45	2.23	241.1	3.4	\$18.77
Parking Garage Area: Daylight Adaptation Zones ⁸	0.73	1.08	116.8	1.7	\$9.09
Performance : Theater area	0.58	0.29	28.5	0.4	\$2.36
Performance : Dressing room	0.03	0.00	0.0	0.0	\$0.00
Pharmacy Area	0.22	0.00	0.0	0.0	\$0.00
Retail: Concourse	1.72	0.91	74.6	0.9	\$6.59
Retail: Grocery Sales	0.36	0.18	15.1	0.2	\$1.33
Retail: Merchandise Sales	14.41	2.25	185.6	2.2	\$16.39
Retail: Fitting Room	0.25	0.09	7.1	0.1	\$0.63
Religious Worship Area	1.16	0.78	75.7	1.0	\$6.27
Restrooms	3.72	0.43	36.0	0.4	\$3.17
Stairwell	1.67	0.11	9.0	0.1	\$0.80
Sports Arena – Playing Area: Class I Facility ¹¹	0.08	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class II Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class III Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class IV Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Transportation: Baggage Area	0.02	0.00	0.0	0.0	\$0.00
Transportation: Concourse	0.13	0.07	6.4	0.1	\$0.53
Transportation : Ticketing Area	0.04	0.01	0.7	0.0	\$0.06
Transportation: Waiting area	0.09	0.06	5.7	0.1	\$0.47
Videoconferencing Studio ¹²	0.28	0.11	9.2	0.1	\$0.81
Warehouse: Storage	15.39	0.00	0.0	0.0	\$0.00
Warehouse: Shipping and Handling	3.58	0.00	0.0	0.0	\$0.00
Totals	135.24	17.42	1,608.6	20.9	\$135.05

Table 12: Technical Potential of Statewide Energy and LSC Impacts – Alterations

Primary Function Area	Statewide Alterations (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Aging Eye/Low-vision:1 Corridor Area	0.10	0.05	3.9	0.0	\$0.35
Aging Eye/Low-vision:1 Dining	0.10	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Main Entry Lobby	0.10	0.09	8.3	0.1	\$0.69
Aging Eye/Low-vision:1 Lounge/Waiting Area	0.10	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Multipurpose Room	0.10	0.02	1.7	0.0	\$0.14
Aging Eye/Low-vision:1 Religious Worship Area	0.10	0.03	3.3	0.0	\$0.28
Aging Eye/Low-vision:1 Restroom	0.10	0.00	0.0	0.0	\$0.00
Aging Eye/Low-vision:1 Stairwell	0.10	0.00	0.0	0.0	\$0.00
Atria < 20 ft tall	1.34	1.65	136.1	1.6	\$12.02
Atria 20 to < 40 ft	0.62	0.43	35.8	0.4	\$3.16
Atria > 40 ft	0.11	0.02	1.6	0.0	\$0.14
Audience Seating Area	6.91	2.33	225.5	3.0	\$18.69
Auditorium Area	4.24	2.85	276.8	3.7	\$22.94
Auto Repair / Maintenance Area	15.68	0.00	0.0	0.0	\$0.00
Barber, Beauty Salon and Spa Area	1.57	0.55	45.4	0.5	\$4.01
Civic Meeting Room	0.75	0.38	36.7	0.5	\$3.04
Convention Center: Ballroom	0.20	0.10	9.6	0.1	\$0.80
Convention: Concourse	0.77	0.39	37.5	0.5	\$3.11
Convention: Exhibit Space	0.77	0.64	62.5	0.8	\$5.18
Convention: Meeting Room	0.77	0.26	25.0	0.3	\$2.07
Control room	0.35	0.00	0.0	0.0	\$0.00
Copy Room	4.24	0.49	41.0	0.5	\$3.61
Corridor Area	23.55	0.00	0.0	0.0	\$0.00
Data center: Computer room	10.41	0.00	0.0	0.0	\$0.00
Dining Area: Bar/Lounge and Fine Dining	1.04	0.25	25.0	0.3	\$2.04
Dining Area: Cafeteria/Fast Food	7.72	1.85	186.5	2.6	\$15.16
Dining Area: Family and Leisure	2.28	0.55	55.1	0.8	\$4.48
Kitchen/Food Preparation Area	8.54	4.09	412.8	5.7	\$33.55
Education/Business: Classroom, Training,	22.52	2.13	189.6	2.3	\$16.17
Educational, civic: Multipurpose room (art, music etc)	2.90	0.31	27.2	0.3	\$2.32
Electrical, Mechanical, Telephone Rooms	11.08	0.00	0.0	0.0	\$0.00
Exercise/Fitness Center and Gymnasium Area	8.24	(1.45)	(119.3)	(1.4)	(\$10.54)

Primary Function Area	Statewide Alterations (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Financial Transaction Area	5.00	1.39	116.1	1.4	\$10.22
Healthcare: Corridor	2.73	0.00	0.0	0.0	\$0.00
Healthcare: Exam/Treatment Room	7.17	1.04	88.3	1.1	\$7.74
Healthcare: Imaging Room	0.40	0.00	0.0	0.0	\$0.00
Healthcare: Medical Supply Room	0.28	0.04	3.4	0.0	\$0.30
Healthcare: Nursery	0.32	(0.09)	(7.9)	(0.1)	(\$0.69)
Healthcare: Nurse's Station	0.52	0.08	6.4	0.1	\$0.56
Healthcare: Operating Room	0.32	0.09	7.9	0.1	\$0.69
Healthcare: Patient Room - Critical care	0.44	0.00	0.0	0.0	\$0.00
Healthcare: Patient Room - General	1.12	(0.16)	(13.8)	(0.2)	(\$1.21)
Healthcare: Physical Therapy Room	0.64	0.19	15.9	0.2	\$1.39
Healthcare: Recovery Room	0.32	(0.05)	(3.9)	(0.0)	(\$0.35)
Laboratory: Scientific and Teaching	2.25	0.85	78.8	1.0	\$6.52
Laundry Area	1.95	0.14	11.3	0.1	\$1.00
Library : Reading Area	0.74	0.17	14.0	0.2	\$1.23
Library : Stacks Area	0.62	0.13	11.2	0.1	\$0.98
Lobby: Elevator	1.24	0.00	0.0	0.0	\$0.00
Lobby: Main entry	17.17	(2.89)	(280.3)	(3.8)	(\$23.23)
Lobby: Performing Arts	1.35	(0.23)	(22.1)	(0.3)	(\$1.83)
Locker Room	4.11	0.79	65.4	0.8	\$5.78
Lounge, Breakroom, or Waiting Area	11.16	3.69	358.1	4.8	\$29.68
Manufacturing & Commercial Work Area: Low Bay	27.02	(2.12)	(168.5)	(2.0)	(\$15.17)
Manufacturing & Commercial Work Area: High Bay	13.09	0.00	0.0	0.0	\$0.00
Manufacturing & Commercial Work Area: Precision	2.62	0.37	29.5	0.3	\$2.65
Motion picture: Theater area	2.64	1.57	151.8	2.1	\$12.58
Museum: Exhibition/Display	1.10	0.56	54.0	0.7	\$4.48
Museum Area: Restoration Room	0.19	0.03	3.1	0.0	\$0.26
Office Area: ≤ 250 square feet	45.06	5.70	475.2	5.8	\$41.83
Office Area: > 250 square feet	46.71	5.42	452.2	5.5	\$39.81
Office: Conference Room	5.31	1.85	154.2	1.9	\$13.58
Parking Garage Area: Parking Zone and Ramps	31.69	4.30	464.4	6.6	\$36.15
Parking Garage Area: Daylight Adaptation Zones ⁸	1.40	2.08	224.9	3.2	\$17.51
Performance : Theater area	2.53	1.28	123.7	1.7	\$10.25
Performance : Dressing room	0.15	0.00	0.0	0.0	\$0.00

Primary Function Area	Statewide Alterations (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
Pharmacy Area	1.23	0.00	0.0	0.0	\$0.00
Retail: Concourse	10.66	5.62	463.1	5.5	\$40.89
Retail: Grocery Sales	2.48	1.27	104.2	1.2	\$9.20
Retail: Merchandise Sales	91.67	14.33	1,180.6	14.1	\$104.24
Retail: Fitting Room	1.53	0.54	44.3	0.5	\$3.91
Religious Worship Area	5.07	3.42	331.7	4.5	\$27.49
Restrooms	17.11	1.99	165.7	2.0	\$14.58
Stairwell	7.05	0.46	38.2	0.5	\$3.36
Sports Arena – Playing Area: Class I Facility ¹¹	0.36	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class II Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class III Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Sports Arena – Playing Area: Class IV Facility ¹¹	0.00	0.00	0.0	0.0	\$0.00
Transportation: Baggage Area	0.10	0.00	0.0	0.0	\$0.00
Transportation: Concourse	0.57	0.29	28.1	0.4	\$2.33
Transportation : Ticketing Area	0.19	0.03	3.1	0.0	\$0.26
Transportation: Waiting area	0.38	0.26	25.0	0.3	\$2.07
Videoconferencing Studio ¹²	1.07	0.43	35.5	0.4	\$3.13
Warehouse: Storage	75.85	0.00	0.0	0.0	\$0.00
Warehouse: Shipping and Handling	17.60	0.00	0.0	0.0	\$0.00
Totals	609.67	72.84	6,560.5	83.9	\$557.54

Table 13 summarizes the technical potential of first-year statewide savings from new construction, additions, and alterations.

Table 13: Technical Potential of First-Year Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	Annual Construction (Million sf/yr)	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
New Construction	135	17.4	1,609	21	\$135
Additions and Alterations	610	72.8	6,561	84	\$558
STATEWIDE TOTALS	745	90.3	8,169	105	\$693

After applying the statewide market probability adjustment factors described in Appendix C, the technical potential savings are derated to 58 percent for new

construction and derated to 43 percent for alterations. Table 14 summarizes the market adjusted first-year statewide savings from new construction, additions, and alterations.

Table 14 Market Adjusted Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations

Construction Type	First-year Electricity Savings (GWh/yr)	Peak Electrical Demand Saving (kW)	Source Energy Savings (Million kBtu/yr)	30-Year LSC Savings (Million 2029 PV\$)
New Construction	10.1	933	12.1	\$78
Additions and Alterations	31.3	2,821	36.1	\$240
STATEWIDE TOTALS	41.4	3,754	48.2	\$318

6.2 Statewide Greenhouse Gas Emissions Reductions

Table 15 presents the market adjusted estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 5,427 metric tons of carbon dioxide equivalent (CO₂e) emissions. These reductions, along with their associated monetary value, at \$123.15 per metric ton, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC’s 2028 Metrics Report. See the 2028 CASE Methodology Report for additional information. On average the statewide total GHG emission reduction is 59 metric tons CO₂ equivalent per GWh saved. This is about 2/3s of the 90 tons per GWh from a 24/7 continuous load reduction would be saving. The lower tons per GWh reflects that many of the loads reduced are during daytime which has higher levels of renewable generation and less carbon emissions per unit of electricity.

Table 15: Market Adjusted First-Year Statewide GHG Emissions Impacts

Construction Type	Electricity Savings (GWh/yr)	Reduced GHG Emissions (Metric Ton CO ₂ e/yr)	Annualized Cost GHG reduction (\$/yr)
New Construction	10.1	642	\$79,067
Additions and Alterations	31.3	1,769	\$217,880
STATEWIDE TOTAL	41.4	2,411	\$296,947

6.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts.

6.4 Statewide Material Impacts

The Statewide CASE Team estimated material impacts using the following methodology:

- Estimated the material composition of a typical luminaire.
- Estimated the number of luminaires in California (based on construction forecasts) under 2025 LPDs.
- Estimated the number of luminaires in California (based on construction forecasts) under proposed 2028 LPDs.
- Calculated the difference in luminaire counts between 2025 and proposed 2028 LPDs, and therefore the difference in materials required.

The Statewide CASE Team estimated luminaire material composition using a 2012 study on metals contained within different lamp types, including LEDs (Lim et al., 2013). The study provides estimated quantities of various metals present in a typical LED luminaire. While the Statewide CASE Team recognizes that this information may not fully reflect the composition of luminaires manufactured in 2020 and beyond, it was the most comprehensive source identified.

Using the Lim et al. data, the Statewide CASE Team estimated the total material content for luminaire types commonly found in indoor applications. Per-unit material impacts were developed and applied to statewide new construction forecasts, using estimated luminaire quantities associated with both the 2025 LPDs and the proposed 2028 LPDs.

The proposed updates affect statewide material impact by supporting the continued use of existing luminaires when linear LED lamp replacements are installed and additionally basing the deemed wattage of luminaires with line voltage sockets to be based on the total installed lamp wattage instead of “factory-installed maximum rated wattage or relamping rated wattage label.” This clarification supports greater use of lamp-based retrofits in situations where the luminaire housing, optics, and structural components remain serviceable, reducing the need for full fixture replacement.

The Statewide CASE Team is still collecting data and calculating material use. The First-Year Statewide Impacts on Material Use will be presented in the Final CASE Report.

For more information on the Statewide CASE Team’s methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

6.5 Environmental Impacts

The proposed measure is expected to yield positive environmental benefits. By reducing LPDs, the measure lowers energy use, which in turn reduces associated greenhouse gas emissions and upstream generation impacts. Fewer luminaires may also be required in some applications, resulting in reduced material use and minor decreases in associated manufacturing, transportation, and end-of-life impacts.

No significant adverse environmental effects are anticipated. The measure does not introduce new materials, hazardous substances, or processes that would increase environmental burden. Any indirect impact, such as changes in product selection or procurement, are expected to be minimal and consistent with current industry practice.

Reasonable alternatives—such as maintaining current LPD values—were considered but would not achieve the same energy-use reductions or emissions benefits. These alternatives offer no environmental advantage and would not meet the purpose of the proposal. For these reasons, the proposed measure represents the most effective approach with the least environmental effect.

6.6 Other Non-Energy Impacts

The measure may offer minor benefits related to visual comfort and lighting quality where more efficient luminaires can provide improved distribution or reduced glare, but these effects are expected to vary by project and are not central to the proposal. No adverse effects on comfort, safety, or productivity are anticipated, and the measure is not expected to influence property valuation.

In evaluating equipment efficacy, the models used to inform this proposal made use of an increasing fraction of 90+ CRI (color rendering index) equipment. This reflects market trends that have increased the use of 90+ CRI sources, often as the default color rendition. Increased color rendition assists in color discrimination and visibility.

At this time, the Statewide CASE Team has not identified any additional non-energy impacts that would require consideration in the CEC's California Environmental Quality Act analysis for this rulemaking action.

7. Proposed Language Code

7.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions). New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics*.

Markups are provided to the restructured 2025 Energy Code that the CEC developed in response to feedback that aligning the structure of Title 24, Part 6 with other parts of the California Building Standards Code (Title 24) would improve readability, usability, and navigation.⁸ New section numbers are shown as bold followed square brackets that document the section in the 2025 Title 24, Part 6 section numbers prior to the restructuring. For example, “**Section 601.1** [Section 130.0(a)] **General**” contains the content that is in the current Section 130.0(a).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

7.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to the administrative code.

7.3 Energy Code (Title 24, Part 6)

7.3.1 Proposed Changes to Definitions Section

SECTION 201 [100.1] DEFINITIONS

...

This definition identifies which applications are prohibited from having their code requirements changed during the 2028 code cycle by AB 130.

⁸ <https://www.energy.ca.gov/media/12153> for more details see the docket log for docket number 24-BSTD-05 <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=24-BSTD-05>

GROUP R OCCUPANCIES AND COMMON OR PUBLIC USE AREAS: Group R occupancy as defined by the California Building Code and spaces ancillary to the occupancy that are not part of individual dwelling or sleeping units and are intended for shared, common, or public use, including areas that support occupant use or building operations.

7.3.2 Proposed Changes to Lighting Classification and Power for New Construction and Alterations

SECTION 601

NONRESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES

(NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

601.1 [Section 130.0(a)] General.

The design and installation of all *lighting* systems and *equipment* in *nonresidential* and *hotel/motel buildings*, *outdoor lighting*, and *electrical power distribution systems* within the scope of Section 100.3 [Section 100.0(a)], shall comply with the applicable provisions of Section 601 .

NOTE: The requirements of Sections 601.2 through 601.4 apply to *newly constructed buildings*. Section 601.5 applies to *additions* or *alterations* to existing *buildings*.

601.1.1 [Section 130.0(b)] Functional areas where compliance with the single-family residential lighting standards is required.

The design and installation of all *lighting* systems, *lighting* controls and *equipment* in the following functional areas shall comply with the applicable residential *lighting* requirements of Section 602.2.1 [Section 150.0(k)]. In *buildings* containing these functional areas, all other functional areas, such as common areas, shall comply with the applicable nonresidential *lighting* and controlled receptacle requirements.

1. *Outdoor lighting* attached to a *hotel/motel building* and separately controlled from the inside of a guest room.
2. Fire station *dwelling* accommodations.
3. Hotel and motel guest rooms. Additionally, hotel and motel guest rooms shall meet the requirements of Section 601.2.2.3.7 [Section 130.1(c)8] and Section 601.2.6.4.1 [Section 130.5(d)4].

601.2 Mandatory requirements (Newly Constructed, Additions, Alterations).

Note: *This section below splits the changed new requirements for nonresidential occupancies in Section 601.2.1.1 and its subsections from the unchanged requirements in Section 601.2.1.2 and its subsections*

601.2.1 [Section 130.0(c)] Luminaire classification, and power.

Luminaires shall be classified, and their wattage shall be determined and labeled as follows: in accordance with Section 601.2.1.2 for *Group R occupancies and common or public use areas* and in accordance with Section 601.2.1.1 for all other Nonresidential Occupancies

601.2.1.1 Luminaire classification, and power in Nonresidential Occupancies Not Including *Group R occupancies and common or public use areas*.

Luminaires shall be classified, and their wattage shall be determined and labeled as follows:

~~601.2.1.1.1. [Section 130.0(c)1A] Rated wattage label.~~

~~The maximum rated wattage or relamping rated wattage of a *luminaire* shall be listed on a permanent, preprinted, factory installed label, as specified by *UL 1574, 1598, 2108 or 8750*, as applicable.~~

~~601.2.1.2 [Section 130.0(c)1B] Permanent label.~~

~~The factory installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the *luminaire* has been shipped from the manufacturer.~~

~~**Exception to Section 601.2.1.2:** Peel-down labels may be used only for the following *luminaires*, when they can accommodate a range of *lamp* wattages without changing the *luminaire* housing, ballast, transformer or wiring. Qualifying *luminaires* shall have a single *lamp*, and shall have integrated ballasts or transformers. Peel-down labels must be layered such that the rated wattage reduces as successive layers are removed.~~

~~High-intensity discharge *luminaires*, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.~~

~~Low-voltage *luminaires* (except *low voltage* track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.~~

~~Compact fluorescent *luminaires*, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.~~

601.2.1.3 601.2.1.1.1 [Section 130.0(c)2] Luminaires with line voltage lamp holders not served by drivers, ballasts or transformers.

For *luminaires* with line voltage *lamp* holders not served by *drivers*, ballasts, or transformers; the wattage of such *luminaires* shall be ~~determined as the maximum relamping rated wattage as labeled in accordance with Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1].~~ the labeled maximum wattage of the specified and installed lamps or solid state lighting (SSL) light engines.

~~601.2.1.5~~ 601.2.1.1.2 [Section 130.0(c)4] Inseparable Solid State Lighting (SSL) luminaires and SSL luminaires with remotely mounted drivers.

For inseparable *SSL luminaires* and *SSL luminaires* with remotely mounted *drivers*, including luminaires that are field-adjustable, the ~~maximum rated~~ wattage of the *SSL luminaire* shall be the maximum rated wattage of the luminaire ~~as specified in Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1] when tested in accordance with UL 1598, 2108 or 8750, or IES LM-79, listed on a permanent, preprinted, label installed by the manufacturer or manufacturer's authorized representative, as specified by UL 1574, 1598, 2108 or 8750, as applicable~~ .

601.2.1.4 601.2.1.1.3 [Section 130.0(c)3] Luminaires with permanently installed or remotely installed ballasts.

For *luminaires* with permanently installed or remotely installed ballasts, the wattage of such *luminaires* shall be the operating input wattage of the rated *lamp*/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by *UL 1598*.

Note: *The following covers UL Type A retrofits*

601.2.1.1.4 [new] Luminaires with ballasts powering SSL lighting.

Wattage of luminaires containing HID or fluorescent ballasts powering solid state lighting shall be the maximum rated wattage of the ballast.

601.2.1.6 601.2.1.1.5 [Section 130.0(c)5] LED tape lighting.

For *LED tape lighting* and *LED linear lighting* with *LED tape lighting* components, the maximum rated wattage shall be the sum of the installed length of the *tape lighting* times its rated linear power density in watts per linear feet, or the maximum rated input wattage of the *driver* or power supply providing power to the *lighting* system, with *tape lighting* tested in accordance with *UL 2108 or 8750, or IES LM-79*.

601.2.1.7 601.2.1.1.6 [Section 130.0(c)6] Modular lighting systems.

For modular *lighting* systems that allow the addition or relocation of *luminaires* without altering the wiring of the system, shall be determined as follows:

1. The wattage shall be the greater of:
 - 1.1 30 watts per linear foot of track or plug-in busway; or
 - 1.2 the rated wattage of all of the *luminaires* included in the system, where the *luminaire* wattage is determined as specified in Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1].

~~2. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:~~

~~2.1 The volt-ampere rating of the current limiter as specified by UL 1077;
or~~

~~2.2 The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for *track lighting supplementary overcurrent protection panel*.~~

2.3 For other modular *lighting* systems with power supplied by a *driver*, power supply or transformer, including but not limited to low-voltage *lighting* systems, the wattage of the system shall be the maximum rated input wattage of the *driver*, power supply or transformer published in the manufacturer's catalogs, as specified by *UL 2108 or 8750*.

Exception to Section ~~601.2.1.7~~ 601.2.1.1.6 : For power-over-Ethernet *lighting* systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

Note: *The following allows the deemed wattage all lighting system types (not just track lighting) to be the maximum wattage allowed by a current limiter or supplementary overcurrent protection control*

601.2.1.1.7 [new] Current limiters or supplementary overcurrent protection.

For any lighting system controlled by a current limiter or supplementary overcurrent protection panel, the wattage shall be determined as follows:

1. The volt-ampere rating of the current limiter as specified by UL 1077; or
2. The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for the lighting supplementary overcurrent protection panel.

601.2.1.1.8 [Section 130.0(c)7] All other lighting equipment.

For all other *lighting equipment* not addressed by Sections 601.2.1.1.1 through 601.2.1.1.7 [Sections 130.0(c)2 through 6], the wattage of the *lighting equipment* shall be the maximum rated wattage of the *lighting equipment*, or operating input wattage of the system, labeled on a permanent, preprinted, factory installed label, as specified by UL 1574, 1598, 2108 or 8750, as applicable, or published in manufacturer's catalogs, based on independent testing lab reports as specified by *UL 1574, 1598, 2108 or 8750*, or *IES LM-79*.

Note: this section is unchanged from the requirements in the restructured 2025 Title 24 part 6 energy code outside of numbering

601.2.1.2 Group R occupancies and common or public use areas: classification, and power. Luminaires shall be classified, and their wattage shall be determined and labeled as follows:

601.2.1.1 601.2.1.2.1 [Section 130.0(c)1A] Rated wattage label.

The maximum rated wattage or relamping rated wattage of a *luminaire* shall be listed on a permanent, preprinted, factory installed label, as specified by *UL 1574, 1598, 2108 or 8750*, as applicable.

601.2.1.2 601.2.1.2.2 [Section 130.0(c)1B] Permanent label.

The factory-installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the *luminaire* has been shipped from the manufacturer.

Exception to Section 601.2.1.2 601.2.1.2.2: Peel-down labels may be used only for the following *luminaires*, when they can accommodate a range of *lamp* wattages without changing the *luminaire* housing, ballast, transformer or wiring. Qualifying *luminaires* shall have a single *lamp*, and shall have integrated ballasts or transformers. Peel-down labels must be layered such that the rated wattage reduces as successive layers are removed.

1. High-intensity discharge *luminaires*, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.
2. Low-voltage *luminaires* (except *low voltage* track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.
3. Compact fluorescent *luminaires*, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.

601.2.1.3 601.2.1.2.3 [Section 130.0(c)2] Luminaires with line voltage lamp holders not served by drivers, ballasts or transformers.

For *luminaires* with line voltage *lamp* holders not served by *drivers*, ballasts, or transformers; the wattage of such *luminaires* shall be determined as the maximum relamping rated wattage as labeled in accordance with Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1].

601.2.1.4 601.2.1.2.4 [Section 130.0(c)3] Luminaires with permanently installed or remotely installed ballasts.

For *luminaires* with permanently installed or remotely installed ballasts, the wattage of such *luminaires* shall be the operating input wattage of the rated *lamp*/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by *UL 1598*.

601.2.1.5 601.2.1.2.5 [Section 130.0(c)4] Solid State Lighting (SSL).

For inseparable *SSL luminaires* and *SSL luminaires* with remotely mounted *drivers*, the maximum rated wattage shall be the maximum rated input wattage of the *SSL luminaire* as specified in Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1] when tested in accordance with *UL 1598, 2108 or 8750*, or *IES LM-79*.

601.2.1.6 601.2.1.1.6 [Section 130.0(c)5] LED tape lighting.

For *LED tape lighting* and *LED linear lighting* with *LED tape lighting* components, the maximum rated wattage shall be the sum of the installed length of the *tape lighting* times its rated linear power density in watts per linear feet, or the maximum rated input wattage of the *driver* or power supply providing power to the *lighting* system, with *tape lighting* tested in accordance with *UL 2108 or 8750*, or *IES LM-79*.

601.2.1.7 601.2.1.2.7 [Section 130.0(c)6] Modular lighting systems.

For modular *lighting* systems that allow the addition or relocation of *luminaires* without altering the wiring of the system, shall be determined as follows:

1. The wattage shall be the greater of:
 - 1.1 30 watts per linear foot of track or plug-in busway; or
 - 1.2 the rated wattage of all of the *luminaires* included in the system, where the *luminaire* wattage is determined as specified in Sections 601.2.1.1 and 601.2.1.2 [Section 130.0(c)1].
2. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:
 - 2.1 The volt-ampere rating of the current limiter as specified by UL 1077; or
 - 2.2 The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for *track lighting supplementary overcurrent protection panel*.
3. For other modular *lighting* systems with power supplied by a *driver*, power supply or transformer, including but not limited to low-voltage *lighting* systems, the wattage of the system shall be the maximum rated input wattage of the *driver*, power supply or transformer published in the manufacturer's catalogs, as specified by *UL 2108 or 8750*.

Exception to Section 601.2.1.7 601.2.1.2.7: For power-over-Ethernet *lighting* systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

601.2.1.8 601.2.1.2.8 [Section 130.0(c)7] All other lighting equipment.

For all other *lighting equipment* not addressed by Sections [601.2.1.3](#) [601.2.1.2.3](#) through [601.2.1.7](#) [601.2.1.2.7](#) [Sections 130.0(c)2 through 6], the wattage of the *lighting equipment* shall be the maximum rated wattage of the *lighting equipment*, or operating input wattage of the system, labeled in accordance with Sections [601.2.1.4](#) [601.2.1.2.1](#) and [601.2.1.2](#) [601.2.1.2.2](#) [Section 130.0(c)1], or published in manufacturer's catalogs, based on independent testing lab reports as specified by *UL 1574, 1598, 2108 or 8750*, or *IES LM-79*.

Note: *The following change to the alterations section streamlines the use of one-to-one luminaire alterations in nonresidential buildings by limiting its use to post alteration total wattages of no greater than 3,000 Watts which simplifies the use of the Type B and Type C alterations as compared to specifying the total floor area. When floor area is defines the scope, this may require the expense of drawing plans to document the coverage area.*

601.5.2.2 [Section 141.0(b)2] Prescriptive requirements (Alterations).

...

601.5.2.2.4 [Section 141.0(b)2I] Altered indoor lighting systems.

Alterations to indoor *lighting* systems that include 10% or more of the *luminaires* serving an *enclosed space* shall meet the requirements of 1, 2, ~~or~~ 3, or 4 below:

1. Comply with Section 601.3.1 and Table 601.5-A. The *alteration* shall comply with the indoor lighting power requirements specified in Section 601.3.1 [Section 140.6] and the *lighting* control requirements specified in Table 601.5-A [Table 141.0-F];

2. 80% of power requirements and Table 601.5-A. The *alteration* shall not exceed 80% of the indoor lighting power requirements specified in Section 601.3.1 [Section 140.6], and shall comply with the lighting control requirements specified in Table 601.5-A [Table 141.0-F]; or

3. One-to-one alterations for Nonresidential Buildings not Including Group R occupancies and common or public use areas. The *alteration* shall be a one-to-one alteration, the total wattage of the altered luminaires shall be no greater than 3,000 watts per alteration project, and the total wattage of the altered *luminaires* shall be at least 40% lower compared to their total pre-alteration wattage, and the *alteration* shall comply with the lighting control requirements specified in Table 601.5-A [Table 141.0-F].

3. 4. One-for-one luminaire alterations One-to-one alterations for Group R occupancies and common use or public use areas . The *alteration* shall be a

~~one-for-one luminaire alteration~~ one-to-one alteration within a *building* or *tenant space* of 5,000 square feet or less, the total wattage of the altered *luminaires* shall be at least 40% lower compared to their total pre-alteration wattage, and the *alteration* shall comply with the lighting control requirements specified in Table 601.5-A [Table 141.0-F].

Alterations to indoor *lighting* systems shall not prevent the operation of existing, unaltered controls, and shall not alter controls to remove functions specified in Section 601.2.2 [Section 130.1].

Alterations to *lighting* wiring are considered *alterations* to the *lighting* system. *Alterations* to indoor *lighting* systems are not required to separate existing general, floor, wall, display, or *decorative lighting* on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Section 601.2.2.1.3 [Section 130.1(a)3].

Exception 1 to Section 601.5.2.2.4: *Alteration* of portable *luminaires*, *luminaires* affixed to moveable partitions, or *lighting* excluded as specified in Section 601.3.1.1.3 [Section 140.6(a)3].

Exception 2 to Section 601.5.2.2.4: Any *enclosed space* with only one *luminaire*.

Exception 3 to Section 601.5.2.2.4: Any *alteration* that would directly cause the disturbance of asbestos unless the *alteration* is made in conjunction with asbestos abatement.

Exception 4 to Section 601.5.2.2.4: Acceptance testing requirements of Section 601.2.5 [Section 130.4] are not required for *alterations* where lighting controls are added to control 20 or fewer *luminaires*.

Exception 5 to Section 601.5.2.2.4: Any *alteration* limited to adding lighting controls or replacing *lamps*, ballasts, or *drivers*.

Exception 6 to Section 601.5.2.2.4: One-for-one *luminaire alteration* of up to 50 *luminaires* either per complete floor of the *building* or per complete *tenant space*, per annum.

TABLE 601.5-A [Table 141.0-F] – CONTROL REQUIREMENTS FOR INDOOR LIGHTING SYSTEM ALTERATIONS

Control Specifications	Coded Section	Projects complying with Section 601.5.2.2.4 item 1	Projects complying with 601.5.2.2.4. item 2 , or 3 , <u>or 4</u>
Manual Area Controls	601.2.2.1.1 [130.1(a)1]	Required	Required

Control Specifications	Coded Section	Projects complying with Section 601.5.2.2.4 item 1	Projects complying with 601.5.2.2.4. item 2, or 3, or 4
Manual Area Controls	601.2.2.1.2 <i>[130.1(a)2]</i>	Required	Required
Manual Area Controls	601.2.2.1.3 <i>[130.1(a)3]</i>	Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multilevel Controls	601.2.2.2 <i>[130.1(b)]</i>	Required	Not Required
Automatic Shut-Off Controls	601.2.2.3.1 <i>[130.1(c)1]</i>	Required	Required
Automatic Shut-Off Controls	601.2.2.3.2 <i>[130.1(c)2]</i>	Required	Required
Automatic Shut-Off Controls	601.2.2.3.3 <i>[130.1(c)3]</i>	Required	Required
Automatic Shut-Off Controls	601.2.2.3.4 <i>[130.1(c)4]</i>	Required	Required
Automatic Shut-Off Controls	601.2.2.3.5 <i>[130.1(c)5]</i>	Required	Required
Automatic Shut-Off Controls	601.2.2.3.6 <i>[130.1(c)6]</i>	Required	Required; except for 601.2.2.3.6.4 <i>[130.1(c)6D]</i>
Automatic Shut-Off Controls	601.2.2.3.7 <i>[130.1(c)8]</i>	Required	Required
Daylight Responsive Controls	601.2.2.4 <i>[130.1(d)]</i>	Required	Not Required

Control Specifications	Coded Section	Projects complying with Section 601.5.2.2.4 item 1	Projects complying with 601.5.2.2.4. item 2, or 3, or 4
Demand Responsive Controls	600.4.1 [110.12(a)] and 600.4.2 [110.12(c)]	Required	Not Required

...

7.3.3 Lighting Power Density (LPD)

Note to reviewers: State Law AB130 prohibits modifications to residential dwellings until 2031. This has been interpreted to include GROUP R OCCUPANCIES AND COMMON OR PUBLIC USE AREAS. This is newly defined in the definition section as follows:

[GROUP R OCCUPANCIES AND COMMON OR PUBLIC USE AREAS. Group R occupancy as defined by the California Building Code and spaces ancillary to the occupancy that are not part of individual dwelling or sleeping units and are intended for shared, common, or public use, including areas that support occupant use or building operations.](#)

There is only one Complete Building Method table, Table 601.3-B [Table 140.6-B], as this table does not include residential or hotel/motel building types.

However there are two area category method tables:

1. Table 601.3-C1 [Table 140.6-C1] A revised Lighting Power Density table for nonresidential buildings not including *Group R occupancies and common use areas*. Almost all of the values in this table have been updated and the table is presented in a simpler format
2. Table 601.3-C2 [Table 140.6-C2] An unchanged Lighting Power Density table for *Group R occupancies and common use areas*.

The common use areas of Hotel/Motel buildings were historically combined with nonresidential requirements as many space types in nonresidential buildings are found in the common areas of hotel/motel buildings such as: exercise spaces, offices, lounges, parking garages etc. For the 2028 code cycle, the same application may have different lighting power allowances depending upon the type of building the space is located.

It should be noted that for a couple of applications, the additional lighting power is listed as “TBD”. These are the few applications where the additional lighting power allowance calculation is more complex and still under development.

TABLE 601.3-B [TABLE 140.6-B] COMPLETE BUILDING METHOD LIGHTING POWER DENSITY VALUES

TYPE OF BUILDING	ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)
Assembly Building	0.65 <u>0.55</u>
Bank or Financial Institution Building	0.65 <u>0.55</u>
Grocery Store Building	0.90 <u>0.80</u>
Gymnasium Building	0.60 <u>0.55</u>
Healthcare Facility (<u>outpatient</u>)	0.90 <u>0.75</u>
Healthcare Facility (<u>inpatient</u>)	0.90 <u>0.85</u>
Industrial/Manufacturing Facility Building	0.60
Library Building	0.70 <u>0.65</u>
Motion Picture Theater Building	0.60 <u>0.55</u>
Museum Building	0.65 <u>0.60</u>
Office Building	0.60 <u>0.55</u>
Parking Garage Building	0.13 <u>0.11</u>
Performing Arts Theater Building	0.75 <u>0.65</u>
Religious Facility Building	0.70 <u>0.65</u>
Restaurant Building	0.65 <u>0.55</u>
Retail Store Building	0.90 <u>0.80</u>
School Building	0.60 <u>0.55</u>
Sports Arena Building	0.75 <u>0.70</u>
<u>Service Facility (including auto repair)</u>	<u>0.60</u>
All other buildings	0.40

Note: Table 601.3-C1 [Table 140.6-C1] is a new proposed table for the 2028 code cycle.

in Section 2.4.3 of this report to see a comparison of updated Primary Function Areas and Allowed Base LPD values in Table 601.3-C1 [Table 140.6-C1] and 601.3-C2 [Table 140.6-C2].

TABLE 601.3-C1 [TABLE 140.6-C1] AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²) FOR NONRESIDENTIAL BUILDINGS NOT INCLUDING GROUP R OCCUPANCIES AND COMMON USE OR PUBLIC USE AREAS

Primary Function Areas	Allowed Base LPD (W/sf)	Additional Qualified Lighting System 1	Additional Allowance 1 (W/ft ² unless other units)	Additional Qualified Lighting System 2	Additional Allowance 2 (W/ft ² unless other units)
Aging Eye/Low-vision: ¹ Corridor Area	0.60	Decorative/Display	0.30		
Aging Eye/Low-vision: ¹ Dining	0.80	Decorative/Display	0.30	Tunable white or dim-to-warm ²	0.10
Aging Eye/Low-vision: ¹ Main Entry Lobby	0.80	Decorative/Display	0.30	Transition Lighting OFF at night ³	0.80
Aging Eye/Low-vision: ¹ Lounge/Waiting Area	0.80	Decorative/Display	0.30	Tunable white or dim-to-warm ²	0.10
Aging Eye/Low-vision: ¹ Multipurpose Room	0.80	Decorative/Display	0.30	Tunable white or dim-to-warm ²	0.10
Aging Eye/Low-vision: ¹ Religious Worship Area	0.80	Decorative/Display	0.40	Tunable white or dim-to-warm ²	0.10
Aging Eye/Low-vision: ¹ Restroom	0.90	Decorative/Display	0.30		
Aging Eye/Low-vision: ¹ Stairwell	0.80	Decorative/Display	0.30		
Atria < 20 ft tall	0.30	Decorative/Display	0.20		
Atria 20 to < 40 ft	0.40	Decorative/Display	0.25		
Atria > 40 ft	0.50	Decorative/Display	0.30		
Audience Seating Area	0.30	Display/decorative	0.35		
Auditorium Area	0.50	Display/decorative	0.45		
Auto Repair / Maintenance Area	0.55	Detailed Task ⁴	0.20		
Barber, Beauty Salon and Spa Area	0.65	Decorative/Display	0.30	Detailed Task ⁴	0.20
Civic Meeting Room	0.70	Decorative/Display	0.30		
Convention Center: Ballroom	0.45	Decorative/Display	0.40		
Convention: Concourse	0.45	Decorative/Display	0.25		
Convention: Exhibit Space	0.45	Decorative/Display	0.30		
Convention: Meeting Room	0.65	Decorative/Display	0.25		
Control room	0.60	N/A	0.00		
Copy Room	0.45	N/A	0.00		
Corridor Area	0.35	Decorative/Display	0.30		
Data center: Computer room	0.45	Detailed Task ⁴	0.25		
Dining Area: Bar/Lounge and Fine Dining	0.30	Decorative/Display	0.45	TBD	

Primary Function Areas	Allowed Base LPD (W/sf)	Additional Qualified Lighting System 1	Additional Allowance 1 (W/ft2 unless other units)	Additional Qualified Lighting System 2	Additional Allowance 2 (W/ft2 unless other units)
Dining Area: Cafeteria/Fast Food	0.40	Decorative/Display	0.25		
Dining Area: Family and Leisure	0.35	Decorative/Display	0.25		
Kitchen/Food Preparation Area	0.85	N/A	0.00		
Education/Business: Classroom, Training,	0.56	Whiteboard or chalkboard ⁷	7 W/lf		
Educational, civic: Multipurpose room (art, music etc)	0.65	Decorative/Display	0.30		
Electrical, Mechanical, Telephone Rooms	0.40	Detailed Task ⁴	0.20		
Exercise/Fitness Center and Gymnasium Area	0.55	N/A	0.00		
Financial Transaction Area	0.53	Decorative/Display	0.30		
Healthcare: Corridor	0.55	Decorative/Display	0.25		
Healthcare: Exam/Treatment Room	1.10	N/A	0.00		
Healthcare: Imaging Room	0.55	Decorative/Display	0.25	Tunable white or dim-to-warm ²	0.10
Healthcare: Medical Supply Room	0.50	N/A	0.00		
Healthcare: Nursery	0.80	Decorative/Display	0.10	Tunable white or dim-to-warm ²	0.10
Healthcare: Nurse's Station	0.80	Decorative/Display	0.30		
Healthcare: Operating Room	1.80	N/A	0.00		
Healthcare: Patient Room - Critical care	0.90	Decorative/Display	0.25	Tunable white or dim-to-warm ²	0.10
Healthcare: Patient Room - General	0.65	Decorative/Display	0.25	Tunable white or dim-to-warm ²	0.10
Healthcare: Physical Therapy Room	0.65	Decorative/Display	0.10		
Healthcare: Recovery Room	0.85	Decorative/Display	0.10	Tunable white or dim-to-warm ²	0.10
Laboratory: Scientific and Teaching	0.80	Specialized Task ⁵	0.35		
Laundry Area	0.43	N/A	0.00		
Library : Reading Area	0.70	Decorative/Display	0.25		
Library : Stacks Area	0.91	N/A	0.00		
Lobby: Elevator	0.50	Decorative/Display	0.40		
Lobby: Main entry	0.60	Decorative/Display	0.40		
Lobby: Performing Arts	0.60	Decorative/Display	0.40		
Locker Room	0.40	N/A	0.00		
Lounge, Breakroom, or Waiting Area	0.45	Decorative/Display	0.25		
Manufacturing & Commercial Work Area: Low Bay	0.63	Detailed Task ⁴	0.20		
Manufacturing & Commercial Work Area: High Bay	0.65	Detailed Task ⁴	0.20		

Primary Function Areas	Allowed Base LPD (W/sf)	Additional Qualified Lighting System 1	Additional Allowance 1 (W/ft2 unless other units)	Additional Qualified Lighting System 2	Additional Allowance 2 (W/ft2 unless other units)
Manufacturing & Commercial Work Area: Precision	0.80	Precision Specialized ⁶	0.70		
Motion picture: Theater area	0.32	Decorative/Display	0.25		
Museum: Exhibition/Display	0.60	Decorative/Display	0.50		
Museum Area: Restoration Room	0.65	Detailed task	0.35		
Office Area: ≤ 250 square feet	0.55	Decorative/Display and portable ¹⁰	0.25		
Office Area: > 250 square feet	0.50	Decorative/Display and portable ¹⁰	0.25		
Office: Conference Room	0.60	Decorative/Display	0.25		
Parking Garage Area: Parking Zone and Ramps	0.08	N/A	0.00	ATM or Ticket Machine	60 W/each
Parking Garage Area: Daylight Adaptation Zones ⁸	0.08	Transition Lighting OFF at night ³	0.70		
Performance : Theater area	0.50	Decorative/Display	0.40		
Performance : Dressing room	0.47	External illuminated mirror ⁹	40 W/each	Internal illuminated mirror ⁹	120 W/each
Pharmacy Area	1.00	Specialized Task ⁵	0.35		
Retail: Concourse	0.35	Decorative/Display	0.35		
Retail: Grocery Sales	0.85	Decorative/Display	0.35	TBD	
Retail: Merchandise Sales	0.91	Decorative/Display	0.35	TBD	
Retail: Fitting Room	0.50	External illuminated mirror ⁹	40 W/each	Internal illuminated mirror ⁹	120 W/each
Religious Worship Area	0.75	Decorative/Display	0.25		
Restrooms	0.60	Decorative/Display	0.35		
Stairwell	0.57	Decorative/Display	0.35		
Sports Arena – Playing Area: Class I Facility ¹¹	2.25	N/A	0.00		
Sports Arena – Playing Area: Class II Facility ¹¹	1.45	N/A	0.00		
Sports Arena – Playing Area: Class III Facility ¹¹	1.05	N/A	0.00		
Sports Arena – Playing Area: Class IV Facility ¹¹	0.71	N/A	0.00		
Transportation: Baggage Area	0.30	N/A	0.10		
Transportation: Concourse	0.35	Decorative/Display	0.35		
Transportation : Ticketing Area	0.40	Decorative/Display	0.20		
Transportation: Waiting area	0.45	Decorative/Display	0.20		
Videoconferencing Studio ¹²	0.73	Decorative/Display	1.00		
Warehouse: Storage	0.40	N/A	0.00		

Primary Function Areas	Allowed Base LPD (W/sf)	Additional Qualified Lighting System 1	Additional Allowance 1 (W/ft ² unless other units)	Additional Qualified Lighting System 2	Additional Allowance 2 (W/ft ² unless other units)
Warehouse: Shipping and Handling	0.60	N/A	0.00		

Footnotes to TABLE 140.6-C1:

1. Aging Eye/Low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for either senior long-term care, adult day care, senior support, and/or people with special visual needs
2. Tunable white luminaires capable of color change greater than or equal to 2000K CCT, or dim-to-warm luminaires capable of color change greater than or equal to 500K CCT, connected to controls that allows color changing of the luminaires.
3. Transition lighting OFF at night. Lighting power controlled by astronomical time clock or other control to shut off lighting at night. For aging eye/low vision lobbies: additional allowance only applies to area within 30 feet of an exit and not applicable to lighting in daylight zones. For parking garages: additional allowance only applicable to Daylight Adaptation Zones.
4. Detailed task work – Lighting provides high level of visual acuity required for activities with close attention to small elements and/or extreme close up work.
5. Specialized task work – Lighting provides for small-scale, cognitive or fast performance visual tasks; lighting required for operating specialized equipment associated with pharmaceutical/laboratorial activities.
6. Precision specialized work – Lighting for work performed within a commercial or industrial environment that entails working with low contrast, finely detailed, or fast moving objects
7. White board or chalk board. – Directional lighting dedicated to a white board or chalk board.
8. Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage.
9. Illuminated mirrors. Lighting shall be dedicated to the mirror
10. Portable lighting in office areas includes under shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor.
11. Class I Facility is used for competition play for 5000 or more spectators.
Class II Facility is used for competition play for up to 5000 spectators.
Class III Facility is used for competition play for up to 2000 spectators.
Class IV Facility is normally used for recreational play and there is limited or no provision for spectators."
12. The additional videoconferencing lighting power shall be allowed provided the videoconferencing studio meets all the requirements of Section 601.3.1.3.3 [Section 140.6(c)2Gvii].

Note: Table 601.3-C2 [Table 140.6-C2] is unchanged from Table 140.6-C in the 2025 Title 24, part 6 energy code in keeping with the requirements of AB 130 that building codes for Group R Occupancies and Common Use or Public Use Areas remain unchanged until 2031 .

TABLE 601.3-C2 [TABLE 140.6-C2] AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²) FOR GROUP R OCCUPANCIES AND COMMON USE OR PUBLIC USE AREAS

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft ²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Allowance ³ (W/ft ² , unless noted otherwise)
Aging Eye/Low-vision ¹⁰	Corridor Area	0.70	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	Dining	0.80	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	NA	0.80	Tunable white or dim-to-warm ⁹	0.10

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Allowance³ (W/ft², unless noted otherwise)
Aging Eye/Low-vision ¹⁰	Lobby, Main Entry	0.85	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	Lobby, Main Entry	0.85	Transition Lighting OFF at night ¹¹	0.95
Aging Eye/Low-vision ¹⁰	Lobby, Main Entry	0.85	Tunable white or dim-to-warm ⁹	0.10
Aging Eye/Low-vision ¹⁰	Lounge/Waiting Area	0.80	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	Lounge/Waiting Area	0.80	Tunable white or dim-to-warm ⁹	0.10
Aging Eye/Low-vision ¹⁰	Multipurpose Room	0.85	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	Multipurpose Room	0.85	Tunable white or dim-to-warm ⁹	0.10
Aging Eye/Low-vision ¹⁰	Religious Worship Area	1.00	Decorative/Display	0.30
Aging Eye/Low-vision ¹⁰	Religious Worship Area	1.00	Tunable white or dim-to-warm ⁹	0.10
Aging Eye/Low-vision ¹⁰	Restroom	1.00	Decorative/Display	0.20
Aging Eye/Low-vision ¹⁰	Stairwell	0.80	Decorative/Display	0.30
Audience Seating Area	NA	0.50	Decorative/Display	0.25
Auditorium Area	NA	0.70	Decorative/Display	0.45
Auto Repair / Maintenance Area	NA	0.55	Detailed Task Work ⁶	0.20
Barber, Beauty Salon, Spa Area	NA	0.70	Detailed Task Work ⁶	0.30
Barber, Beauty Salon, Spa Area	NA	0.70	Decorative/Display	0.25
Civic Meeting Place Area	NA	0.90	Decorative/Display	0.25
Classroom, Lecture, Training, Vocational Area	NA	0.60	White or Chalk Board ¹	7 W/ft
Concourse and Atria Area	NA	0.60	Decorative/Display	0.25
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Decorative	0.25
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Wall Display MH <= 10'6"	2 W/ft
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Wall Display MH 10'7"- 14'	2.35 W/ft
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Wall Display MH > 14'	2.66 W/ft
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Floor Display and Task MH <= 10'6"	0.30
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Floor Display and Task MH 10'7"- 14'	0.35

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Allowance³ (W/ft², unless noted otherwise)
Convention, Conference, Multipurpose and Meeting Area	NA	0.75	Floor Display and Task MH > 14'	0.40
Copy Room	NA	0.50	NA	NA
Corridor Area	NA	0.40	Decorative/Display	0.25
Dining Area	Bar/Lounge and Fine Dining	0.45	Decorative	0.35
Dining Area	Bar/Lounge and Fine Dining	0.45	Wall Display MH ≤ 10'6"	1.25 W/ft
Dining Area	Bar/Lounge and Fine Dining	0.45	Wall Display MH 10'7"- 14'	1.5 W/ft
Dining Area	Bar/Lounge and Fine Dining	0.45	Wall Display MH > 14'	1.7 W/ft
Dining Area	Bar/Lounge and Fine Dining	0.45	Floor Display and Task MH ≤ 10'6"	0.45
Dining Area	Bar/Lounge and Fine Dining	0.45	Floor Display and Task MH 10'7"- 14'	0.52
Dining Area	Bar/Lounge and Fine Dining	0.45	Floor Display and Task MH > 14'	0.60
Dining Area	Bar/Lounge and Fine Dining	0.45	General Lighting in the enclosed space of ceiling height > 10'	0.25
Dining Area	Cafeteria/Fast Food	0.45	Decorative/Display	0.25
Dining Area	Family and Leisure	0.40	Decorative/Display	0.25
Electrical, Mechanical, Telephone Rooms	NA	0.40	Detailed Task Work ⁶	0.20
Exercise/Fitness Center and Gymnasium Area	NA	0.50	NA	NA
Financial Transaction Area	NA	0.70	Decorative/Display	0.25
Healthcare Facility and Hospitals	Exam/Treatment Room	1.15	NA	NA
Healthcare Facility and Hospitals	Imaging Room	0.60	Decorative/Display	0.20
Healthcare Facility and Hospitals	Imaging Room	0.60	Tunable white or dim-to-warm ⁹	0.10
Healthcare Facility and Hospitals	Medical Supply Room	0.55	NA	NA
Healthcare Facility and Hospitals	Nursery	0.80	Tunable white or dim-to-warm ⁹	0.10
Healthcare Facility and Hospitals	Nurse's Station	0.85	Tunable white or dim-to-warm ⁹	0.10
Healthcare Facility and Hospitals	Nurse's Station	0.85	Detailed Task Work ⁶	0.20
Healthcare Facility and Hospitals	Operating Room	1.90	NA	NA
Healthcare Facility and Hospitals	Patient Room	0.70	Decorative/Display	0.15
Healthcare Facility and Hospitals	Patient Room	0.70	Tunable white or dim-to-warm ⁹	0.10

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Allowance³ (W/ft², unless noted otherwise)
Healthcare Facility and Hospitals	Physical Therapy Room	0.75	Tunable white or dim-to-warm ⁹	0.10
Healthcare Facility and Hospitals	Recovery Room	0.90	Tunable white or dim-to-warm ⁹	0.10
Hotel Function Area	NA	0.85	Decorative/Display	0.25
Kitchen/Food Preparation Area	NA	0.95	NA	NA
Laboratory, Scientific	NA	0.90	Specialized Task Work ⁸	0.35
Laundry Area	NA	0.45	-	-
Library	Reading Area	0.80	Decorative/Display	0.25
Library	Stacks Area	1.00	NA	NA
Lobby, Main Entry	NA	0.70	Decorative	0.25
Lobby, Main Entry	NA	0.70	Wall Display MH ≤ 10'6"	3 W/ft
Lobby, Main Entry	NA	0.70	Wall Display MH 10'7" - 14'	3.5 W/ft
Lobby, Main Entry	NA	0.70	Wall Display MH > 14'	4 W/ft
Locker Room	NA	0.45	NA	NA
Lounge, Breakroom, or Waiting Area	NA	0.55	Decorative/Display	0.25
Manufacturing, Commercial and Industrial Work Area	Low Bay	0.60	Detailed Task Work ⁶	0.20
Manufacturing, Commercial and Industrial Work Area	High Bay	0.65	Detailed Task Work ⁶	0.20
Manufacturing, Commercial and Industrial Work Area	Precision	0.85	Precision Specialized Work ⁸	0.70
Museum Area	Exhibition/Display	0.60	Decorative/Display	0.45
Museum Area	Restoration Room	0.70	Detailed Task Work ⁶	0.35
Office Area	> 250 square feet	0.60	Decorative/Display and Portable lighting for office areas ⁵	0.20
Office Area	≤ 250 square feet	0.65	Decorative/Display and Portable lighting for office areas ⁵	0.20
Parking Garage Area	Parking Zone and Ramps	0.10	First ATM or Ticket Machine	100 W
Parking Garage Area	Parking Zone and Ramps	0.10	Additional ATM or Ticket Machine	50 W/each
Parking Garage Area	Daylight Adaptation Zones ²	1.00	NA	NA
Pharmacy Area		1.00	Specialized Task Work ⁸	0.35
Retail Sales Area	Grocery Sales	1.00	Decorative	0.35
Retail Sales Area	Grocery Sales	1.00	Wall Display MH ≤ 10'6"	6.6 W/ft

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Allowance³ (W/ft², unless noted otherwise)
Retail Sales Area	Grocery Sales	1.00	Wall Display MH 10'7"- 14'	7.76 W/ft
Retail Sales Area	Grocery Sales	1.00	Wall Display MH > 14'	8.8 W/ft
Retail Sales Area	Grocery Sales	1.00	Floor Display and Task MH <= 10'6"	0.60
Retail Sales Area	Grocery Sales	1.00	Floor Display and Task MH 10'7"- 14'	0.70
Retail Sales Area	Grocery Sales	1.00	Floor Display and Task MH > 14'	0.80
Retail Sales Area	Grocery Sales	1.00	General Lighting in the enclosed space of ceiling height > 10'	0.10
Retail Sales Area	Retail Merchandise Sales	0.95	Decorative	0.35
Retail Sales Area	Retail Merchandise Sales	0.95	Wall Display MH <= 10'6"	9.5 W/ft
Retail Sales Area	Retail Merchandise Sales	0.95	Wall Display MH 10'7"- 14'	11.2 W/ft
Retail Sales Area	Retail Merchandise Sales	0.95	Wall Display MH > 14'	12.7 W/ft
Retail Sales Area	Retail Merchandise Sales	0.95	Floor Display and Task MH <= 10'6"	0.45
Retail Sales Area	Retail Merchandise Sales	0.95	Floor Display and Task MH 10'7"- 14'	0.52
Retail Sales Area	Retail Merchandise Sales	0.95	Floor Display and Task MH > 14'	0.60
Retail Sales Area	Retail Merchandise Sales	0.95	Valuable Display Case	0.50
Retail Sales Area	Retail Merchandise Sales	0.95	General Lighting in the enclosed space of ceiling height > 10'	0.10
Retail Sales Area	Fitting Room	0.60	External Illuminated Mirror ⁴	40 W/ea
Retail Sales Area	Fitting Room	0.60	Internal Illuminated Mirror ⁴	120 W/ea
Religious Worship Area		0.95	Decorative/Display	0.25
Restrooms		0.65	Decorative/Display	0.35
Stairwell		0.60	Decorative/Display	0.35
Storage, Commercial/Industrial	Warehouse	0.40	NA	NA
Storage, Commercial/Industrial	Shipping and Handling	0.60	NA	NA
Sports Arena – Playing Area	Class I Facility ¹²	2.25	NA	NA
Sports Arena – Playing Area	Class II Facility ¹²	1.45	NA	NA
Sports Arena – Playing Area	Class III Facility ¹²	1.10	NA	NA

Building Type/Use	Primary Function Area	Allowed Lighting Power Density for General Lighting (W/ft ²)	Additional Lighting Power Qualified Lighting Systems	Additional Lighting Power Additional Allowance ³ (W/ft ² , unless noted otherwise)
Sports Arena – Playing Area	Class IV Facility ¹²	0.75	NA	NA
Theater Area	Motion picture	0.50	Decorative/Display	0.25
Theater Area	Performance	0.80	Decorative/Display	0.25
Transportation Function	Baggage Area	0.40	NA	NA
Transportation Function	Ticketing Area	0.45	Decorative/Display	0.20
Videoconferencing Studio	NA	0.90	Videoconferencing ¹³	1.00
All other	NA	0.40	NA	NA

Footnotes for Table 601.3-C2 [Table 140.6-C2] are listed below.

1. White board or chalk board. – Directional *lighting* dedicated to a white board or chalk board.
2. *Daylight Adaptation Zones* shall be no longer than 66 feet from the entrance to the parking *garage*.
3. MH denotes the *luminaire* mounting height of the qualified *lighting* systems.
4. Illuminated mirrors. *Lighting* shall be dedicated to the mirror.
5. *Portable lighting* in *office areas* includes under shelf or furniture-mounted supplemental *task lighting* qualifies when controlled by a time clock or an *occupancy* sensor.
6. Detailed task work – *Lighting* provides high level of visual acuity required for activities with close attention to small elements and/or extreme close up work.
7. Specialized task work – *Lighting* provides for small-scale, cognitive or fast performance visual tasks; *lighting* required for operating specialized *equipment* associated with pharmaceutical/laboratorial activities.
8. *Precision* specialized work – *Lighting* for work performed within a commercial or industrial environment that entails working with low contrast, finely detailed, or fast moving objects.
9. *Tunable white luminaires* capable of color change greater than or equal to 2000K CCT, or *dim-to-warm luminaires* capable of color change greater than or equal to 500K CCT, connected to controls that allows color changing of the *luminaires*.
10. Aging Eye/Low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for either senior long-term care, adult day care, senior support, and/or people with special visual needs.
11. Transition *lighting* OFF at night. Lighting power controlled by astronomical time clock or other control to shut off *lighting* at night. Additional LPD only applies to area within 30 feet of an exit. Not applicable to *lighting* in *daylit zones*.
12. Class I Facility is used for competition play for 5000 or more spectators. Class II Facility is used for competition play for up to 5000 spectators. Class III Facility is used for competition play for up to 2000 spectators. Class IV Facility is normally used for recreational play and there is limited or no provision for spectators.
13. The additional videoconferencing lighting power shall be allowed provided the *videoconferencing studio* meets all the requirements of [Section 601.3.1.3.3](#) [Section 140.6(c)2Gvii].

7.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

7.5 Compliance Manuals

The Statewide CASE Team will provide CEC with recommended revisions to compliance manuals after the 45-Day Language is published.

7.6 ACM Reference Manual

It is envisioned that the Alternative Compliance Method software will be redesigned so that if one enters a building type that is a Nonresidential Building, excluding *Group R occupancies and common use or public use areas*, the 2028 NRACM ruleset, including the updated LPDs, will be used. If one enters a building type that includes *Group R occupancies and common use or public use areas*, the software will, one way or the other, guide the user to the 2025 version of the performance compliance software or incorporate the 2025 rulesets and LPDs for these building types.

For the final report, the Statewide CASE Team will publish the recommended changes to the LPDs and additional lighting wattage allowances in the 2028 Nonresidential ACM Appendix 5.4A specific to Nonresidential Buildings excluding Group R Occupancies and Common Use or Public Use Areas. This portion of Appendix 5.4A will be in addition to the unchanged LPDs and additional lighting wattage allowances associated with Group R Occupancies and Common Use or Public Use Areas that will be unchanged from the 2025 Nonresidential ACM Appendix 5.4A.

7.7 Compliance Forms

As discussed in Section 2.6.5, If adopted, the current LPD values in the NRCC-LTI-E form will be updated to reflect the proposed change. The Statewide CASE Team can support the CEC in implementing these updates if the proposed change is adopted.

8. Bibliography

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Appendix A: Assumptions for Cost-effectiveness Analysis

Key Assumptions for Energy Savings Analysis

Section 2.4 describes the process of developing the allowed lighting power densities needed to meet the maintained illuminance recommendations of the Illuminating Engineering Society, accounting for good design practice and moderately difficult geometries. The main assumptions that underly the energy savings estimates are:

- Energy savings is based on a design that is minimally compliant with the 2025 Title 24 standard as compared to a similar space compliant with the proposed 2028 Title 24 lighting system.
- Hours of operation and lighting profile (partial operation) schedule are as given by Appendix 5.4 in the nonresidential ACM (alternative compliance method) manual.
- Also, in keeping with the ACM, lighting schedules do not change with climate zones.
- The lighting LPD energy savings model is a spreadsheet only model. It calculates the primary energy savings from reduced energy consumption by lighting for the 70+ space types considered.
- Interaction effects with heating and cooling are ignored.
 - The reduction in light power reduces internal gains which reduces cooling energy consumption and increases heating energy consumption, but the effect is small. The cooling benefit is greater than the heating increase, but overall, the interaction effect is a net small savings benefit (around 10%).
 - From (Sezgen & Koomey 1998) on a nationwide basis across all buildings 1 kWh of lighting energy savings results in an additional 0.19 kWh cooling savings and an additional 0.10 kWh heating energy consumption.⁹
 - From (CPUC 2018) lighting has a 1.10 to 1.17 HVAC kWh interaction factors (increase savings) depending upon California electricity IOU and

⁹Sezgen, Osman, and Jonathan G. Koomey. 1998. *Interactions Between Lighting and Space Conditioning Energy Use in U.S. Commercial Buildings*. Lawrence Berkeley National Laboratory <https://eta-publications.lbl.gov/sites/default/files/lbnl-39795.pdf>

a 12 percent to 2 percent gas take back factors (decrease savings) that varies by California gas IOU.¹⁰

Energy Savings Methodology

Energy savings is not calculated per prototypical building. This would not be particularly useful as the key metric for this analysis is the feasibility and cost-effectiveness of each LPD allowance for each space type. The analysis is conducted per space type in the area category approach.

To calculate annual energy savings, the change in W/sf of each space category is divided by 1,000 to convert into kW and then multiplied by the lighting profile from the NRACM appendix 5.4A for each hour of the day for 365 days per year. This yields a string of annual hourly energy consumption values in units of kWh for each of the 8,760 hours per year. Since interaction effects are not calculated, life cycle energy cost savings, source energy savings, carbon emission reductions and nominal cost savings are directly calculated from the hourly kWh savings multiplied by the applicable hourly conversion factors posted at: <https://www.energy.ca.gov/files/2028-energy-code-energy-accounting-metrics>

¹⁰ CPUC (2018) *Resolution E-4952 updates to the Database for Energy-Efficient Resources (DEER) for program year (PY) 2020.*

<https://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf>

Appendix B: Purpose and Necessity of Proposed Code Changes

Introduction

The sections below provide the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices. This section intends to provide the CEC with the information needed for the Initial Statement of Reasons.

See Section 7 of this report for marked-up code language.

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1

Purpose and Necessity of Changes to Title 24, Part 6

Section: 601.2.1.1.1 [*Section 130.0(c)2*]

Purpose: The purpose of this change is to specify the code determined wattage of a luminaire with line voltage sockets containing removable lamps for calculating the installed wattage of the lighting system. The changes to this section define wattage of luminaires containing line voltage lamps as the total wattage of the specified and installed lamps or solid state lighting (SSL) light engines.

Necessity: The necessity for this change is to remove a barrier to re-using luminaires with line voltage sockets. In many cases the least expensive, energy efficiency upgrade is to replace higher wattage legacy lamps with lower wattage but more efficacious new lamps. Currently luminaire wattage is based on a factory installed label. For code compliance this creates a motivation to throw out the existing luminaire and replace with a new luminaire. In the past, the labeling of luminaires was desirable so as to create a barrier to temporarily installing high efficacy lamps and after inspection replace with a less expensive, low efficacy but higher color quality and more focused beam spread of an incandescent lamp. These issues have diminished with modern LED lamps having the amenity issues resolved and cost differential have also been reduced. There is no longer an energy efficiency rationale to base the luminaire wattage on the luminaire label, the total of the lamp wattages is a more accurate way of allocating wattage to luminaires with line voltage sockets. This reduces the unnecessary disposal of suitable luminaires which reduces the cost of lighting upgrades, reduces the greenhouse gas emissions associated with embodied energy in the luminaire materials and reduces barriers to lighting retrofits.

Section: 601.2.1.2.4 [Section 130.0(c)3]

Purpose: The purpose of this change is to specify the code-defined wattage of an SSL luminaire with integral or remote driver and clarify what is the deemed wattage of a luminaire with multiple power settings. This also addresses technology changes such as programmable drivers which allows the maximum wattage to be changed after a luminaire leaves the factory. The luminaire wattage is defined as the maximum labelled wattage of the luminaire as labelled by the manufacturer or by the manufacturers authorized representative.

Necessity: The update is driven by the growing market share of multi-wattage luminaires. The energy code should provide a clear determination of what the deemed luminaire wattage is when multi-wattage luminaires are used, and how this wattage is displayed on the luminaire. Additionally advances in lighting technology such as programmable drivers reduce supply chain costs and increase product flexibility by setting maximum wattage at the lighting representative or distributor using near field communication (NFC). Prior to this change, the energy code is a barrier to this flexibility by requiring that luminaire wattage labels must be factory installed.

Section: 601.2.1.1.4 [new]

Purpose: Changes to this section are to clarify the defined wattage used when a legacy ballast for HID or fluorescent systems is left in an existing luminaire and remains energized after a solid state lighting (SSL) retrofit. When tubular LEDs are used, they are usually called “Type A” retrofits, as described in Section 2.3 In this situation, there are losses from both the reused ballast and the SSL driver before the electrical power is converted into light in the SSL device. The purpose is to clearly define the wattage of these hybrid devices.

Necessity: California’s AB 2208 has banned fluorescent lamps for environmental health reasons as they contain mercury, a potent neurotoxic element, and less hazardous SSL sources are available, which are less toxic and more efficacious. Because Type A lamps are designed to combine with a variety of fluorescent ballasts, a clearly defined wattage of the lighting system is hard to determine. Additionally, these retrofits are rarely dimmable.

Section: 601.2.1.1.7 [new]

Purpose: This section expands the scope of lighting systems which may use of current limiters or supplementary overprotection protection to define the wattage of the defined lighting system. This used to be reserved for only modular lighting systems. The scope is increased to all lighting systems.

Necessity: Updates to lighting technologies result in multiple technologies to various to vary their light output and wattage input. Expanding the scope of where the deemed

wattage is allowed to be the maximum power draw allowed by current limiters or overcurrent protection, allows more flexibility to design systems that make use of more product types but still maintain the desired wattage limit.

Section: Table 601.3-B [Table 140.6-B],

Purpose: Update allowed lighting power density (LPD) requirements for the Complete Building Method

Necessity: The complete building method is based on the area-weighted general lighting power densities associated with the Area Category Method applied to prototypes of each building type. This reflects changes in lighting equipment performance and design practice from six years ago.

Section: Table 601.3-C1 [Table 140.6-C1]

Purpose: Update allowed lighting power density (LPD) requirements for the Area Category Method for Nonresidential Buildings not Including Group R Occupancies and Common Use or Public Use Areas

Necessity: Though equipment efficiencies have increased over time, there is significant variability in published product efficacy. As product efficacies increase over time, if lighting target LPDs do not decrease correspondingly, the standard does not limit inefficient design practices.

When the performance approach is used, and allowable LPDs are excessively high, the nominal savings from the code-allowed lighting wattage baseline result in the overall efficiency of the building design to be less efficient.

These changes in allowable LPD reflect changes in lighting equipment performance and design practices from six years ago.

Section: 601.5.2.2.4 item 3 (revised) and item 4 (editorial only). [Section 141.0(b)2/ 141.0(b)2/ item iii]

Purpose: For item 3 “one-for-one luminaire alterations” for Nonresidential Buildings not Including Group R Occupancies and Common Use or Public Use Areas, the criteria was changed from 5,000 square feet maximum to no greater than 3,000 Watts. The content of item 4 “one-for-one luminaire alterations” for Group R Occupancies and Common Use or Public Use Areas is unaltered in keeping with requirements associated with AB130 that for Group R Occupancies and Common Use or Public Use Areas building standards be unchanged until 2013. For both item 3 and item 4 the term “one-for-one luminaire alteration” is replaced with the defined term “one-to-one alteration.”

Necessity: By basing the criteria for one-to-one alterations on 3,000 watts of post-altered luminaires, these alterations are streamlined from the 5,000 square feet without changing the stringency of the requirement. In some cases, the jurisdictions require that

a set of plans be drawn up to document that the 5,000 square foot criteria is not exceeded. This adds time and cost to the project without corresponding benefit. Editorially wherever “one-for-one luminaire alteration” appears in items 3 and 4, this is replaced with the defined term “*one-to-one alteration*.” This is fixing a typo as the intention is clear “one-for-one luminaire alteration” was meant to represent the defined term “*one-to-one alteration*.”

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Purpose and Necessity of Changes to Nonresidential ACM

Section: NRACM Appendix 5.4A. Filename: “Appendix_5.4A_SpaceUseData-T24N.xlsx”

Purpose: NRACM Appendix 5.4A Space by Spaces LPDs and Additional Allowances set the base case wattage allowances that the proposed design is compared against.

Necessity: This update to the NRACM is necessary to incorporate the prescriptive values into the baseline and thereby increase the stringency of the performance approach to match that of the prescriptive approach.

Appendix C: Assumptions for Statewide Savings Estimates

The Statewide CASE Team is anticipating updated construction forecasts to be released by the California Energy Commission in February 2026. This will impact statewide energy savings but not the cost effectiveness of the proposal. The final CASE Report will present the updated savings based on the new forecasts.

The Statewide CASE Team estimated statewide impacts for the first year by multiplying the kWh/yr-sf estimates for each space type by the statewide construction forecasts provided by the CEC. The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

C.1 Statewide Technical Potential

To calculate the statewide new construction and retrofit areas for space type:

- Each space type application is mapped to multiple building types associated with the complete building method and weighted by fraction of space type area per building area. The space type fractions add up to 100 percent per building.
- The statewide new construction and retrofit square footages is derated by the fraction of market share impacted by the proposal and then allocated to the various complete building method building types to yield the total construction areas of the complete building methods building types.
- The areas of the complete building method areas are multiplied by the space type fractions to yield the annual new construction and alteration square footage per space type.

The current market share is estimated based on the Statewide CASE Team's professional judgment and data from the evaluation of past Title 24 code cycles. The Statewide CASE Team estimated that the current market share rate for the proposed code change is 100 percent for the new construction market and seven percent (one divided by the 15-year expected useful life) for the retrofit market. One exception is retail lighting, where the expected useful life is not a function of equipment life, but rather lighting systems are upgraded regularly to enhance the store's appearance and attract customers. For retail and grocery stores, the expected useful life of the lighting systems is projected to be 10 years, and the retrofit rate is 10 percent per year of the building stock for these applications.

Controlled environment horticulture building type is not included, as all process lighting in these spaces is specifically exempt from the LPD requirements in Section 140.6 and is covered by the requirements in Section 120.6(h) *Mandatory requirements for Controlled Environment Horticulture (CEH) spaces*.

Table 16 presents the projected nonresidential new construction that the proposed code change will impact in 2026, the percentage estimated to be applicable, and the total applicable area impacted by the code change. Note that lighting in controlled environment horticulture process applications is not included (zero percent applicable) as the lighting systems for these areas are covered by Section 120.6(h) and are excluded from coverage by the LPDs in Section 140.6. Only 40 percent of enclosed parking garage area is included, as it is expected that 60 percent of the enclosed parking garages serve residential buildings (multifamily and hotel/motel), and the new LPDs would not be applicable due to the restrictions placed by AB 130 on residential code updates.

Table 16: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2029, by Building Type (Million Square Feet)

Building Prototype	Nonresidential New Construction (Million sf/yr)	Percent Applicable	NRNC Applicable Area (Million sf/yr)
Large Office	13.3	100%	13.3
Medium Office	15.5	100%	15.5
Small Office	3.2	100%	3.2
Large Retail	8.3	100%	8.3
Medium Retail	7.3	100%	7.3
Strip Mall	6.8	100%	6.8
Large School	7.3	100%	7.3
Small School	4.5	100%	4.5
Non-refrigerated Warehouse	17.4	100%	17.4
Assembly	10.9	100%	10.9
Hospital	5.8	100%	5.8
Laboratory	5.4	100%	5.4
Restaurant	3.6	100%	3.6
Enclosed Parking Garage	10.3	40%	4.1
Open Parking Garage	16.1	100%	16.1
Grocery	0.6	100%	0.6
Refrigerated Warehouse	0.4	100%	0.4
Controlled-environment Horticulture	2.1	0%	0.0
Vehicle Service	6.1	100%	6.1
Manufacturing	0.5	100%	0.5
Unassigned	0.4	100%	0.4
Totals (million sq ft)	152.9		137.7

Table 17 contains a listing of the nonresidential existing statewide building stock that the proposed code change would affect, the percent applicable area projected to be altered per year, based on the expected useful life of lighting systems for each building type. The Statewide CASE Team developed these estimates using the methods described in this section. For most alterations seven percent (one divided by the 15-year expected useful life) of the building stock is expected to be altered per year. One exception is retail lighting, where the expected useful life is not a function of equipment life, but rather lighting systems are upgraded regularly to enhance the store’s appearance and attract customers. For retail and grocery stores, the expected useful life of the lighting systems is projected to be 10 years, and the retrofit rate is 10 percent per year of the building stock for these applications.

Table 17: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2029 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Prototype	Nonresidential Building Stock (Million sf)	Expected Useful Life (yr)	Percent Applicable Area per Year	NR Alterations (Million sf/yr)
Large Office	1,033	15	7%	68.9
Medium Office	644	15	7%	42.9
Small Office	228	15	7%	15.2
Large Retail	436	10	10%	43.6
Medium Retail	535	10	10%	53.5
Strip Mall	462	10	10%	46.2
Large School	396	15	7%	26.4
Small School	313	15	7%	20.9
Non-refrigerated Warehouse	1,168	15	7%	77.9
Assembly	718	15	7%	47.9
Hospital	401	15	7%	26.7
Laboratory	166	15	7%	11.1
Restaurant	192	15	7%	12.8
Enclosed Parking Garage	261	15	3%	7.0
Open Parking Garage	473	15	7%	31.5
Grocery	40	10	10%	4.0
Refrigerated Warehouse	11	15	7%	0.7
Controlled-environment Horticulture	40	15	0%	0.0
Vehicle Service	392	15	7%	26.1
Manufacturing	742	15	7%	49.5
Unassigned	63	15	7%	4.2
Totals (million sq ft)	9,091			616.9

The matrix in Table 18 assigns a fraction of the complete building method areas (columns) to each of the CEC forecast building types (rows). All rows for new

construction add up to 100 percent, as all the building construction type forecasts are completely allocated to the different complete building method buildings. There is one exception: Controlled-environment horticulture is not assigned to any complete building method building types as this application is exempt from the lighting power requirements but is instead regulated in terms of its Photosynthetic Photon Efficacy (see Title 24, part 6 Section 120.6(h)).

Table 19 contains the projected areas by complete building method building type of one year's new construction and additions activity and alterations activity. This estimate for new construction was accomplished by taking the last column in Table 16 (million square feet from the CEC forecast estimated to be within scope of revised LPDs for each forecasted building type) and multiplying this value by the fraction of building type that is mapped to the complete building method type in Table 18.

For alterations the same approach is taken, by taking the last column in Table 17 (million of square feet from the portion of CEC building stock estimate projected to be within scope of revised LPDs for each forecasted building type) and multiplying this by the fraction of building type that is mapped to the complete building method type. This yields the total complete building method areas subject to alterations each year.

Note that the sum of the areas in Table 19 equals the sum of the impacted areas in Table 16 and Table 17; this illustrates that the total areas are the same, but building types are defined differently.

Table 18: Assignment of Complete Building Method Areas (Columns) to CEC Forecast Areas (Rows).

Complete Building Type/CEC Forecast Building	Assembly	Bank/Financial	Grocery Store	Gymnasium	Healthcare-Outpatient	Healthcare-inpatient	Industrial manufacturing	Library	Motion Picture	Museum	Office	Parking Garage	Performing Arts Theatre	Religious	Restaurant	Retail store	School	Sports Arena	Warehouse	All Other
Large Office											100%									
Medium Office		6%									94%									
Small Office		10%			8%						82%									
Large Retail																100%				
Medium Retail																100%				
Strip Mall																100%				
Large School				10%				2%					1%				87%			
Small School				10%				2%									88%			
Refrigerated Warehouse							20%												80%	
Assembly	40%			10%					10%	5%			10%	20%					5%	
Hospital					40%	60%														
Laboratory							20%				80%									
Restaurant															100%					
Enclosed Parking Garage												50%								
Open Parking Garage												100%								
Grocery			100%																	
Refrigerated Warehouse (Alt)							20%												80%	
Controlled Environment Horticulture																				
Vehicle Service																				
Manufacturing							100%													
Unassigned				5%					5%											90%

Table 19: First Year New Construction and Additions and Alterations Forecasts for each Building Type in the Complete Building Method Approach (Million sf/yr)

Complete Building Method Type of Building	Nonresidential New Construction + Additions (Million sf/yr)	Nonresidential Alterations (Million sf/yr)
Assembly	4.4	19.1
Bank /Financial	1.3	4.1
Grocery Store	0.6	4.0
Gymnasium	2.3	9.7
Healthcare Outpatient	2.6	11.9
Healthcare - Inpatient	3.5	16.0
Industrial /Manuf	5.1	67.4
Library	0.2	0.9
Motion Picture Theater	1.1	5.0
Museum	0.5	2.4
Office	34.8	130.5
Parking Garage	18.2	35.0
Performing Arts Theater	1.2	5.1
Religious facility	2.2	9.6
Restaurant	3.6	12.8
Retail Store	22.4	143.3
School	10.3	41.3
Sports Arena	0.5	2.4
Vehicle Service	6.1	26.1
Warehouse	14.3	62.9
All Other	0.4	3.8
Totals	135.6	613.4

C.2 Statewide Market Probability Adjustment

The technical potential calculation treats the installed power as being minimally compliant with the allowed LPD, thus the change in LPD is multiplied by all the affected applications based on new construction and alteration construction rates. However, the installed lighting power of populations of buildings and applications is more accurately described as a probability distribution of LPDs.

There are two major categories of code compliance: prescriptive compliance and performance compliance.

Prescriptive compliance results from complying with the various mandatory and prescriptive requirements. For lighting power, the total installed lighting power is not

allowed to exceed the allowed lighting power densities. For performance compliance, the efficiency of building components are allowed to vary as long as the whole building energy consumption, as simulated according to the nonresidential alternative compliance method (NRACM) manual, is less than a similar building modelled to be minimally compliant prescriptively.

For performance lighting compliance, the majority of projects have lower installed lighting power than the allowed lighting power, but this difference is used to reduce the efficiency of other building components (primarily the envelope). The market assumption applied here is that most of the reductions in allowed lighting power result in equivalent savings in the performance approach because this resets the stringency of the baseline. As a result, installed lighting savings mostly result in additional energy consumption in other building components. In reviewing a compliance database maintained by the Statewide IOU Codes & Standards Compliance Improvement Team, approximately **31 percent** of nonresidential new construction building area complies with the lighting requirements using the performance approach. Similarly, approximately **7 percent** of the floor area of nonresidential lighting alterations complies with the performance approach.

To quantify the impact of the changed LPDs on the distribution of installing lighting power, a Skewed Normal probability distribution is used. This formulation is used for several reasons. Using a normal distribution, the probability function is well understood and matches well probability distributions found in nature and human factors research, namely a central tendency with smoothly declining probabilities from the central value. A skewed distribution is used to represent that the maximum allowed LPD limit places some constraint on the range of LPDs and as a result, the distribution is single sided with a long tail to the right (left skewed). Conversely, if the LPD was specified to be so high that the installed LPDs were unconstrained, one would expect a symmetric distribution.

The Skewed Normal Probability Distribution Function, SNPDF(LPD) with respect to LPD is given by the following:

$$\text{SNPDF(LPD)} = \left\{ \frac{2}{SD} \times \text{NORM. PDF} \left(\frac{\text{LPD} - \mu}{SD} \right) \times \text{NORM. CDF} \left(\alpha \times \frac{\text{LPD} - \mu}{SD} \right) \right\} \times (\delta \text{LPD})$$

Where,

- SD = Standard deviation, W/sf
- NORM.PDF = Standard normal probability distribution function
- μ = mean of LPDs, W/sf
- NORM.CDF = Standard normal cumulative distribution function
- a = skewness parameter

dLPD = bin width for LPD increments, W/sf

The following hypothetical distribution provides an analysis of the expected change in distribution of installed LPDs from a change in the allowed LPD. This example makes use of a base case condition of a 0.70 W/sf LPD allowance, with a corresponding installed LPD distribution having a mean offset of 0.65 W/sf, a standard deviation of 0.14 W/sf and skewness factor of -7 (left skewed). The proposed case with a LPD allowance of 0.65 W/sf, is expected to squeeze the distribution against the new limit thus it has a mean offset of 0.615 that is less than the offset in the new LPD allowance, has a smaller standard deviation of 0.12 W/sf to represent a tighter clustering of the installed LPDs and a skewness of -8, to represent more LPDs skewed toward the new LPD limit. These distributions are illustrated in Figure 3.

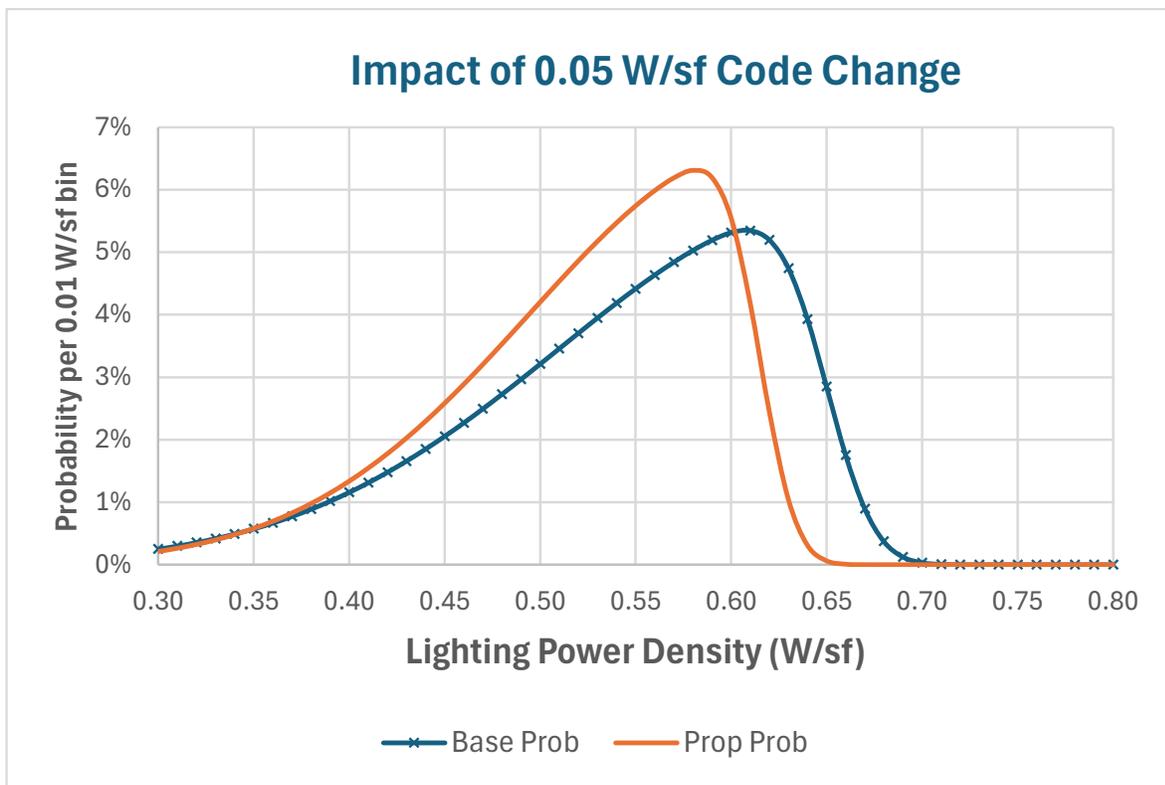


Figure 3: Skewed Normal Distribution of Base Case and Proposed Case probabilities of installed LPDs.

The resulting probability weighted LPDs are 0.539 W/sf for the base case and 0.520 W/sf for the proposed case that has a 0.050 W/sf lower allowed wattage. The weighted average difference in LPDs is 0.019 W/sf or a 39% net installed wattage reduction relative to the allowed LPD reduction.

Thus, when applying the full change in LPD that affects the performance approach (31% of new construction and 7% of alterations) and the 39% fraction of savings that

applies to prescriptive compliance (69% of new construction and 93% in alterations), the corresponding fractions of the statewide wide technical potential are as follows:

New construction market savings (GWh/yr) = NC Statewide technical potential (GWh/yr) x (31% + 69% x 39%)

New construction market savings (GWh/yr) = NC Statewide technical potential (GWh/yr) x (58%)

Alteration market savings (GWh/yr) = Alteration Statewide technical potential (GWh/yr) x (7% + 93% x 39%)

Alteration market savings (GWh/yr) = Alteration Statewide technical potential (GWh/yr) x (43%)

Appendix D: Environmental Analysis

Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

Direct Environmental Benefits

The proposed measure reduces LPDs, which lowers energy use and yields reduced GHG emissions. Some applications may also require fewer luminaires as a result of the lower LPDs, which would result in reduced material usage and associated emissions such as manufacturing, transportation, and end-of-life impacts. The proposed measure also reduces material usage and associated lifecycle emissions by updating requirements for existing luminaires. Specifically, the proposed measure allows certain luminaires to claim updated wattages when new lamps are retrofitted in these scenarios. This means some projects are more likely to simply replace lamps in existing luminaires instead of replacing the whole luminaires and installing new ones. Materials and associated lifecycle emissions are significantly reduced as a result, especially in scenarios where significant deconstruction and installation activities would have been required. An example scenario is where luminaires are installed in a concrete ceiling. Previously, the only way to claim different (lower) wattage would have been to demolish the concrete to allow the entire luminaire to be replaced with a lower wattage luminaire. The proposed measure allows a new lower wattage lamp to simply be installed into the existing luminaire which yields significant material savings.

Direct Adverse Environmental Impacts

The proposed code change would not result in any direct adverse environmental impacts.

Indirect Environmental Impacts

Indirect Environmental Benefits

The proposed code change would not result in any indirect environmental benefits.

Indirect Adverse Environmental Impacts

The proposed code change would not result in any indirect adverse environmental impacts.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore, did not develop any mitigation measures.

Reasonable Alternatives to Proposal

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve its purpose with less environmental effect.

Water Use and Water Quality Impacts Methodology

This proposal has no impacts on water.

Appendix E: Energy Cost Savings in Nominal Dollars

The CEC requested energy cost savings over the 30-year period of analysis in both 2029 present value dollars (2029 PV\$) and nominal dollars. The cost-effectiveness analysis uses energy cost values in 2029 PV\$. Costs and cost effectiveness in 2029 PV\$ are presented in Section 6 of this report. This appendix presents energy cost savings in nominal dollars.

Table 20: First Year Statewide Nominal Energy Cost Savings Impacts for New Construction and Additions and Alterations.

Primary Function Area	First year Statewide NC & Addition (Million sf/yr)	NC Nom Energy Cost Savings (Million 30 Yr Nom \$)	First Yr Statewide Alteration (M sf/yr)	Alteration Nom Energy Cost Savings (Million 30 yr Nom \$)
Aging Eye/Low-vision:1 Corridor Area	0.03	\$0.13	0.10	\$0.54
Aging Eye/Low-vision:1 Dining	0.03	\$0.00	0.10	\$0.00
Aging Eye/Low-vision:1 Main Entry Lobby	0.03	\$0.27	0.10	\$1.09
Aging Eye/Low-vision:1 Lounge/Waiting Area	0.03	\$0.00	0.10	\$0.00
Aging Eye/Low-vision:1 Multipurpose Room	0.03	\$0.05	0.10	\$0.22
Aging Eye/Low-vision:1 Religious Worship Area	0.03	\$0.11	0.10	\$0.44
Aging Eye/Low-vision:1 Restroom	0.03	\$0.00	0.10	\$0.00
Aging Eye/Low-vision:1 Stairwell	0.03	\$0.00	0.10	\$0.00
Atria < 20 ft tall	0.33	\$4.67	1.34	\$18.81
Atria 20 to < 40 ft	0.14	\$1.12	0.62	\$4.95
Atria > 40 ft	0.02	\$0.05	0.11	\$0.22
Audience Seating Area	1.58	\$6.77	6.91	\$29.54
Auditorium Area	0.98	\$8.39	4.24	\$36.26
Auto Repair / Maintenance Area	3.22	\$0.00	15.68	\$0.00
Barber, Beauty Salon and Spa Area	0.36	\$1.45	1.57	\$6.28
Civic Meeting Room	0.07	\$0.46	0.75	\$4.81

Primary Function Area	First year Statewide NC & Addition (Million sf/yr)	NC Nom Energy Cost Savings (Million 30 Yr Nom \$)	First Yr Statewide Alteration (M sf/yr)	Alteration Nom Energy Cost Savings (Million 30 yr Nom \$)
Convention Center: Ballroom	0.05	\$0.29	0.20	\$1.26
Convention: Concourse	0.17	\$1.12	0.77	\$4.91
Convention: Exhibit Space	0.17	\$1.87	0.77	\$8.19
Convention: Meeting Room	0.17	\$0.75	0.77	\$3.28
Control room	0.08	\$0.00	0.35	\$0.00
Copy Room	1.13	\$1.51	4.24	\$5.67
Corridor Area	5.35	\$0.00	23.55	\$0.00
Data center: Computer room	2.13	\$0.00	10.41	\$0.00
Dining Area: Bar/Lounge and Fine Dining	0.28	\$0.87	1.04	\$3.22
Dining Area: Cafeteria/Fast Food	1.79	\$5.58	7.72	\$24.01
Dining Area: Family and Leisure	0.64	\$1.97	2.28	\$7.10
Kitchen/Food Preparation Area	1.98	\$12.33	8.54	\$53.14
Education/Business: Classroom, Training,	5.05	\$5.70	22.52	\$25.43
Educational, civic: Multipurpose room (art, music etc)	0.71	\$0.89	2.90	\$3.65
Electrical, Mechanical, Telephone Rooms	2.44	\$0.00	11.08	\$0.00
Exercise/Fitness Center and Gymnasium Area	1.99	-\$3.97	8.24	-\$16.49
Financial Transaction Area	1.45	\$4.66	5.00	\$16.03
Healthcare: Corridor	0.59	\$0.00	2.73	\$0.00
Healthcare: Exam/Treatment Room	1.56	\$2.65	7.17	\$12.18
Healthcare: Imaging Room	0.09	\$0.00	0.40	\$0.00
Healthcare: Medical Supply Room	0.06	\$0.10	0.28	\$0.47
Healthcare: Nursery	0.07	-\$0.24	0.32	-\$1.09
Healthcare: Nurse's Station	0.11	\$0.19	0.52	\$0.88
Healthcare: Operating Room	0.07	\$0.24	0.32	\$1.09
Healthcare: Patient Room - Critical care	0.10	\$0.00	0.44	\$0.00
Healthcare: Patient Room - General	0.24	-\$0.42	1.12	-\$1.91

Primary Function Area	First year Statewide NC & Addition (Million sf/yr)	NC Nom Energy Cost Savings (Million 30 Yr Nom \$)	First Yr Statewide Alteration (M sf/yr)	Alteration Nom Energy Cost Savings (Million 30 yr Nom \$)
Healthcare: Physical Therapy Room	0.14	\$0.48	0.64	\$2.19
Healthcare: Recovery Room	0.07	-\$0.12	0.32	-\$0.54
Laboratory: Scientific and Teaching	0.41	\$1.86	2.25	\$10.27
Laundry Area	0.34	\$0.27	1.95	\$1.56
Library : Reading Area	0.19	\$0.48	0.74	\$1.93
Library : Stacks Area	0.16	\$0.39	0.62	\$1.54
Lobby: Elevator	0.29	\$0.00	1.24	\$0.00
Lobby: Main entry	4.10	-\$8.76	17.17	-\$36.73
Lobby: Performing Arts	0.31	-\$0.66	1.35	-\$2.89
Locker Room	0.80	\$1.77	4.11	\$9.04
Lounge, Breakroom, or Waiting Area	2.32	\$9.75	11.16	\$46.92
Manufacturing & Commercial Work Area: Low Bay	3.09	-\$2.72	27.02	-\$23.73
Manufacturing & Commercial Work Area: High Bay	1.00	\$0.00	13.09	\$0.00
Manufacturing & Commercial Work Area: Precision	0.20	\$0.32	2.62	\$4.15
Motion picture: Theater area	0.59	\$4.43	2.64	\$19.89
Museum: Exhibition/Display	0.25	\$1.62	1.10	\$7.08
Museum Area: Restoration Room	0.04	\$0.09	0.19	\$0.41
Office Area: ≤ 250 square feet	10.88	\$15.84	45.06	\$65.64
Office Area: > 250 square feet	12.35	\$16.51	46.71	\$62.46
Office: Conference Room	1.41	\$5.67	5.31	\$21.30
Parking Garage Area: Parking Zone and Ramps	16.45	\$29.87	31.69	\$57.53
Parking Garage Area: Daylight Adaptation Zones ⁸	0.73	\$14.46	1.40	\$27.86
Performance : Theater area	0.58	\$3.74	2.53	\$16.20
Performance : Dressing room	0.03	\$0.00	0.15	\$0.00
Pharmacy Area	0.22	\$0.00	1.23	\$0.00
Retail: Concourse	1.72	\$10.31	10.66	\$64.00

Primary Function Area	First year Statewide NC & Addition (Million sf/yr)	NC Nom Energy Cost Savings (Million 30 Yr Nom \$)	First Yr Statewide Alteration (M sf/yr)	Alteration Nom Energy Cost Savings (Million 30 yr Nom \$)
Retail: Grocery Sales	0.36	\$2.09	2.48	\$14.41
Retail: Merchandise Sales	14.41	\$25.65	91.67	\$163.17
Retail: Fitting Room	0.25	\$0.99	1.53	\$6.12
Religious Worship Area	1.16	\$9.92	5.07	\$43.46
Restrooms	3.72	\$4.97	17.11	\$22.88
Stairwell	1.67	\$1.25	7.05	\$5.27
Sports Arena – Playing Area: Class I Facility ¹¹	0.08	\$0.00	0.36	\$0.00
Sports Arena – Playing Area: Class II Facility ¹¹	0.00	\$0.00	0.00	\$0.00
Sports Arena – Playing Area: Class III Facility ¹¹	0.00	\$0.00	0.00	\$0.00
Sports Arena – Playing Area: Class IV Facility ¹¹	0.00	\$0.00	0.00	\$0.00
Transportation: Baggage Area	0.02	\$0.00	0.10	\$0.00
Transportation: Concourse	0.13	\$0.84	0.57	\$3.69
Transportation : Ticketing Area	0.04	\$0.09	0.19	\$0.41
Transportation: Waiting area	0.09	\$0.75	0.38	\$3.28
Videoconferencing Studio ¹²	0.28	\$1.28	1.07	\$4.91
Warehouse: Storage	15.39	\$0.00	75.85	\$0.00
Warehouse: Shipping and Handling	3.58	\$0.00	17.60	\$0.00
Totals	135.24	\$212.97	609.67	\$877.86

Appendix F: Summary of Stakeholder Engagement

Introduction to Stakeholder Engagement

Collaborating with stakeholders who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, with the goal of submitting recommendations to the CEC in this Draft CASE Report that reflect broad technical input and stakeholder engagement. Public stakeholders provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement considerations, and potential impacts on human health or the environment. Some stakeholders also provide project experience, design practice insights, and technical data that the Statewide CASE Team uses to refine assumptions and support analyses.

This appendix summarizes the stakeholder engagement conducted by the Statewide CASE Team during the development and refinement of the report's recommendations, including participation in utility-sponsored stakeholder meetings, live polling activities, and written comments submitted during webinars.

Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity for stakeholders to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals being evaluated for the 2028 Title 24 code cycle. The goal of these meetings is to solicit input on proposals early enough in the process to ensure the proposals and supporting analyses are well vetted and have as few outstanding issues as possible prior to submission of the Draft CASE Report.

To promote transparency in the development of code change proposals, the Statewide CASE Team uses stakeholder meetings to solicit feedback on:

- Proposed code changes
- Draft code language
- Draft assumptions and results of energy and cost effectiveness analyses
- Data to support modeling assumptions
- Compliance and enforcement considerations
- Technical feasibility and market readiness

To date, the Statewide CASE Team has hosted one utility-sponsored stakeholder meeting focused on LPD and Luminaire Classification and Power measures via webinar, as described in Table 21. Please see below for dates and links to event pages

on Title24Stakeholders.com. Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Table 21: Utility-Sponsored Stakeholder Meetings

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round of LPD and Luminaire Classification Utility-Sponsored Stakeholder Meeting	September 24, 2025	Update 1) the prescriptive requirements for allowed lighting power density for nonresidential indoor spaces, and 2) the luminaire classification and adjusted indoor lighting power determination.
Second Round of LPD and Luminaire Classification Utility-Sponsored Stakeholder Meeting	March 19, 2026	Presentation of refined code proposals, preliminary analysis results, and updated draft code language.

First Round Stakeholder Meeting Summary

The first round of utility-sponsored stakeholder meetings began in September 2025 and served as an early forum to promote transparency and gather stakeholder feedback on measures under consideration by the Statewide CASE Team. The objectives of the first round of stakeholder meetings were to:

- Solicit input on the scope of the proposed code changes for the 2028 code cycle
- Request data and feedback on approaches, assumptions, and methodologies used in the energy impacts and cost-effectiveness analyses
- Identify potential technical, market, and compliance barriers.
- Present and collect feedback on preliminary draft code language

Lighting Power Density

During the first round stakeholder meeting, stakeholders participated in several live polling questions designed to better understand current lighting design practices and assumptions used in lighting calculations. Poll questions focused on topics such as lamp lumen depreciation (LLD) factors, total light loss factors (LLF), compliance pathways for lighting power allowances, and the use of additional power allowances and power adjustment factors.

Results from these polls indicated a wide range of stakeholder familiarity with lighting design assumptions. For example, when asked about the LLD factor typically applied in indoor lighting applications, approximately 19 percent of respondents indicated values

of 0.90 or greater, while 20 percent selected values between 0.8 and 0.85. A majority of respondents indicated that the question was not applicable to their role at 62 percent, suggesting that many meeting participants were not directly involved in lighting calculations.

Similarly, when asked about the LLF used in typical clean indoor environments such as offices, responses varied, with approximately 19 percent indicating an LLF around 0.8, while most respondents (69 percent) indicated the question was not applicable to their work.

Additional polls explored how frequently lighting projects require compliance trade-offs using performance modeling software. Responses suggested that performance trade-offs are used occasionally but are not the dominant compliance pathway for most projects worked on by stakeholders at the first stakeholder meeting.

Participants were also asked how frequently additional lighting power allowances (such as decorative or tunable white lighting allowances) and power adjustment factors are used to comply with lighting budgets. The majority of respondents indicated that these tools were either used only occasionally or not applicable to their projects, suggesting that most lighting designs generally comply within standard prescriptive lighting power limits.

Another poll asked stakeholders about the ratio of installed lighting power to allowed lighting power in a typical project. Responses suggested that many projects operate near the allowable lighting power limit, with 25 percent of respondents reporting installed power levels between 90 and 100 percent of the allowed power.

Stakeholders also provided qualitative feedback through open-ended responses. One respondent noted that projects involving high-quality lighting designs with RGB color capability or tunable correlated color temperature (CCT) may experience more difficulty complying with standard lighting power allowances due to the additional power requirements associated with these features.

Luminaire Classification & Power

The meeting also included polling and discussion regarding proposed changes to luminaire wattage determination for retrofit situations. Stakeholders were asked about preferred approaches for verifying luminaire wattage labeling when retrofits occur.

The majority of respondents (58 percent) preferred a flexible approach allowing either lamp labeling or luminaire manufacturer labeling, while 17 percent supported using only lamp labels and 25 percent supported using only manufacturer-supplied luminaire labels.

Stakeholders were also asked when and how compliance with new wattage labeling requirements should be verified. Responses were distributed across several verification approaches:

- 38 percent preferred verification during both plan review and inspection,
- 31 percent preferred verification during field inspection only,
- 23 percent preferred documentation-based verification during plan review only, and
- 8 percent preferred other.

In addition to polling, stakeholders submitted questions and comments through the webinar chat and Q&A functions. These discussions provided additional insights into technical considerations related to lighting equipment performance, retrofit practices, and compliance approaches.

Several stakeholders commented on LED driver reliability and actual equipment lifetime, noting that some field installations may not achieve the commonly assumed 50,000-hour lifetime used in lighting calculations. These comments highlighted the importance of considering real-world equipment performance when establishing lighting system assumptions.

Other stakeholders raised questions about the environmental and cost implications of different retrofit approaches, including Type A LED retrofit lamps. Participants noted that while Type A retrofits may not provide the highest energy savings, they can be a practical and cost-effective upgrade for facilities with limited budgets.

Stakeholders also discussed compliance challenges related to selectable-wattage luminaires and the need for clear guidance on how adjustable-output luminaires should be treated in lighting power calculations. Participants suggested that if wattage selection mechanisms cannot be permanently locked, the maximum selectable wattage should be used for compliance purposes.

These polls and discussions provided valuable insights into potential compliance challenges and areas where additional guidance in the compliance manuals or supporting documents may be beneficial.

Table 22 summarizes this feedback from the Utility-Sponsored Stakeholder Meeting on September 24, 2025. Stakeholders provided input on the potential benefits of allowing reuse of existing luminaires with replaceable lamps, as well as questions and concerns related to compliance, Type A retrofit lamps, and wattage calculations for selectable-output solid-state lighting (SSL) products.

Table 22: Summary of Manufacturers & Facility Teams Feedback during First Stakeholder Meeting

Category	Stakeholder Feedback	Notes
Support / Key Benefits	General support for reusing existing luminaires with replaceable lamps	“Glad to see that luminaires with removable lamps will be allowed. We have experienced a lot of early failure of LEDs so replacing lamps only is our preferred option for reducing cost and avoiding waste.”
Concerns / Questions	Compliance with retrofit using SSL and existing luminaires	If retrofit lamps use existing ballasts (e.g., Type A), actual energy savings may not reflect intended reductions because input ballast power, not new LED lamp power, determines wattage.
	Clarity regarding Type A retrofit lamps	Draft language does not explicitly mention Type A; recommended to clearly state in standard or compliance manual whether Type A is allowed or disallowed.
	Wattage calculation for selectable-output SSL luminaires	For adjustable-output luminaires, if output can be locked, selected wattage may be used; otherwise, maximum selectable wattage governs compliance.

The Statewide CASE Team will continue engaging with lighting manufacturers using the following manufacturer survey instrument to solicit input on the proposed updates.

Second Round Stakeholder Meeting Planning

The second round of utility-sponsored stakeholder meetings will take place March 19, 2026 and provide updated details on proposed code changes. These meetings will introduce early results of energy, cost effectiveness, and incremental cost analyses, and solicited feedback on refined draft code language.

Stakeholder Outreach and Participation

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the full Title 24 Stakeholders listserv, which includes more than

3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service comprising participants from a diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels outside beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted in to the listserv. Exported webinar meeting data captured attendance numbers, individual comments, and results from live attendee polls to help evaluate stakeholder participation and support.

Targeted Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous stakeholders when developing this report. The Statewide CASE Team will continue to solicit feedback from relevant organizations that have not yet responded at the time of this draft report, and findings will be updated in the Final CASE report.

Manufacturer & Facility Team Outreach

Specific to manufacturers and facility teams, the Statewide CASE Team communicated with six organizations. One organization represented four individuals, for a total of nine individual responses. A summary of the stakeholder feedback is provided below as well as the survey tool used to guide the discussions.

Summary of Stakeholder Feedback from Manufacturers & Facility Teams

Stakeholder engagement revealed broad support for maintaining clear and enforceable wattage determination rules for multi-wattage luminaires, with most designers already complying at the maximum selectable wattage and manufacturers favoring this approach for simplicity. However, stakeholders expressed strong opposition to break-off tabs and current limiter requirements, citing inspection challenges, cost, and reduced flexibility. Some designers advocated for limited flexibility pathways, such as allowing commissioned set wattage if verifiable.

With respect to LED retrofit lamps, Type A products remain widely used, particularly in institutional settings due to cost and funding flexibility. Manufacturers generally support their continued allowance, though designers are divided on whether ballast-input wattage should be required or if use should be restricted in non-repair projects.

Concerns were raised that overly restrictive treatment of retrofit lamps could increase costs and slow fluorescent-to-LED transitions. Type B lamps are commonly used but

raise safety concerns in some settings, while Type C lamps are viewed by many as safer and more reliable, despite occasional early driver issues. Across stakeholders, there was consistent emphasis on avoiding adoption barriers and preserving practical compliance pathways.

Detailed individual responses are provided in Table 23.

Table 23: Engaged Stakeholders – Manufacturers & Facility Teams

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
Manufacturer Representative 1	Manufacturer Representative	Response pending from represented luminaire and linear LED lamp manufacturers.
Manufacturer Representative 2	Manufacturer Representative	Response pending from represented luminaire and linear LED lamp manufacturers.
Manufacturer Representative 3	Manufacturer Representative	Response pending from represented luminaire and linear LED lamp manufacturers.
Manufacturer Association 1	Manufacturer Association	Response received from four anonymous members regarding luminaire classification and power. Most respondents offer multi-wattage luminaires and retrofit lamps (Types A/B/A+B, some C) and generally support rating products at the highest selectable wattage for code compliance to preserve flexibility and reduce waste; Type A lamps should remain allowed (not limited to repairs), though opinions differ on using ballast-rated wattage due to accuracy concerns; break-off tabs are largely discouraged; labeling approaches vary (lamp, field, or flexible), with concerns about labels being ignored, and at least one respondent recommends verification at both plan check and inspection, emphasizing installer responsibility when manufacturers provide required documentation.
University 1	Higher Education Campus	A university facilities team reported that Type A LED retrofits are widely used due to cost and funding flexibility, while Type B (ballast bypass) is prohibited for safety reasons; labor costs depend on project scale and timing (with higher costs for contractor, night, or weekend work); Type A systems face maintenance issues including 3–5 year driver failures and discontinued lamp/ballast tracking; Type C is preferred for longevity but has seen early driver failures in some applications; overall, policy should enable practical, cost-effective fluorescent-to-LED transitions without creating adoption barriers.

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
Manufacturer 1	Luminaire Manufacturer	The manufacturer indicated that higher-efficacy (HE) luminaires achieve the same lumen output at lower wattage primarily by using more LEDs operated at lower drive currents, sometimes with additional boards depending on the product, resulting in modest (6 - 10 lm/W) efficacy gains and slight thermal benefits; HE products use the same core components with no performance trade-offs beyond a small, market-dependent cost premium, face no lead-time constraints, and represent a small share of overall sales, with limited growth expected as baseline LED efficacy continues to improve and rebate influence declines.

Lighting Designer Outreach

Specific to lighting designers, the Statewide CASE Team invited 14 individuals to participate in the survey. At the time of this report, six responses had provided responses. A summary of the stakeholder feedback is provided below as well as the survey tool used to guide the discussions.

Summary of Stakeholder Feedback from Lighting Designers

Preliminary data collected from the lighting designer focus group surveyed is as follows:

Accuracy of Manufacturers data on specification cut sheets. While the general trend is that data is accurate, most designers felt the manufacturer’s performance data was often conservative. Manufacturers understate performance to avoid potential liabilities.

Luminaire lumen depreciation factor used for your design applications. Most of the designers use 0.9 LLD, a few use 0.85 LLD. When asked the total Light Loss Factor (LLF) the consensus was 0.85 to 0.80 LLF.

Use of additional power allowances and adjustment factors. Most of the designers surveyed to date said they usually must use these allowances/factors to meet code compliance.

Multi-Wattage Luminaires with User Selectable CCT and Lumen Outputs. Several designers stated that they specify this type of luminaire with the primary application being when project budgets are an issue. Of those designers using these luminaires most said they complied with code at the highest rated full power output. One designer said they would like to have the code allow use of average power output for compliance. None of them liked the idea of break off taps to set allowed watts for compliance. In instances when maximum power output cause compliance issues designers suggested that current limiter panels or dimming controls be used to meet code compliance.

Questions about LED Retrofit Lamps. Most designers, when using retrofit LED lamps, prefer the type B product. A few designers were also ok with type A LED retrofit lamps when project budgets were an issue or on small, limited area retrofit projects. One designer expressed the concern that the use of type B lamps is a safety issue, especially if the installation is in 277V input system. This designer only uses the type C LED retrofit lamps as type A retrofit lamp installations are sometimes unreliable and older legacy fluorescent luminaires are subject to ongoing maintenance issues.

Questions About Multi-Wattage LED Retrofit Lamps. As with luminaires with user selectable CCT and lumen outputs, designers that specify this type of LED retrofit lamps of those designers using these luminaires said they complied with code at the highest rated full power output. One designer, however, said they would like to have the code allow use of average power output for compliance. None of them liked the idea of breaking off taps to set allowed watts for compliance. When requiring maximum power output caused compliance issues, they suggested adjusting power output to meet compliance by using current limiter panels or dimming controls to meet code compliance.

Detailed individual responses are provided in Table 24.

Table 24: Engaged Stakeholders – Lighting Designers

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
Lighting Designer 1	Lighting Designer	Response pending.
Lighting Designer 2	Lighting Designer	Response pending.
Lighting Designer 3	Lighting Designer	Response pending.
Lighting Designer 4	Lighting Designer	<p>The stakeholder indicated that manufacturer cut-sheet efficacy data is generally representative of both older and recently introduced luminaires, though IES files are not always updated; modeled performance aligns with expectations. They typically apply a 0.90+ LLD and ~0.81 LLF, rarely require trade-offs or additional allowances to meet Title 24, and report installed lighting power typically at 90–100% of allowed levels.</p> <p>Compliance challenges arise primarily with indirect lighting designs. The respondent specifies 90+ CRI products as standard and uses selectable-output luminaires, demonstrating compliance at full output. For multi-wattage luminaires, they prefer rating at the highest wattage option and suggest lower wattage allowances when connected to dimming controls.</p>

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
		<p>They strongly favor Type C LED retrofit lamps (for safety and performance), recommend disallowing Type A and B for code-compliant projects, and do not specify multi-wattage retrofit lamps, instead recommending controls that limit maximum installed wattage.</p>
Lighting Designer 5	Lighting Designer	<p>The stakeholder generally finds manufacturer cut-sheet efficacy data representative in most cases but notes rapid LED improvements make it challenging for specifications to stay current; they verify photometric file dates and adjust factors when discrepancies arise. They report an approximate $\pm 15\%$ efficacy difference between 80 and 90 CRI products and observe that 90+ CRI is quickly becoming the standard in hospitality and retail applications. They typically apply ~ 0.9 LLD and 0.8 LLF values.</p> <p>From a compliance standpoint, they indicate projects rarely require trade-offs, but hospitality projects with significant decorative lighting components can present challenges. They prefer early coordination with engineers to establish compliance strategies. Installed power ratios and use of adjustment factors were generally marked as limited or not applicable.</p> <p>The respondent does not currently use selectable-output luminaires but recognizes their potential value; when used on code projects, compliance has been demonstrated via annotated spec sheets. For LED retrofit lamps, they typically use Type B and prefer allowing Type A under the option that counts ballast input wattage. They do not currently specify multi-wattage retrofit lamps and offered no additional recommendations regarding multi-tap luminaires or retrofit controls.</p>
Lighting Designer 6	Lighting Designer	Response pending.
Lighting Designer 7	Lighting Designer	Response pending.
Lighting Designer 8	Lighting Designer	<p>The stakeholder generally believes manufacturers update cut sheets to reflect current information, particularly for recently introduced products, though IES files are only sometimes updated. They rely on current photometric files and expect modeled performance to align with those files. Rather than focusing on manufacturer-stated lumen depreciation, they apply a total LLF in design practice.</p>

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
		<p>They report continued use of 80 CRI products due to cost and energy considerations, while acknowledging that 90+ CRI luminaires are common in retail and hospitality. They do not apply LLD separately and typically use an LLF around 0.85. Projects sometimes require trade-offs, though this respondent noted they are not responsible for completing Title 24 documentation.</p> <p>From a compliance perspective, they indicated more frequent use of additional power allowances and adjustment factors, with installed power typically in the 90–100% range of allowed power. Designs that must also meet health codes (e.g., commercial kitchens and public restrooms) present the most compliance challenges.</p> <p>They use selectable-output luminaires in commercial kitchens and retail projects and demonstrate compliance by using the highest wattage setting. Among proposed code approaches for multi-wattage luminaires, they consider rating at the highest wattage the most reasonable and have not had compliance issues using that method; they view visible switches as undesirable and current limiters as adding unnecessary cost.</p> <p>The respondent does not use LED retrofit lamps but notes that retail projects frequently use Type A, B, and hybrid lamps. They oppose restrictions that would penalize owners for retrofitting to lower-wattage LED sources and question the need for strict limitations when energy use is reduced. They have not used multi-wattage retrofit lamps but believe replacing higher-wattage legacy sources with lower-wattage LEDs inherently provides an energy benefit.</p>
Lighting Designer 9	Lighting Designer	<p>The stakeholder believes luminaire efficacy has improved significantly in recent years, though it is not always clear whether improvements are reflected consistently on cut sheets. They note that IES file updates can be difficult to verify and feel photometric files may sometimes underperform relative to installed results, potentially due to LLF assumptions or conservative manufacturer reporting. Manufacturer documentation often includes factors for finish, CRI, and CCT, and the respondent typically applies ~0.9 LLF for interiors and ~0.85 for exteriors.</p> <p>They report that efficacy differences between 80 and 90 CRI products can vary, sometimes up to ~17%,</p>

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
		<p>and agree that 90+ CRI appears to be becoming the baseline in hospitality and retail applications.</p> <p>From a compliance standpoint, they typically apply 0.90+ LLD and around 0.90 total LLF for interiors. Projects sometimes require trade-offs, particularly in hospitality work. Restrooms, hotel/dwelling corridors, and tape light applications are described as especially difficult to bring into compliance due to decorative layering and driver/linear footage calculation challenges. Additional power allowances and adjustment factors are used frequently, and installed power can exceed allowances, relying on extra allowances to achieve layered lighting designs (often dimmed in practice).</p> <p>They use selectable-output luminaires frequently, particularly cost-conscious downlights, and typically count them at maximum wattage for compliance. While they see merit in multiple compliance approaches for multi-wattage luminaires, they question practicality and cost impacts of certain options (e.g., underside switches, current limiters). They suggest the possibility of using average wattage for compliance or actual commissioned set wattage if verifiable, and emphasize flexibility for low-budget projects.</p> <p>For LED retrofit lamps, they sometimes use them (Type B noted as most common). They favor allowing Type A retrofits under the ballast-input-wattage method but advocate exemptions or flexibility for small retrofit budgets so as not to discourage energy-saving upgrades. They believe code should be more lenient for modest retrofit projects, as overly stringent requirements can delay improvements and negatively impact lighting quality.</p> <p>They have not yet specified multi-wattage retrofit lamps but see potential user benefits (stocking one lamp for multiple applications). They caution against penalizing users for selecting adjustable lamps in fixtures originally rated for higher wattages and recommend practical compliance pathways (e.g., using maximum wattage if required but recognizing retrofit energy reductions). Overall, they emphasize keeping compliance achievable to avoid discouraging energy-efficient upgrades.</p>
Lighting Designer 10	Lighting Designer	The stakeholder generally finds manufacturer data accurate, though IES updates vary by product.

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
		<p>Modeled performance typically matches expectations. Applied LLF values depend on space type, commonly around 0.95–0.90 for generic spaces.</p> <p>They note that 90+ CRI is typical for higher-end retail and hospitality, but lower-budget projects often use 80 CRI due to cost. Compliance challenges are most common in small retail, restaurants, and boutique offices with layered lighting designs. They report always using additional allowances and adjustment factors when multiple lighting systems are present, with installed power often near the allowed limit.</p> <p>They frequently use selectable-output luminaires for flexibility and cost reasons and document required wattage/CCT clearly in specifications. They oppose rating multi-wattage luminaires at the highest setting and believe this reduces design flexibility. They support clear labeling and accountability in specifications instead of added hardware or restrictions.</p> <p>LED retrofit lamps are used infrequently in their projects. They believe retrofit solutions should be encouraged to reduce outdated technology and waste. They prefer dedicated-wattage lamps and caution that overly rigid code rules could limit flexibility, reduce design quality, and increase environmental waste.</p>
Lighting Designer 11	Lighting Designer	Response pending.
Lighting Designer 12	Lighting Designer	<p>The stakeholder is uncertain about the accuracy of manufacturer efficacy data and does not typically perform lighting calculations themselves. They prefer specifying higher CRI and note that CRI is often driven by price rather than end-user priorities.</p> <p>They report that projects sometimes require trade-offs to comply. Additional power allowances are usually used. Decorative fixtures with replaceable A19 LED retrofit lamps create confusion around allowable wattage, and they describe the current system as unclear.</p> <p>They use selectable CCT luminaires but dislike break-off tabs (difficult to inspect and irreversible) and are skeptical of current limiters. They believe that if exact wattage is shown on plans, installers should follow the specification rather than adding additional hardware or restrictions. They question why designers should be</p>

Organization/ Individual Name	Market Role	Mentioned in CASE Report Sections
		<p>penalized by requiring multi-wattage fixtures to be rated at the highest wattage.</p> <p>LED retrofit restrictions are viewed negatively. They believe prohibiting ballast-compatible retrofit lamps (UL Type A) increases costs and may discourage compliance, particularly for small businesses. They suggest manufacturers provide clearer compatibility and power data instead of restricting retrofit use.</p>
Lighting Designer 13	Lighting Designer	Response pending.
Lighting Designer 14	Lighting Designer	Response pending.

Engagement with ESJ communities

As discussed in 4.3, the Statewide CASE Team does not expect any major impacts on ESJ communities. The Statewide CASE Team is still conducting outreach. Any efforts related to engaging with ESJ communities will be documented in the Final CASE Report.

Appendix G: Luminaire Review

Details to posted in Final CASE Report.