CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

MEMO

To: California Energy Commission

From: Statewide Utility Codes and Standards Enhancement Team
Prepared by Energy Solutions

Date: March 8, 2021

Subject: **Revised Wattage Threshold for Advanced Daylighting Controls**

1. Introduction

On September 8, 2020, the National Electrical Manufacturers Association Daylighting Management Council (NEMA DMC) submitted a comment to the Statewide CASE Team urging that the California Energy Code (Title 24, Part 6) be updated with modifications to the wattage threshold that defines when automatic daylighting controls are required in nonresidential buildings. Specifically, NEMA DMC recommended that Title 24, Part 6 align with the proposed threshold presented in Addendum O to the 2019 version of American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 90.1 (ANSI/ASHRAE/IES 90.1-2019). In their comment NEMA DMC stated, “Alignment of the requirements of these two main building energy efficiency standards makes compliance, enforcement, and education easier for all parties involved in the design and construction of buildings.”

In response to NEMA DMC’s request, the Statewide CASE Team conducted a preliminary analysis to explore the feasibility of modifying the wattage threshold in Title 24, Part 6. Results of this preliminary analysis indicate that revising the threshold will result in cost-effective energy savings. The Statewide CASE Team agrees with NEMA DMC that the wattage threshold in Title 24, Part 6 should be adjusted and is interested in working with the California Energy Commission (Energy Commission) to explore this recommendation further.

This document presents results of the preliminary analysis and is structured as follows:

- Section 2: Description of the proposed code change along with relevant background information;
- Section 3: Energy savings estimates;
- Section 4: Cost effectiveness analysis; and
- Section 5: Marked-up code language.

The Statewide CASE Team would like to discuss this code change opportunity with Energy Commission staff and can work collaboratively to develop the recommendations presented in this memo further as needed.

2. Measure Description

2.1 Measure History

Title 24, Part 6 includes a mandatory requirement that the general lighting in skylit daylit zones, primary sidelit daylit zones, and secondary sidelit zones must have automatic daylighting controls unless there is less than 120 watts of general lighting installed in these daylit zones [Section 130.1(d) and Section 140.6(d)].[1] The stability of a wattage threshold made sense because it directly links the life cycle savings to the cost of the measure. Life cycle savings is based on:

- The wattage of controlled lighting;
- The full load hours per year of lighting reduction; and
- The unit cost of electricity.

Unless the costs of the controls change, or how the control saves energy, this provides a stable cost-effective threshold value that is not impacted by changes in lighting efficacy of allowed LPDs.

This 120-watt threshold has remained unchanged for multiple code cycles while lighting efficacy (lumens per watt) has significantly increased since the threshold was established. To reflect this market shift, the indoor lighting power densities (LPDs) were updated in the 2019 version of Title 24, Part 6 to be based on LED technology instead of legacy lighting technology (metal halide, fluorescent, or others), which resulted in a LPDs values being reduced by on average around 20 percent. As LPDs were reduced but the 120-watt threshold remained unchanged, fewer spaces were subject to the automatic daylighting controls requirement.

These thresholds were developed with the assumption that under full daylight conditions, the lighting power is reduced to 35 percent of full power. The Statewide CASE Team has proposed that lighting power be reduced to 10 percent of full power,

[1] Currently, automatic daylighting control requirements for secondary sidelit daylit zones are prescriptive (Section 140.6). However, the Statewide CASE Team is proposing to move them to the mandatory section (Section 130.1) in a separate CASE Report.

the minimum required control step for LED lighting in accordance with existing mandatory multi-level lighting control requirements in Table 130.1-A. Thus, daylighting controls would save more energy (larger full load hours per year savings) under the 2022 code than they do when the current threshold was proposed in 2013.

The NEMA DMC recommended alignment with ASHRAE 90.1 to improve compliance with both Title 24, Part 6 and ASHRAE 90.1. The 2019 version of ASHRAE 90.1 requires automatic daylight-responsive controls with the following wattage thresholds:

1. If the combined lighting power of all general lighting completely or partially within the primary sidelighted[2] area is 150 watts or greater, automatic daylight responsive controls are required in the primary sidelighted area.
2. If the combined lighting power of all general lighting completely or partially within the primary sidelighted area and the secondary sidelighted area is 300 watts or greater, then automatic daylight responsive controls are required in the primary sidelighted area and the secondary sidelighted area.
3. If the combined input power of all general lighting completely or partially within daylight area under skylights and daylight area under roof monitors is 150 watts or greater, then automatic daylight-responsive controls are required in the daylight area.

The ASHRAE 90.1 Lighting Subcommittee (LSC) has developed a proposal that would revise the wattage thresholds from 150 watts to 75 watts, 300 watts to 150 watts, and 150 watts to 75 watts in the three scenarios described above, respectively. These proposed changes were released for public review in Summer 2020 as Addendum O to ASHRAE 90.1-2019. The LSC has also presented the proposal to the full ASHRAE 90.1 committee and it was received a generally positive response. The ASHRAE 90.1 LSC is currently developing responses to public comments, including conducting additional analysis on cost impacts. Addendum O to ASHRAE 90.1-2019 could be approved by the end of 2020. Note that ASHRAE 90.1 evaluates cost-effectiveness of electricity savings proposals using average national electricity costs, which are approximately half of those in California. Requirements that are cost effective for ASHRAE would typically be even more cost effective in California.

The Statewide CASE Team was aware that the ASHRAE 90.1 LSC was examining the wattage threshold and considering revisions to requirements in ASHRAE 90.1. The

[2] ASHRAE 90.1 uses the term “sidelighted” whereas Title 24, Part 6 uses the term “sidelit”. When describing ASHRAE 90.1 requirements, the ASHRAE terminology is used. When describing changes to Title 24, Part 6, the Title 24, Part 6 terminology is used.

intent was to consider harmonizing the Title 24, Part 6 threshold with the revised ASHRAE 90.1 thresholds after Addendum O was approved. With the revisions to the ASHRAE 90.1 threshold moving forward faster than expected, the timing may be such that the ASHRAE 90.1 revision is finalized in time for California to adopt a similar revision for the 2022 code cycle.

2.2 Summary of Proposed Change

The proposed code change would adjust the wattage thresholds that apply to both the primary and secondary sidelit daylit zones. The change would modify Exception 3 to Section 130.1(d) and Exception 1 to Section 140.6(d), substituting 75W where 120W appears, and 150W where 240W is now indicated. This revision reflects the appropriate threshold wattage now based on greater savings from daylighting controls.

3. Energy Savings

3.1 Energy Savings Analysis Methodology

To evaluate the revised threshold, the Statewide CASE Team examined the energy savings and cost effectiveness of the revised threshold as it applies to the Primary and Secondary Sidelit Daylit Zones combined. As discussed in Section 2.1, the current wattage thresholds are as follows:

1. Primary Sidelit Daylit Zones: automatic daylighting controls required if the generally lighting power in the Primary Sidelit Daylit Zone is 120W or greater (Section 130.1(d)).
2. Secondary Sidelit Daylit Zones: automatic daylighting controls required if:
    a. The generally lighting power in the Secondary Sidelit Daylit Zone is 120W or greater; AND|
    b. The general lighting power in the combined Primary and Secondary Sidelit Daylit Zones is 240W or greater (Exception 1 to Section 140.6(d)).

For the analysis presented in this report, the Statewide CASE Team evaluated the energy savings and cost effectiveness of revising the threshold for the combined Primary and Secondary Sidelit Daylit Zones from 240W to 150W (option 2b above). As a next step, it may be appropriate to examine the cost effectiveness of other thresholds. However, it is expected that the scenario evaluated in this report will be the limiting scenario for cost-effectiveness. Energy savings per watt is higher for the Primary Sidelit Daylit Zone than the Secondary Sidelit Daylit Zone but the costs per installed watt

remain the same. Therefore, it is expected that the cost effectiveness of a updating the 120W threshold for the Primary Sidelit Daylit Zone to 75W will be higher than the cost effectiveness of the 150W threshold for the combined Primary and Secondary Sidelit Daylit Zone. For the Secondary Sidelit Daylit Zone, daylighting controls are required if both of the two thresholds identified above (option 2a or 2b) are met. Option 2b is expected to be more cost effective than option 2a.

The Statewide CASE Team evaluated the energy savings of daylighting controls in a prototypical building using the same general methodology used to evaluate all proposed changes developed for the 2022 code cycle. The savings per watt of controlled lighting were then used to evaluate the energy savings associated with the threshold wattage of 150 watts in the primary and secondary zones.

The energy savings were simulated using EnergyPlus version 9.01 and the rulesets defined in the 2022 Research Version of California Building Energy Code Compliance software for Commercial buildings (CBECC-Com). EnergyPlus provides whole-building energy consumption for every hour of the year measured in kilowatt-hours per year (kWh/yr) and therms per year (therms/yr). The 2022 time dependent valuation (TDV) factors were then applied to calculate annual energy use in TDV thousand British thermal units per year (TDV kBtu/yr) and annual peak electricity demand reductions measured in kilowatts (kW). The Statewide CASE Team also calculated TDV energy cost savings values measured in 2023 present value dollars (2023 PV$) using the TDV kBTU to 2023 PV$ conversion factors that the Energy Commission provided along with the 2022 TDV factors (California Energy Commission 2020a, California Energy Commission 2020b).

The energy impacts of the proposed code change vary by climate zone, so energy impacts were simulated in every climate zone and climate-zone-specific TDV factors were applied when calculating energy and energy cost impacts.

The Statewide CASE Team used the Large Office prototype building, which the Energy Commission provided in the 2022 Research Version of CBECC-Com, to evaluate impacts. The Large Office prototype was selected because it represents the highest floor area among all nonresidential building types based on the statewide construction forecast that the Energy Commission provided (California Energy Commission n.d.). Offices are also good candidate spaces for automatic daylighting controls as they typically have significant sidelit daylit space. Table 1 presents information about the Large Office prototype.

Table 1: Prototype Building Used for Energy, Demand, Cost, and Environmental Analysis

Prototype Name	Number of Stories	Floor Area (square feet)	Description
OfficeLarge	13	498,589	13 story + 1 basement office building with 5 zones and a ceiling plenum on each floor. Window/Wall Ratio (WWR)-0.40

The Statewide CASE Team developed building-wide energy use estimates for both the Standard Design and the Proposed Design. The Standard Design represents the geometry of the proposed design that the builder would like to build and inserts a defined set of features that result in an energy budget that is minimally compliant with 2019 Title 24, Part 6 code requirements. Features used in the Standard Design are described in the 2019 Nonresidential ACM Reference Manual. The Proposed Design represents the same geometry as the Standard Design, but it assumes the energy features that the software user describes with user inputs.

For both the Standard Design and Proposed Designs, the Statewide CASE Team assumed an LPD of 0.6 watts per square foot (W/ft^2), which is the allowed lighting power density (LPD) for general lighting for Open Plan Offices in 2019 Title 24, Part 6 if using the area category method (Table 140.6-C). In the Standard Design, it was assumed that there are no automatic daylighting controls. In the Proposed Design, it was assumed that there are automatic continuous daylighting dimming controls with minimum lighting and power factors of 0.2 for the Primary and Secondary Sidelit Daylit Zones. This is equivalent to a requirement that would require dimming to 20 percent of total design power. The current Title 24, Part 6 requirement requires dimming to 35 percent, but the compliance software calculates the impact of daylighting controls assuming dimming to 20 percent. For this analysis, the Statewide CASE Team used the default dimming to 20 percent values that are used in the 2019 compliance software. As discussed, the Statewide CASE Team is recommending that for the 2022 code cycle, Title 24, Part 6 be updated to required dimming to 10 percent of total design power. If the Energy Commission approves the proposed dimming to 10 percent proposal, the savings estimates presented in this document will be understated and the revised threshold will result in more savings and be more cost effective.

Table 2 presents assumptions made in both the Standard Design and the Proposed Design.

Table 2: Modifications Made to the Standard Design in Each Prototype to Simulate Proposed Code Change

Prototype ID	Climate Zones	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
OfficeLarge	All	Daylit Zone	Primary and Secondary Sidelit	Primary and Secondary Sidelit
OfficeLarge	All	100% Controlled	No	Yes
OfficeLarge	All	Daylighting Control Type	N/A	Continuous
OfficeLarge	All	Minimum Dimming Light Fraction	N/A	0.2
OfficeLarge	All	Minimum Dimming Power Fraction	N/A	0.2

Comparing the energy impacts of the Standard Design to the Proposed Design reveals the savings opportunity of automatic daylighting controls applied to 100 percent of the sidelit daylit space in the Large Office prototype. The Standard Design has a full load hours of operation (of the lighting system) of approximately 43.1 hours per week. For the lights in either the primary or secondary sidelit zone, the Proposed Design has a full load hours of operation range of approximately 19.7 to 25.4 hours per week, depending on both climate zone and location in the building.[3] The operating hours of lighting is the same for standard and proposed design but full load hours are lower for the proposed design because the lights are dimmed during all daylight hours. See Appendix A for more details on full load hours. As discussed below, the Statewide CASE Team conducted additional analysis to evaluate the impact of revising the wattage threshold, which impacts a subset of the total daylit space.

Simulation results yield the energy savings if automatic daylighting controls were applied to all lighting in a Primary and Secondary Sidelit Daylit Zones. In the Large Office prototype building, each of the 13 stories has four perimeter lighting zones, one for each side of the building. Each perimeter zone has a Primary Sidelit Daylit Zone and a Secondary Sidelit Daylit Zone (see Figure 1). Table 3 presents the floorspace of each

[3] The full load hours are the total Watt hours of lighting energy consumption divided by the system wattage. If the lights are controlled in an on/off manner then the full load hours are the same as the operating hours. When lights are dimmed, the full load hours will be less than the operating hours.

perimeter zone and the area within the Primary and Secondary Sidelit Daylit Zones. The table also shows the combined installed wattage in the Primary and Secondary Sidelit Daylit Zones assuming an LPD of 0.6W/ft^2. The simulated results assume that automatic daylighting controls would be applied to 133,102 ft^2 in the Large Office prototypical building, or 79,873 Watts of installed general lighting in the entire building assuming 0.6W/ft^2. As discussed in Appendix A, this is an overstatement of the energy savings what would be realized from the daylighting control requirements for the entire building given the wattage threshold requirements limit where controls are required. Revising the wattage threshold would result in an additional 18.75% of the floorspace in a Primary or Secondary Sidelit Daylit Zone having daylighting controls.

The reminder of this section presents energy savings and costs associated with daylighting controls in a zone that just meets the wattage threshold (150-watts).

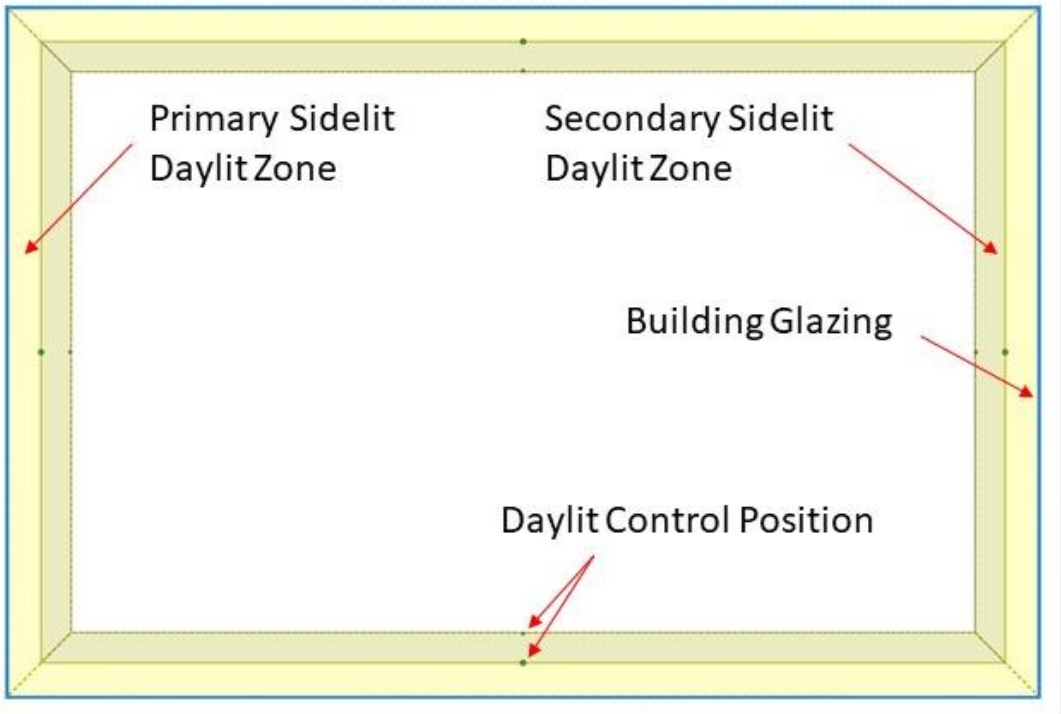

Figure 1: Large Office prototype building glazing, daylit zone, and control position.

Table 3: Summary of Primary and Secondary Sidelit Daylit Zones in Large Office Prototypical Building – Assuming 0.6W/ft^2

Zone Name	Number of Floors Applicable to	Area of Entire Lighting Zone (ft^2)	Total Installed Lighting Power in Entire Zone (Watts)	Primary Sidelit Daylit Space (ft^2)	Secondary Sidelit Space (ft^2)	Total Sidelit Daylit Space (ft^2)	Installed Lighting Power in Primary Sidelit Daylit Zone (Watts)	Installed Lighting Power in Secondary Sidelit Daylit Zone (Watts)	Installed Lighting Power in Primary and Secondary Zones (Watts)
Basement Spc	1	38,353	23,012						
Core_bottom	1	27,258	16,355						
GroundFloor_Plenum	1	38,353							
Perimeter_bot_ZN_1	1	3,374	2,024	1,901	1,471	3,372	1,141	883	2,024
Perimeter_bot_ZN_2	1	2,174	1,304	1,239	934	2,173	744	561	1,305
Perimeter_bot_ZN_3	1	3,374	2,024	1,901	1,471	3,372	1,141	883	2,024
Perimeter_bot_ZN_4	1	2,174	1,304	1,245	928	2,173	747	557	1,304
Core_mid	5	27,258	16,355						
MidFloor_Plenum	5	38,353							
Perimeter_mid_ZN_1	5	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024
Perimeter_mid_ZN_2	5	2,174	1,304	1,215	958	2,173	729	575	1,304
Perimeter_mid_ZN_3	5	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024
Perimeter_mid_ZN_4	5	2,174	1,304	1,215	958	2,173	729	575	1,304
Core_hi	5	27,258	16,355						
HiFloor_Plenum	5	38,353							
Perimeter_hi_ZN_1	5	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024
Perimeter_hi_ZN_2	5	2,174	1,304	1,215	958	2,173	729	575	1,304
Perimeter_hi_ZN_3	5	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024
Perimeter_hi_ZN_4	5	2,174	1,304	1,215	958	2,173	729	575	1,304
Core_top	1	27,258	16,355						
Perimeter_top_ZN_1	1	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024
Perimeter_top_ZN_2	1	2,174	1,304	1,215	958	2,173	729	575	1,304
Perimeter_top_ZN_3	1	3,374	2,024	1,855	1,518	3,373	1,113	911	2,024

Perimeter_top_ZN_4	1	2,174	1,304	1,215	958	2,173	729	575	1,304
TopFloor_Plenum	1	38,353							
			Sum	**73,826**	**59,276**	**133,102**	**44,297**	**35,576**	**79,873**

3.2 Per 150-Watt Zone Energy Impacts Results

Table 4 presents the energy savings associated with automatic daylighting controls in the large office prototype per watt of installed general lighting in the Primary or Secondary Sidelit Daylit Zone. Table 5 presents the energy savings that can be expected in a zone that just meets the proposed 150-watt threshold. Any instances of negative values are denoted in red with ( ) in the tables below.

Most of the savings are a result of lighting system electrical savings. Heat generated by that lighting system would be reduced as well, in a limited secondary effect. During those hours where lighting is dimmed by the daylighting controls, internal gains are reduced, depending upon the loads of the building this will either decrease cooling loads or increase heating loads. The most pronounced instance of energy savings being reduced (i.e., increased energy use) associated with increased natural gas consumption is in heating dominated climates including Climate Zone 1 (Arcata) and Climate Zone 16 (Blue Canyon). In all climate zones, the result is a positive total TDV energy savings.

Table 4: First-Year Energy Impacts Per Watt of Controlled Lighting – Combined Primary and Secondary Zone – New Construction/Additions and Alterations – OfficeLarge

Climate Zone	Electricity Savings (kWh/W)	Peak Electricity Demand Reductions (kW/W)	Natural Gas Savings (therm/W)	TDV Energy Savings (TDV kBtu/W)
1	1.2	0.0	(0.0)	20.5
2	1.3	0.0	(0.0)	30.0
3	1.3	0.0	(0.0)	27.5
4	1.3	0.0	(0.0)	31.6
5	1.3	0.0	(0.0)	25.7
6	1.3	0.0	(0.0)	29.0
7	1.3	0.0	0.0	27.0
8	1.4	0.0	0.0	35.2
9	1.4	0.0	0.0	35.8
10	1.6	0.0	0.0	40.5
11	1.3	0.0	(0.0)	30.0
12	1.3	0.0	(0.0)	30.4
13	1.4	0.0	(0.0)	31.9
14	1.4	0.0	(0.0)	35.1
15	1.4	0.0	0.0	34.7
16	1.3	0.0	(0.0)	23.8

Table 5: First-Year Energy Impacts Per 150-Watt Combined Primary and Secondary Sidelit Zone - New Construction/Additions and Alterations – OfficeLarge

Climate Zone	Electricity Savings (kWh/150-Watt Zone)	Peak Electricity Demand Reductions (kW/150-Watt Zone)	Natural Gas Savings (therm/150-Watt Zone)	TDV Energy Savings (TDV kBtu/150-Watt Zone
1	174.7	0.0	(1.3)	3,080.5
2	194.0	0.0	(0.5)	4,493.5
3	190.6	0.0	(0.0)	4,121.6
4	198.5	0.0	(0.0)	4,747.0
5	195.5	0.0	(0.2)	3,848.6
6	196.3	0.0	(0.5)	4,351.5
7	191.1	0.0	0.4	4,042.7
8	206.0	0.0	0.3	5,276.1
9	204.8	0.0	0.3	5,362.7
10	233.3	0.0	0.3	6,080.8
11	197.2	0.0	(0.3)	4,501.1
12	197.3	0.0	(0.3)	4,553.9
13	203.0	0.0	(0.2)	4,786.7
14	204.8	0.0	(0.2)	5,261.1
15	212.7	0.0	0.4	5,208.0
16	190.1	0.0	(0.9)	3,571.1

4. Cost and Cost Effectiveness

4.1 Energy Cost Savings Methodology

Energy cost savings were calculated by applying the TDV energy cost factors to the energy savings estimates that were derived using the methodology described in Section 3.1. TDV is a normalized metric to calculate energy cost savings that accounts for the variable cost of electricity and natural gas for each hour of the year, along with how costs are expected to change over the period of analysis (30 years for residential measures and nonresidential envelope measures, and 15 years for all other nonresidential measures). In this case, the period of analysis used is 15 years. The TDV

cost impacts are presented in 2023 present value dollars and represent the energy cost savings realized over 15 years.

4.2 Energy Cost Savings Results

Energy cost savings for an average office with 150 Watts of lighting in the combined primary and secondary sidelit zone that are realized over the 15-year period of analysis are presented in 2023 present value dollars in Table 6.

Any instances of negative values are denoted in red with ( ) in the tables below.

Table 6: First-Year Energy Impacts and 2023 PV TDV Energy Cost Savings Over 15-Year Period of Analysis – Per 150 Watt Zone – New Construction/Additions/Alterations – Office Large

Climate Zone	Electricity Savings (kWh/150-Watt Zone)	Natural Gas Savings (therm/150-Watt Zone)	TDV Energy Savings (TDV kBtu/150-Watt Zone)	15-Year TDV Energy Cost Savings (2023 PV$/150 W Zone)
1	175	-1.3	3,081	$274
2	194	-0.5	4,494	$400
3	191	0.0	4,122	$367
4	199	0.0	4,747	$422
5	196	-0.2	3,849	$343
6	196	-0.5	4,352	$387
7	191	0.4	4,043	$360
8	206	0.3	5,276	$470
9	205	0.3	5,363	$477
10	233	0.3	6,081	$541
11	197	-0.3	4,501	$401
12	197	-0.3	4,554	$405
13	203	-0.2	4,787	$426
14	205	-0.2	5,261	$468
15	213	0.4	5,208	$464
16	190	-0.9	3,571	$318

4.3 Incremental Cost

4.3.1 Description of Costs Associated with Revised Wattage Threshold

All buildings that would be subject to the revised wattage thresholds would already be required to have automatic daylighting control systems compliant with 2019 Title 24, Part 6. The incremental cost of the revised threshold is the cost of adding additional zones (controlled wattage / floorspace) to the existing automatic daylight control system. Below is a description of the components of an automatic daylighting control system along with assumptions the Statewide CASE Team made about the daylighting control system that would be present in the building to comply with the existing code requirements.

1. **Equipment and material costs:** The following components are required for automatic daylighting controls. While they are discussed separately, one or more of the components may be physically combined into a single device. For example, a zone or room controller may have built-in relays, hence incorporating the functionality of powerpacks; a powerpack may have controller logics and dimming channels built-in to double as a controller.
    - **Controller:** a controller is where the logic resides to control a variety of components within a lighting system, including photosensors and luminaires. The controller takes real-time information from sensors and makes actuation decisions, such as dimming the lights or switching the lights on or off. For automatic daylighting control using 0-10V dimming technology, a controller must have one or more dimming channels to drive the light level of the luminaires connected to it. Luminaires in different areas that need to be dimmed differently, such as the Primary and Secondary Daylit Zones, need to be connected to separate dimming channels of the controller. For the cost analysis presented in this report, it was assumed that the controllers that are installed to comply with the 2019 Title 24, Part 6 requirements have multiple dimming channels and have the ability to receive information from one photosensor and implement a control strategy for both the primary and secondary zones. Reducing the wattage threshold would not require additional controllers or an upgrade in control functionality.[4]

[4] Examples:

- **Photosensor:** Photosensors collect information on the amount of light available within an area and relay the information back to the controller to dim luminaires appropriately. The most common photosensors used in sidelit spaces are closed-loop photosensors that detect the combined daylight and electric light available in the space. Some photosensors are able to collect information to control both the Primary and Secondary Sidelit Daylit Zones. It was assumed that the existing daylighting control system uses a single photosensor to collect information for one primary zone and one secondary zone and transmits that information to a controller with multiple dimming channels.
- **Powerpack:** A powerpack in a lighting system is primarily a relay that connects and disconnects lighting load, i.e., luminaires, from the line power. It takes signals from the controller, which may be voltage differentials or digital signals, to switch the lighting load on and off. Some powerpacks have the additional option of providing a low-voltage output (e.g., 24 VDC) to power sensors. Powerpacks are not always essential for automatic daylight dimming, depending on the control strategy being implemented. Additional powerpacks would not be needed to expand an automatic daylighting control system to include additional zones.
- **Other components**: such as additional wiring, junction boxes, and wire connectors.
- **Luminare Level Lighting Controls (LLLCs)**: LLLCs are lighting products that embed programmable controls in each luminaire. Many LLLCs have software enabled daylight dimming capabilities. Since enabling daylighting capabilities in LLLCs is a matter of software configuration, the incremental equipment cost is effectively zero. Some lighting designers report preferring them to traditional controls systems for their flexibility in both installation and use. Including LLLCs in the cost-effectiveness calculation analysis would increase cost-benefit calculations of the measure, however, the conservative analysis presented in this report did not include LLCs.

- https://www.gordonelectricsupply.com/p/Leviton-Mzd20-102-Mini-Z-Dimming-2-Zone/5835375?gclid=EAIaIQobChMI_NOx64OA7AIVuyCtBh1XRAOKEAQYASABEgKDwfD_BwE
- http://www.cooperindustries.com/content/dam/public/lighting/controls/solutions/RC_Application_Spec_Sheets/class_daydim_recctrl_susfix_specsht_rc3de.pdf
- https://www.elanlighting.com/Content/files/greengate-roomcontroller-.pdf
- https://www.legrand.us/wattstopper/daylighting-controls/daylighting-controls/lmls-500.aspx
- https://control-products.com/product/lmls-500-wattstopper-open-loop-photosensor/?gclid=EAIaIQobChMIio6Xv4aA7AIVgT6tBh1D3AEkEAQYASABEgK-TPD_BwE

2. **Labor costs:** This accounts for the cost of labor needed to physically install and wire components for automatic daylighting controls. It also includes the cost of labor to commission the system to configure controls to ensure they are working properly.

Since the proposed code change would add controlled area to an existing lighting control system and areas that already require multi-level lighting controls, it was assumed that the buildings already have lighting systems capable of automatic daylighting controls that include controllers, photosensors, and powerpacks.[5] There are a number of different control system design options. For this analysis it was assumed that the building would have a wireless control system with local controls (i.e., not a networked control system). A wireless control strategy is likely the least cost strategy for a large office building. Although wireless is less expensive, wired solutions are still common. One of the main arguments in favor of a wired solution over a wireless solution is reduced concerns about network security. Networked control systems, in which the system can be controlled remotely or locally, are gaining in popularity though they are more expensive and come with the perception of increased network security risk. The analysis does not include cost for wiring, but it does include the incremental cost of replacing batteries for wireless photosensors that would be added to the system because of the revised wattage thresholds.

For newly constructed buildings, control systems would be designed to comply with the revised threshold requirements (more photosensors). Multiple strategies that can be implemented to expand existing automatic daylighting controls into newly covered daylit areas. The Statewide CASE Team assumed the additional photosensors needed for the additional daylit controlled areas would be connected directly to controllers and powerpacks already required to be installed to meet 2019 Title 24, Part 6 requirements.[6] Therefore, the incremental cost of reducing the wattage threshold includes: additional

[5] Areas that are greater than 100 square feet with a general lighting load in excess of 0.5W/ft^2 are required to be capable of multi-level lighting controls. Offices that are 250 ft^2 or smaller must have occupancy sensors installed. These requirements are found in Section 130.1(b) and 130.1(c)5.

[6] For example, Leviton provides a simple system where photosensors can be added to an existing controller where an occupancy sensor is already connected for shut-off controls, which eliminates the need for an additional powerpack or controller. Depending on the strategy/daylighting system used, some instances will require additional powerpacks and controllers to be installed with the additional photosensors. Other systems, such as Acuity Light, provide a variety of sensor options in similar form factors, including occupancy sensor, occupancy & daylight combo sensor. In this case, the incremental cost for daylight dimming controls would just be the price differential between the occupancy-only sensor and occupancy & daylight combo sensor.

photosensors, installation, commissioning costs, and battery replacements for wireless photosensors.

4.3.2 Incremental Cost – Data Collection Methodology

In 2019 and early 2020, members of the Statewide CASE Team collected data on the cost of daylighting controls to support the ASHRAE 90.1 LSC in their efforts to consider revisions to the 150-watt threshold for daylighting controls. This work was completed as part of the Statewide Utility Codes and Standards support for the advancement of National Codes and Standards. Data is also relevant to the analysis for proposed changes to Title 24, Part 6.

Data was collected using a survey with the project team followed up with phone calls and emails to gather additional data. Lighting manufacturers, lighting representatives, contractors, and commissioning agents were contacted. The survey respondents represented a cross-section of perspectives and reported an average 7 to 10 years of daylighting controls experience. A summary of outreach is presented below in Table 7.

Table 7: Summary of Survey Outreach

Stakeholder Category	Contacted	Responded	Provided Data
Commissioning Agents	9	2	1
Contractors	1	1	1
Manufacturers	23	9	8
Manufacturer Representatives	17	11	5
Total:	**50**	**23**	**15**

Data was collected for both daylighting control systems that pair remote sensors installed at a location in the room other than in the luminaire housing with luminaires and luminaire level lighting control (LLLCs) systems. For the preliminary analysis presented in this document, the Statewide CASE Team used cost data from these ‘traditional’ daylighting systems because they are currently more common than LLLC systems. Although LLLC systems show promise as a way to reduce project costs, the costs of traditional design provide both a conservative estimate of incremental cost and represent the system that is expected to maintain the vast majority of market share throughout the 2022 code cycle.

For traditional daylighting control systems, respondents were asked to provide information on each component of the equipment cost and the installation time.

Survey respondents were asked to provide the least-cost solution for achieving daylighting controls. Many respondents chose to provide a range for their inputs to

accommodate for variability in location, design choice, and other logistics. For traditional daylighting systems, respondents were asked if the system used to provide cost estimates was capable of using a single photosensor to collect information that the controller could use to control both a primary and secondary daylighting zone.

Cost outliers triggered additional follow up with respondents to verify that respondents understood the scenarios and pricing units, and to ensure consistency across inputs.

Labor rate for both installation contractors and commissioning agents were collected from respondents. Since there was wide variation in labor rates, and a desire to standardize labor rates across 2022 code change proposals for the Title 24, Part 6 analysis, the Statewide CASE Team used the same labor rates that were used in the 2022 Indoor Lighting CASE Report (California Utilities Statewide Codes and Standards Team 2020).

4.3.3 Incremental Cost – Results

The incremental cost of adding daylighting controls to a 150-watt zone is presented in Table 8 as are assumptions used in the cost estimates. As discussed, the incremental cost is adding a photosensor to an existing wireless daylighting control system with local controls (not networked). The incremental maintenance cost is limited to replacing the battery of the added photosensor during years 6 and 12 during the 15-year period of analysis. It was assumed that the photosensor would not need to be replaced during the 15-year period of analysis.[7]

[7] http://e3tnw.org/ItemDetail.aspx?id=144. Effective Life: We estimate that the proposed technology will have a useful lifespan of approximately 15 years.

Table 8: Total Incremental PV Costs Per Square Foot – New Construction/Additions and Alterations – OfficeLarge

ID	Factor	Value	Notes
A	Total Incremental First Cost (2023 PV$ per additional photosensor)	$290.51	B + C
B	Equipment (Photosensor cost ($/unit))	$142.50	Cost collected from outreach described in Section 4.3.1; only includes data points from photosensors that can be used to collect information for both a primary and secondary zone.
C	Labor (2023 PV$)	$148.01	C x D Installation and Commissioning Cost
D	Installation and commissioning time per zone (hours)	1.25	Assumed – includes time to install photosensor, connect to control system, and commission each photosensor for one primary zone and one secondary zone.
E	Labor rate ($/hr)	$118.41	See Table 20 in the Indoor Lighting CASE Report (California Utilities Statewide Codes and Standards Team 2020)
F	Total Incremental Maintenance Cost (2023 PV$ per photosensor)	$8.20	Calculated using 3% discount rate and battery replacements happening in year 6 and 12
G	Battery replacement ($ Nominal per photosensor per replacement)	$5.33	H + J
H	Battery (nominal $ per photosensor)	0.54	Two AA batteries; bulk pricing assumes $0.27/battery
I	Labor hours per photosensor (hours)	0.08	five minutes per photosensor
J	Labor cost ($)	$9.87	I x E
K	Photosensor battery lifetime (years)	6	Per photosensor specifications.
L	**Total Incremental Cost Over 15-year Period of Analysis (2023 PV$ per photosensor)**	**$299**	**A + F**

4.4 Cost-Effectiveness

The Energy Commission establishes the procedures for calculating cost effectiveness. The methodology in this report is consistent with their guidelines, including which costs were included in the analysis. The incremental first cost and incremental maintenance costs over the 15-year period of analysis were included. The TDV energy cost savings from electricity and natural gas savings were also included in the evaluation.

For this initial analysis, design costs were not included nor were the incremental costs of code compliance verification.

According to the Energy Commission's definitions, a measure is cost effective if the benefit-to-cost (B/C) ratio is greater than 1.0. The B/C ratio is calculated by dividing the cost benefits realized over 15 years by the total incremental costs, which includes maintenance costs over 15 years. The B/C ratio was calculated using 2023 PV costs and cost savings. Results are presented in Table 9. The revision would result in cost savings over the 15-year analysis period relative to the existing conditions in 15 of 16 climate zones. As mentioned previously, the energy simulations assumed lighting power would be reduced to 20 percent. If the Energy Commission accepts the Statewide CASE Team's proposal for the 2022 cycle that lighting power be reduced to 10 percent, we expect the B/C ratio to be over 1 for all 16 climate zones.

Table 9: 15-Year Cost-Effectiveness Summary Per 150-Watt Zone – New Construction/Additions and Alterations - OfficeLarge

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings per ft² (2023 PV$/150-Watt Zone) [a]	Costs Total Incremental PV Costs per ft² (2023 PV$ / 150-Watt Zone) [b]	Benefit-to-Cost Ratio
1	$274	$299	0.9
2	$400	$299	1.3
3	$367	$299	1.2
4	$422	$299	1.4
5	$343	$299	1.1
6	$387	$299	1.3
7	$360	$299	1.2
8	$470	$299	1.6
9	$477	$299	1.6
10	$541	$299	1.8
11	$401	$299	1.3
12	$405	$299	1.4
13	$426	$299	1.4
14	$468	$299	1.6
15	$464	$299	1.6
16	$318	$299	1.1

a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate. Costs include incremental first cost if proposed first cost is

greater than current first cost. Costs include PV of maintenance incremental cost if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no Total Incremental PV Costs, the Benefit-to-Cost ratio is infinite.

5. Proposed Revision to Code Language

5.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). As noted in Section 2.1, the Statewide CASE Team is proposing (in a separate CASE Report) to move automatic daylighting controls in the secondary sidelit daylit zone from prescriptive to mandatory. The Statewide CASE Team has shown those changes compiled with these revisions to code language in Appendix B.

5.2 Standards

SECTION 130.1 – MANDATORY INDOOR LIGHTING CONTROLS

Nonresidential, high-rise residential, and hotel/motel buildings shall comply with the applicable requirements of Sections 130.1(a) through 130.1(f), in addition to the applicable requirements of Sections 110.9 and 130.0.

(sections omitted)

(d) Automatic Daylighting Controls. The general lighting in skylit daylit zones and primary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall provide controls that automatically adjust the power of the installed lighting up and down to keep the total light level stable as the amount of incoming daylight changes. For skylight located in an atrium, the skylit daylit zone definition shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

1. All skylit daylit zones, primary sidelit daylit zones, and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

   NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

2. The automatic daylighting controls shall provide separate control for luminaires in each type of daylit zone. Luminaires that fall in both a skylit and sidelit daylit zone shall be controlled as part of the skylit zone.

3. The automatic daylighting controls shall:

A. For spaces required to install multilevel controls under Section 130.1(b), adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;

B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

C. For areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the design illuminance received from the general lighting system at full power, the general lighting power in that daylight zone shall be reduced by a minimum of 65 percent; and

D. For parking garages, ensure that when illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power consumption is zero.

4. When photosensors are located within the daylit zone, at least one photosensor shall be located so that they are not readily accessible to unauthorized personnel.

5. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access.

EXCEPTION 1 to Section 130.1(d): Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8a.m. and 4p.m.

EXCEPTION 2 to Section 130.1(d): Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations or greater than 1 for North orientations.

EXCEPTION 3 to Section 130.1(d): Rooms in which the combined total installed general lighting power in the Skylit Daylit Zone, and Primary Sidelit Daylit Zone, is less than 75 ~~120~~ Watts, or parking garage areas where the total combined general lighting power in the sidelit daylight zones is less than 60 watts.

EXCEPTION 4 to Section 130.1(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

EXCEPTION 5 to Section 130.1(d): For parking garages, luminaires located in the daylight adaptation zone and luminaires for only dedicated ramps. Daylight adaptation zone and dedicated ramps are defined in Section 100.1.

EXCEPTION 6 to Section 130.1(d): Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

(d) **Automatic Daylighting Controls in Secondary Daylit Zones.** All luminaires providing general lighting that is in, or partially in a Secondary Sidelit Daylit Zone, and that is not in a Primary Sidelit Daylit Zone shall:

1. Be controlled independently from all other luminaires by automatic daylighting controls that meet the applicable requirements of Section 110.9; and
2. Be controlled in accordance with the applicable requirements in Section 130.1(d); and
3. All Secondary Sidelit Daylit Zones shall be shown on the plans submitted to the enforcing agency.

EXCEPTION 1 to Section 140.6(d): Luminaires in Secondary Sidelit Daylit Zone(s) in an enclosed space in which the combined total general lighting power in Secondary Daylit Zone(s) is less than 75 ~~120~~ watts, or where the combined total general lighting power in Primary and Secondary Daylit Zone(s) is less than 150 ~~240~~ watts.

EXCEPTION 2 to Section 140.6(d): Luminaires in parking garages complying with Section 130.1(d)3.

EXCEPTION 3 to Section 140.6(d): Areas adjacent to vertical glazing below an overhang, where there is no vertical glazing above the overhang and where the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations, or where the ratio of the overhang projection to the overhang rise is greater than 1 for North orientations.

EXCEPTION 4 to Section 140.6(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

EXCEPTION 5 to Section 140.6(d): Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

5.3 Reference Appendices

The Reference Appendices will not need to be updated as a result of the proposed change.

5.4 ACM Reference Manual

5.4.5 Daylighting Control

(sections omitted)

Daylight Control Requirements	
Applicability	All spaces with exterior fenestration

Definition	The extent of daylighting controls in skylit and sidelit areas of the space
Units	List
Input Restrictions	When the installed general lighting power in the primary daylit zone is equal to or exceeds ~~120W~~ 75W, daylighting controls are required, per the Title 24 mandatory requirements.
Standard Design	For nonresidential spaces, when the installed general lighting power in the skylit or primary sidelit daylit zone is equal to or exceeds ~~120W~~ 75W, daylighting controls are required in the primary daylit zone, per the Title 24 mandatory requirements. For parking garages, when the installed general lighting power in the primary sidelit or secondary sidelit daylit zone is equal to or exceeds ~~120W~~ 75W, daylighting controls are required, per the Title 24 mandatory requirements. Luminaires located in daylit transition zones or dedicated ramps are exempt from this requirement. For nonresidential spaces, daylighting controls are specified when the installed general lighting power in the skylit, primary sidelit, or secondary sidelit daylit zone(s) is equal to or exceeds ~~120W~~ 75W. For parking garages, when the installed general lighting power in the primary sidelit or secondary sidelit daylit zone is equal to or exceeds ~~120W~~ 75W, daylighting controls are required. Luminaires located in daylit transition zones or dedicated ramps are exempt from this requirement.
Standard Design: Existing Buildings	When lighting systems in an existing altered building are not modified as part of the alteration, daylighting controls are the same as the proposed design. When an alteration increases the area of a lighted space, increases lighting power in a space, or when luminaires are modified in a space where proposed design lighting power density is greater than 85 percent of the standard design LPD, daylighting control requirements are the same as for new construction.

Reference Position for Illuminance Calculations	
Applicability	All spaces or thermal zones, depending on which object is the primary container for daylighting controls
Definition	The position of the two daylight reference points within the daylit space. Lighting controls are simulated so that the illuminance at the reference position is always maintained at or above the illuminance setpoint. For step switching controls, the combined daylight illuminance plus uncontrolled electric light illuminance at the reference position must be greater than the setpoint illuminance before the controlled lighting can be

<table>
<tr><td></td><td>dimmed or tuned off for stepped controls. Similarly, dimming controls will be dimmed so that the combination of the daylight illuminance plus the controlled lighting illuminance is equal to the setpoint illuminance.

Preliminary reference points for primary and secondary daylit areas are located at the farthest end of the daylit area aligned with the center of each window. For skylit area, the preliminary reference point is located at the center of the edge of the skylit area closest to the centroid of the space. In each case, the Z – coordinate of the reference position (elevation) shall be located 2.5 feet above the floor.

Up to two final reference positions can be selected from among the preliminary reference positions identified in for each space.</td></tr>
<tr><td>Units</td><td>Data structure</td></tr>
<tr><td>Input Restrictions</td><td>The user does not specify the reference position locations; reference positions are automatically calculated by the compliance software based on the procedure outlined below. Preliminary reference positions are each assigned a relative daylight potential (RDP) which estimates the available illuminance at each position, and the final reference position selection is made based on the RDP.

RDP: An estimate of daylight potential at a specific reference position. This is NOT used directly in the energy simulation, but it used to determine precedence for selecting the final reference points. The relative daylight potential is calculated as a function of effective aperture, azimuth, illuminance setpoint and the type (skylit, primary sidelit, or secondary sidelit) of the associated daylit zone. RDP is defined as:

$$RDP = C_1 \times EA_{dz} + C_2 \times SO + C_3$$

Where: C_1,C_2, and C_3 are selected from the following table.
<table>
<tr><td></td><td colspan="3">Skylit Daylit Zones</td><td colspan="3">Primary Sidelit Daylit Zones</td><td colspan="3">Secondary Sidelit Daylit Zones</td></tr>
<tr><td>Illuminance Setpoint</td><td>C_1</td><td>C_2</td><td>C_3</td><td>C_1</td><td>C_2</td><td>C_3</td><td>C_1</td><td>C_2</td><td>C_3</td></tr>
<tr><td>≤ 200 lux</td><td>3927</td><td>0</td><td>3051</td><td>1805</td><td>-0.40</td><td>3506</td><td>7044</td><td>-3.32</td><td>1167</td></tr>
<tr><td>≤ 1000 lux</td><td>12046</td><td>0</td><td>-421</td><td>6897</td><td>-7.22</td><td>475</td><td>1512</td><td>-2.88</td><td>-22</td></tr>
<tr><td>> 1000 lux</td><td>5900</td><td>0</td><td>-516</td><td>884</td><td>-5.85</td><td>823</td><td>212</td><td>-0.93</td><td>57</td></tr>
</table>
Illuminance Setpoint: This is defined by the user, and is entered by the user, subject to the limits specified in Appendix 5.4A, determined from the space type.

Source Orientation (SO): The angle of the outward facing normal of the daylight source’s parent surface projected onto a horizontal plane, expressed as degrees from south. This is not a user input but is calculated from the geometry of the parent surface. For skylights, the source orientation is not applicable. For vertical fenestration, it is defined:</td></tr>
</table>

$$SO = |(180 - Azimuth)|$$

Where: Azimuth is defined as the azimuth of the parent object containing the fenestration associated with the preliminary reference point.

Effective Aperture (EA): For this calculation, effective aperture represents the effectiveness of all sources which illuminate a specific reference position in contributing to the daylight available to the associated daylit zone. In cases where daylit zones from multiple fenestration objects intersect, the effective aperture of an individual daylit zone is adjusted to account for those intersections according to the following rules:

- For skylit and primary sidelit daylit zones, intersections with other skylit or primary sidelit daylit zones are considered.
- For secondary sidelit daylit zones, intersections with any toplit or sidelit (primary or secondary) daylit zones are considered.

Effective aperture is defined as follows:

$$EA_{dz} = \left(VT_{fdz} \times A_{fdz} + \sum F_i \times VT_i \times A_i\right) / A_{dz}$$

Where:

EA_{dz}	Is the combined effective aperture of all daylight sources illuminating a specific daylit zone.
VT_{fdz}	Is the user specified visible transmittance of the fenestration object directly associated with the daylit zone.
A_{fdz}	Is the area of the fenestration object directly associated with the daylit zone.
VT_i	Is the user specified visible transmittance of the fenestration object associated with each intersecting daylit zone.
A_i	Is the area of the fenestration object directly associated with each intersecting daylit zone.
F_i	Is the fraction of intersecting area between the daylit zone in question and each intersecting daylit zone: $F_i = A_{intersection} / A_{dzi}$
A_{dzi}	Is the area of each intersecting daylit zone (including area that might fall outside a space or exterior boundary).
A_{dz}	Is the area of the daylit zone (including area that might fall outside a space or exterior boundary).

First Reference Position: Select the preliminary reference point with the highest relative daylight potential (RDP) from among all preliminary reference points located within either top or primary sidelit daylit zones. If multiple reference points have identical RDPs, select the reference point geometrically closest to the centroid of the space.

	Second Reference Position: Select the preliminary reference point with the highest RDP from amongst all remaining preliminary reference points located within either top or primary sidelit daylit zones. If multiple reference points have identical RDPs, select the reference point geometrically closest to the centroid of the space.
Standard Design	Reference positions for the standard design shall be selected using the same procedure as those selected for the proposed design.
Standard Design: *Existing Buildings*	Additions or alternations of lighting in spaces trigger the daylighting control requirements whenever the total installed lighting in the daylit zone is ~~120~~ 75 W or greater, and the reference positions shall be determined in the same manner as with new construction. This only applies when alterations or additions to the lighting in an existing building trigger daylighting control requirements.

5.5 Compliance Manual

Chapter 5.4.4.4 of the Nonresidential Compliance Manual would need to be revised with the new 75-watt value replacing the current 120-watt value.

5.6 Compliance Documents

The Statewide CASE Team does not expect any changes to compliance documents.

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Appendix A: Energy Savings and Cost Effectiveness Per Entire Prototypical Large Office Building

Energy Impacts Methodology – Per Square Foot of Large Office Floorspace

Simulating energy impacts of proposed code changes using prototypical buildings standardizes building geometry and makes it easier to evaluate the relative impacts of multiple code change proposals. To simplify calculations, prototypical buildings do not have the same level of design detail required for actual buildings. In many cases, the simplified prototypes are sufficient to demonstrate whole-building energy impacts of a proposed code change. In this instance, the Large Office prototypical building has lighting zones are significantly larger than zones seen in real buildings. This simplified zoning poses a challenge in evaluating the whole-building impact of revised wattage threshold requirements.

In the Large Office prototype building, each of the 13 stories has four perimeter lighting zones, one for each side of the building. Each perimeter zone has a Primary Sidelit Daylit Zone and a Secondary Sidelit Daylit Zone (see Figure 1 in Section 3.1). Table 3 in Section 3.1 presents the floorspace of each perimeter zone and the area within the Primary and Secondary Sidelit Daylit Zones. The table also shows the combined installed wattage in the Primary and Secondary Sidelit Daylit Zones assuming an LPD of 0.6W/ft^2. Since the zones are large the total installed wattage in the daylit zones is significantly higher than 120 watts. In the prototypical building, the entire area of the sidelit daylit zone would meet the wattage threshold and automatic daylighting controls would be required for all Primary and Secondary Sidelit Daylit Zones.

Comparing the prototypical design with actual designs, it is apparent that the zone sizing in the prototypical building is not consistent with actual designs. It is common for the interior space to be divided to provide smaller functional spaces with smaller lighting zones serving each functional space. Figure 2 provides an example office layout with typical functional spaces. In 2013, the Pacific Northwest National Laboratory (PNNL) explored opportunities for daylighting code requirements. After reviewing 12 floor plans, the report authors used the informed assumption that 50 percent of daylit zones in offices are smaller than 250 ft^2 (Pacific Northwest National Laboratory (PNNL) 2013). The Statewide CASE Team used this same assumption to add detail to the energy savings analysis conducted using the Large Office prototypical building to approximate whole-building impacts of the revised wattage threshold.

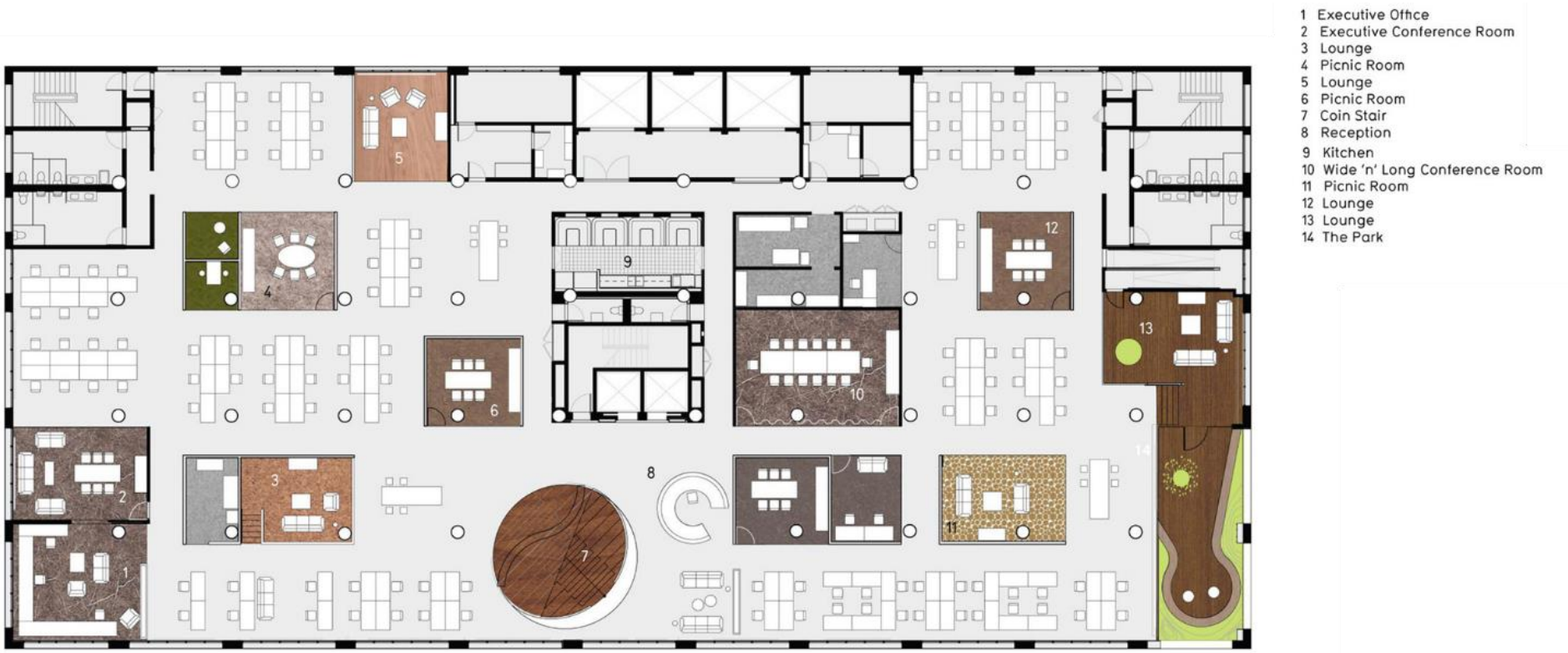

Figure 2. Example real world office layout.

The Statewide CASE Team used a three-step process to refine the simulated whole-building energy savings results so that the data could be used to evaluate the impact of the revised wattage threshold. First, the relationship between the area of the sidelit daylit zone and installed wattage was established. Next, the Statewide CASE Team estimated the percentage of the entire sidelit daylit space within the Large Office prototype that would be located in zones that have a correlated installed wattage between the current and proposed wattage thresholds. Finally, the whole-building energy savings results were adjusted so the savings were only applied to the percentage of area that would be impacted by the revised wattage threshold.

The Statewide CASE Team evaluated the relationship between the area of a daylit zone and installed wattage using the 2016 LPD values, which are based on legacy technology, and the 2019 LPD values, which are based on LED technology (see Table 10). When LPDs were updated for the 2019 code cycle and the 120-watt threshold was not updated to reflect new efficacies, the size of daylit zones that are exempt from automatic daylighting controls increased. Using legacy lighting technology LPDs, the 120-watt threshold corresponds to a lighting zone size in the range of 120 to 160 ft^2. Using 2019 LPDs, the 120-watt threshold corresponds to lighting zones that are in the range of 170 to 200 ft^2. The proposed 75-watt threshold will realign the daylighting control requirements, so controls are required in zone sizes similar to the sizes those that were required to have automatic daylighting controls during the 2016 code cycle.

Table 10: Installed Wattage for Different Zone Areas Assuming Legacy and Current LPDs

Zone Area (ft^2)	250	150	125	100	75
Installed Wattage in Zone Assuming 1.0 W/ ft^2: 2016 Area Category Method LPD for Offices ≤ 250 ft^2	250	150	125	100	75
Installed Wattage in Zone Assuming 0.75 W/ ft^2: 2016 Area Category Method LPD for Offices > 250 ft^2	187.5	112.5	93.75	75	56.25
Installed Wattage in Zone Assuming 0.7 W/ ft^2: 2019 Area Category Method LPD for Offices ≤ 250 ft^2	175	105	87.5	70	52.5
Installed Wattage in Zone Assuming 0.6 W/ ft^2: 2019 Area Category Method LPD for Open Offices	150	90	75	60	45

Next, the Statewide CASE Team approximated the percentage of the floor area designated as either Primary or Secondary Sidelit Daylit Zone in the Large Office prototype that would likely fall within a daylit zones of a size that correlate with an installed wattage between the current and proposed wattage threshold. To do this, it

was assumed that 50 percent of the daylit area was in zones smaller than 250 ft^2, which is consistent with assumptions in the 2013 PNNL report mentioned above. It was assumed that no zones would be smaller than 50 ft^2 and the zone sizes would be evenly distributed between 50 square feet and 250 square feet (see Figure 3). Using the 0.6 W/ ft^2 LPD, the 120- and 75-watt thresholds correspond to a zone size of 200 and 125 ft^2, respectively. As shown in Figure 3, it was assumed that 18.75 percent of the total daylit area in the Large Office prototype would be impacted by the revision to the wattage threshold. That is, 18.75 percent of the total sidelit daylit zone area which would be exempted from the automatic daylighting controls requirement under the 2019 code, would require controls if wattage threshold is adjusted as proposed.

Finally, the energy savings estimate simulated in EnergyPlus was adjusted to account for the savings only applying to 18.75 percent of the total primary and secondary daylit zone rather than using 100 percent, as simulated.

In the next section, per-unit energy impacts are presented per-ft^2 of total building area. The annual adjusted energy and peak demand impacts for the Large Office prototype building were translated into impacts per-ft^2, by dividing by the floor area of the prototype building.

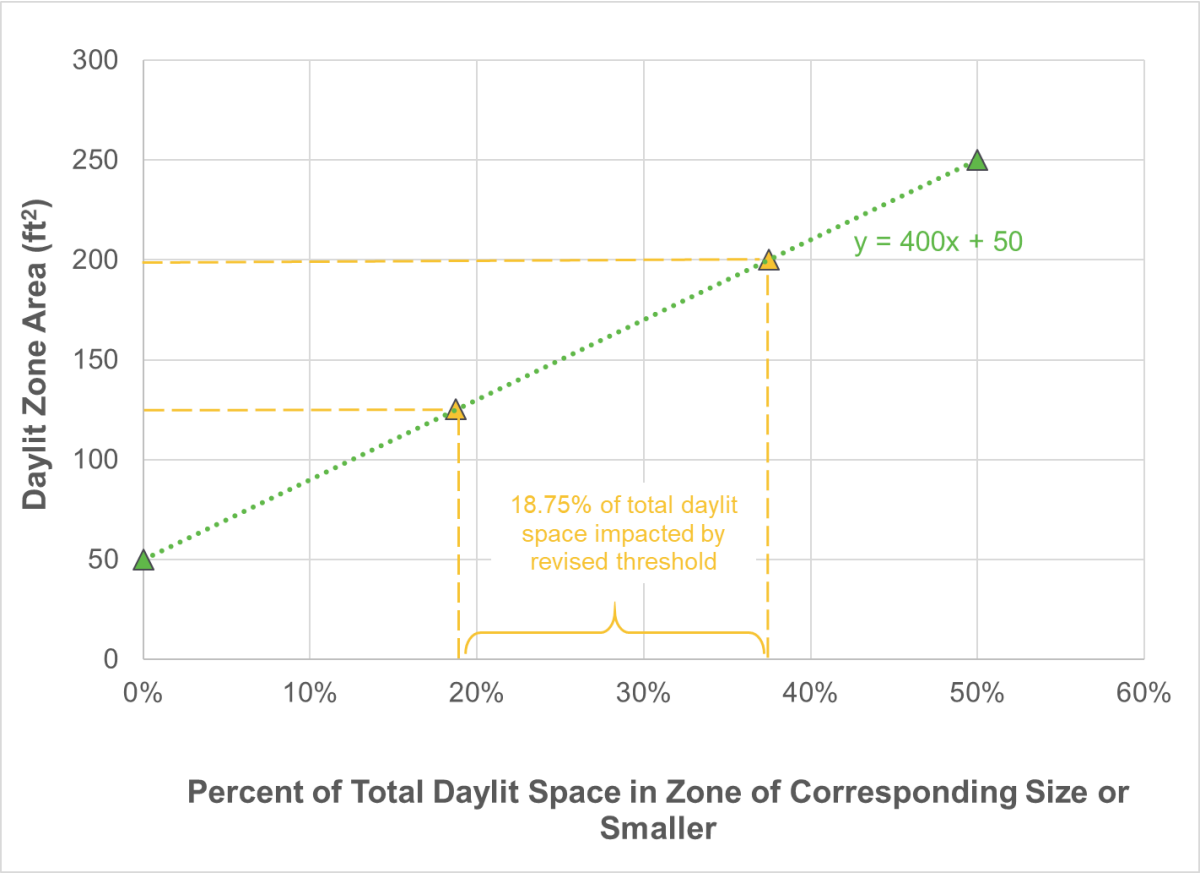

Figure 3: Percent of total daylit space by zone size.

Energy Impacts Results – Per Square Foot of Large Office Floorspace

Energy savings and peak demand reductions per square foot of prototypical large office building are presented in Table 11. The per-unit energy savings figures do not account for naturally occurring market adoption or compliance rates. Per-unit savings for the first year are expected to range from 35.0 to 46.7 Wh/ft^2 in electrical savings depending upon climate zone. Most of the savings are a result of lighting system electrical savings. Heat generated by that lighting system would be reduced as well, in a limited secondary effect. This in turn reduces energy use in cooling-dominated climates (cooling load is reduced) and increases energy use in heating-dominated climates (heating load is increased). The most pronounced instance of energy savings being reduced by added natural gas consumption in heating dominated climates is the OfficeLarge simulation of Climate Zone 1 (Arcata, CA) and Climate Zone 16 (Blue Canyon), which showed a 0.26 thousandth of therms/ft² penalty.

In all climate zones, the result is a positive total TDV energy savings. The electricity use reductions from the lighting and cooling system outweigh the increased natural gas use

from the heating systems. The TDV methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. Most savings would result from reduced lighting energy. In addition, the model indicated peak demand showed a slight decrease within the prototype model (on the order of 10^{-4}).

Table 11 below show the first-year per prototype impacts. Any instances of negative values are denoted in red with ( ) in the tables below.

Table 11: First-Year Energy Impacts Per Square Foot - New Construction/Additions and Alterations – OfficeLarge

Climate Zone	Electricity Savings (Wh/ft^2)	Peak Electricity Demand Reductions (kW/ft^2)	Natural Gas Savings (thousandth of therm/ft^2)	TDV Energy Savings (TDV kBtu/ft^2)
1	35.0	0.00	(0.26)	0.617
2	38.8	0.00	(0.10)	0.900
3	38.2	0.00	(0.01)	0.825
4	39.7	0.00	(0.00)	0.951
5	39.1	0.00	(0.04)	0.771
6	39.3	0.00	(0.10)	0.871
7	38.3	0.00	0.09	0.810
8	41.2	0.00	0.06	1.057
9	41.0	0.00	0.06	1.074
10	46.7	0.00	0.05	1.218
11	39.5	0.00	(0.05)	0.901
12	39.5	0.00	(0.05)	0.912
13	40.6	0.00	(0.03)	0.959
14	41.0	0.00	(0.05)	1.054
15	42.6	0.00	0.07	1.043
16	35.0	0.00	(0.26)	0.715

Cost Effectiveness – Per Square Foot of Large Office Floorspace

Energy Cost Savings

Energy cost savings were calculated by applying the TDV energy cost factors to the energy savings estimates

Incremental Costs

To calculate incremental cost for the entire building, the Statewide CASE Team used costs per additional photosensor added presented in Section 3 and multiplied by the number of new zones expected for the entire building. See Table 12 for assumptions and notes about incremental cost assumptions for the whole-building analysis. The total incremental cost (first cost and maintenance cost) over the 15-year period of analysis for the entire Large Office prototypical buildings is estimated at $23,000 or $0.046 per square foot of total building space.

Table 12: Total Incremental PV Costs Per Square Foot – New Construction/Additions and Alterations – OfficeLarge

ID	Factor	Value	Notes
A	**Total Incremental Cost Over 15-year Period of Analysis (2023 PV$ per photosensor)**	**$299**	**See Table 8**
B	Daylit Area (ft^2)	133,102	From prototype building geometry
C	Percent of Impacted Daylit Area	18.75%	Assumed, see Figure 3
D	Impacted Daylit Area (ft^2)	24,957	B x C
E	Average area of each newly added daylit zone (ft^2)	162.5	Zones that will be impacted by the revised wattage threshold have installed wattage between 75W and 120W. It was assumed that the average zone size would be half-way between 75W and 120W at 97.5W. Using a 0.6W/ft^2 lighting power density, this corresponds to a zone size of 162.5 ft^2
F	Number of new daylit zones (primary and secondary)	154	D / E
G	Number of additional photosensors needed per prototypical building	77	F / 2 One photosensor for every 2 zones
H	Total Incremental Cost Over 15-yr Period of Analysis for Entire Large Office Prototypical Building (2023 PV$/building)	$23,000.84	A X G
I	Total building floor area (ft^2)	498,589	From prototype building geometry
J	Total Incremental Cost Over 15-Year Period of Analysis (2023 PV$ per sf of prototypical building floorspace)	$0.0461	H / I

Cost Effectiveness

Cost effectiveness results for the entire Large Office prototypical building on a per square foot of total building floorspace are presented in Table 13. On a whole-building basis, the revision would result in cost savings over the 15-year analysis period relative to the existing conditions in all 16 climate zones.

Table 13: 15-Year Cost-Effectiveness Summary Per Square Foot of Building Space – New Construction/Additions and Alterations - OfficeLarge

Climate Zone	Benefits TDV Energy Cost Savings + Other PV Savings per ft^2 (2023 PV$/$ft^2$) [a]	Costs Total Incremental PV Costs per ft^2 (2023 PV$/$ft^2$) [b]	Benefit-to-Cost Ratio
1	$0.055	$0.046	1.2
2	$0.080	$0.046	1.7
3	$0.073	$0.046	1.6
4	$0.085	$0.046	1.8
5	$0.069	$0.046	1.5
6	$0.078	$0.046	1.7
7	$0.072	$0.046	1.6
8	$0.094	$0.046	2.0
9	$0.096	$0.046	2.1
10	$0.108	$0.046	2.3
11	$0.080	$0.046	1.7
12	$0.081	$0.046	1.8
13	$0.085	$0.046	1.8
14	$0.094	$0.046	2.0
15	$0.093	$0.046	2.0
16	$0.064	$0.046	1.4

a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2016, 51-53). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Includes PV maintenance cost savings if PV of proposed maintenance costs is less than PV of current maintenance costs.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate. Costs include incremental first cost if proposed first cost is greater than current first cost. Costs include PV of maintenance incremental cost if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no Total Incremental PV Costs, the Benefit-to-Cost ratio is infinite.

Interior Lighting Full Load Hours

For the Standard Design, interior lighting full load hours per week is 43.21 for all the thermal zones for the entire Large Office prototypical building in Table 14. The Standard design does not have any daylighting controls which is why there is no difference in full load hours per thermal zone or per climate zone. For the Proposed Design, the interior lighting full load hours per week vary by thermal zones and climate zones, from 19.77 to 25.4, as presented in Table 15. For both Standard and Proposed Designs, the core zones have 43.21 full load hours per week because there are no daylighting controls in these zones. These zones have not been included in Table 14 and Table 15 because they are not affected by this proposal.

Table 14: Standard Design: Interior Lighting Full Load Hours per Week (OfficeLarge) for Daylit Zones

	First Floor Daylit Zones [a]				Floors 2 through 6 Daylit Zones				Floors 7 through 11 Daylit Zones				Top Floor Daylit Zones			
Climate Zone	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 8**	**Zone 9**	**Zone 10**	**Zone 11**	**Zone 13**	**Zone 14**	**Zone 15**	**Zone 16**	**Zone 18**	**Zone 19**	**Zone 20**	**Zone 21**
1	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
2	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
3	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
4	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
5	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
6	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
7	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
8	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
9	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
10	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
11	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
12	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
13	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
14	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
15	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21
16	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21	43.21

a. **Zones:** This table only shows zones that appear in daylit areas within the prototype. For this analysis, only full load hours for zones in daylit areas are affected. Zones that are not in daylit areas do not appear in this table.

Table 15: Proposed Design: Interior Lighting Full Load Hours per Week (OfficeLarge) for Daylit Zones

	First Floor Daylit Zones [a]				Floors 2 through 6 Daylit Zones				Floors 7 through 11 Daylit Zones				Top Floor Daylit Zones			
Climate Zone	**Zone 3**	**Zone 4**	**Zone 5**	**Zone 6**	**Zone 8**	**Zone 9**	**Zone 10**	**Zone 11**	**Zone 13**	**Zone 14**	**Zone 15**	**Zone 16**	**Zone 18**	**Zone 19**	**Zone 20**	**Zone 21**
1	20.95	22.88	24.94	22.18	21.33	23.26	25.4	22.56	21.33	23.26	25.4	22.56	21.33	23.26	25.4	22.56
2	20.2	22.21	24.51	21.34	20.6	22.57	24.96	21.69	20.6	22.57	24.96	21.69	20.6	22.57	24.96	21.69
3	20.06	22.12	24.42	21.2	20.43	22.47	24.87	21.55	20.43	22.47	24.87	21.55	20.43	22.47	24.87	21.55
4	20.24	22.14	24.57	21.33	20.59	22.51	25.02	21.67	20.59	22.51	25.02	21.67	20.59	22.51	25.02	21.67
5	19.90	21.91	24.22	20.9	20.25	22.27	24.68	21.23	20.25	22.27	24.68	21.23	20.25	22.27	24.68	21.23
6	19.98	22.04	24.21	20.8	20.33	22.38	24.67	21.13	20.33	22.38	24.67	21.13	20.33	22.38	24.67	21.13
7	19.92	22.01	24.02	20.7	20.29	22.37	24.49	21.04	20.29	22.37	24.49	21.04	20.29	22.37	24.49	21.04
8	20.11	22.15	24.33	20.92	20.48	22.49	24.78	21.25	20.48	22.49	24.78	21.25	20.48	22.49	24.78	21.25
9	20.05	21.98	24.35	20.93	20.39	22.32	24.8	21.26	20.39	22.32	24.8	21.26	20.39	22.32	24.8	21.26
10	20.09	22.07	24.35	20.9	20.46	22.41	24.8	21.23	20.46	22.41	24.8	21.23	20.46	22.41	24.8	21.23
11	20.39	22.37	24.85	21.69	20.73	22.7	25.3	22.04	20.73	22.7	25.3	22.04	20.73	22.7	25.3	22.04
12	20.3	22.18	24.68	21.44	20.65	22.51	25.13	21.78	20.65	22.51	25.13	21.78	20.65	22.51	25.13	21.78
13	20.16	22.01	24.5	21.15	20.53	22.34	24.95	21.49	20.53	22.34	24.95	21.49	20.53	22.34	24.95	21.49
14	19.77	21.77	24.28	20.75	20.12	22.09	24.73	21.07	20.12	22.09	24.73	21.07	20.12	22.09	24.73	21.07
15	19.85	21.86	24.19	20.75	20.18	22.19	24.64	21.08	20.18	22.19	24.64	21.08	20.18	22.19	24.64	21.08
16	20.48	22.34	24.88	21.65	20.84	22.67	25.33	22.00	20.84	22.67	25.33	22.00	20.84	22.67	25.33	22.00

a. **Zones:** This table only shows zones that appear in daylit areas within the prototype. For this analysis, only full load hours for zones in daylit areas are affected. Zones that are not in daylit areas do not appear in this table.

Appendix B: Compiled Revisions to Code Language

The following shows proposed changes to the standards compiled with the (separate) proposal to move automatic daylighting controls requirements for secondary sidelit daylit zones from prescriptive to mandatory. The code language is taken directly from the Daylighting CASE Report and combined with the proposed daylighting wattage threshold language (California Utilities Statewide Codes and Standards Team 2020). Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Compiled changes from the Daylighting CASE Report are marked with blue underlining (new language) and ~~strikethroughs~~ (deletions).

SECTION 130.1 – MANDATORY INDOOR LIGHTING CONTROLS

Nonresidential, high-rise residential, and hotel/motel buildings shall comply with the applicable requirements of Sections 130.1(a) through 130.1(f), in addition to the applicable requirements of Sections 110.9 and 130.0.

(sections omitted)

(d) Automatic Daylighting Controls. The general lighting in Sskylit Ddaylit Zzones, ~~and~~ Pprimary Ssidelit Ddaylit Zzones, and Secondary Sidelit Daylit Zones as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed general lighting ~~up and down to keep the total light level stable as the amount of incoming daylight changes~~. For skylights located in an atrium, the Sskylit Ddaylit Zzone ~~definition~~ shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

1. All skylit daylit zones, primary sidelit daylit zones, Secondary Sidelit Daylit Zones, and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

   NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

2. The automatic daylighting controls shall provide separate control for ~~luminaires~~ General Lighting in each type of daylit zone. ~~Luminaires that fall in both a~~ General Lighting in overlapping Sskylit Daylit Zone and a Primary or Secondary Ssidelit Ddaylit Zzone shall be controlled as part of the Sskylit Daylit Zzone. General lighting in overlapping Primary and Secondary Sidelit Daylit Zones shall be controlled as part of the Primary Sidelit Daylit Zone.

   EXCEPTION to 130.1(d)2: Light emitting diodes (LEDs) and other solid state lighting (SSL) sources shall be treated as lamps in increments of 2 feet. General lighting LEDs or SSLs crossing across multiple daylit zones types or from daylit zone to non-daylit zone shall be

segmented within 1 foot of the edge of each type of daylit zone and separately controlled based on the type of zone the segment is primarily located.

3. The automatic daylighting controls shall:
   A. For spaces required to install multilevel controls under Section 130.1(b), adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;
   B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;
   C. For areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the design illuminance received from the general lighting system at full power, the general lighting power in that daylight zone shall be reduced by a minimum of 65 percent; and
   D. For parking garages, ensure that when illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power consumption is zero.
4. When photosensors are located within the daylit zone, at least one photosensor shall be located so that they are not readily accessible to unauthorized personnel.
5. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access.

EXCEPTION 1 to Section 130.1(d): Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8a.m. and 4p.m.

EXCEPTION 2 to Section 130.1(d): Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations or greater than 1 for North orientations.

EXCEPTION 3 to Section 130.1(d): Rooms in which the combined total installed general lighting power in the Skylit Daylit Zone, and Primary Sidelit Daylit Zone, is less than 75 ~~120~~ Watts, or parking garage areas where the total combined general lighting power in the sidelit daylight zones is less than 60 watts.

EXCEPTION 4 to Section 130.1(d): Luminaires in Secondary Sidelit Daylit Zone(s) in an enclosed space in which the combined total general lighting power in Secondary Daylit Zone(s) is less than 75 ~~120~~ watts, or where the combined total general lighting power in Primary and Secondary Daylit Zone(s) is less than 150 ~~240~~ watts.

EXCEPTION 4 5 to Section 130.1(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

EXCEPTION ~~5~~ 6 to Section 130.1(d): For parking garages, luminaires located in the daylight adaptation zone ~~and luminaires for only dedicated ramps. Daylight adaptation zone and dedicated ramps are defined in Section 100.1~~.

EXCEPTION ~~6~~ 7 to Section 130.1(d): Luminaires in S~~s~~idelit D~~d~~aylit Z~~z~~ones in retail merchandise sales and wholesale showroom areas.

SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

~~(d) **Automatic Daylighting Controls in Secondary Daylit Zones.** All luminaires providing general lighting that is in, or partially in a Secondary Sidelit Daylit Zone, and that is not in a Primary Sidelit Daylit Zone shall:~~

~~1. Be controlled independently from all other luminaires by automatic daylighting controls that meet the applicable requirements of Section 110.9; and~~

~~2. Be controlled in accordance with the applicable requirements in Section 130.1(d); and~~

~~3. All Secondary Sidelit Daylit Zones shall be shown on the plans submitted to the enforcing agency.~~

~~**EXCEPTION 1 to Section 140.6(d):** Luminaires in Secondary Sidelit Daylit Zone(s) in an enclosed space in which the combined total general lighting power in Secondary Daylit Zone(s) is less than 120 watts, or where the combined total general lighting power in Primary and Secondary Daylit Zone(s) is less than 240 watts.~~

~~**EXCEPTION 2 to Section 140.6(d):** Luminaires in parking garages complying with Section 130.1(d)3.~~

~~**EXCEPTION 3 to Section 140.6(d):** Areas adjacent to vertical glazing below an overhang, where there is no vertical glazing above the overhang and where the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations, or where the ratio of the overhang projection to the overhang rise is greater than 1 for North orientations.~~

~~**EXCEPTION 4 to Section 140.6(d):** Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.~~

~~**EXCEPTION 5 to Section 140.6(d):** Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.~~