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## 5. Nonresidential Indoor Lighting

This chapter covers the Title 24 California Code of Regulations, Part 6 (the Energy Standards) requirements for indoor lighting design and installation including controls for conditioned and unconditioned nonresidential buildings. This chapter is addressed primarily to lighting designers, electrical engineers, and enforcement agency personnel responsible for lighting design, installation, plan check, and inspection.

Chapter 6 addresses nonresidential outdoor lighting requirements.

Chapter 7 addresses sign lighting requirements.

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### 5.1 Overview

The Energy Standards primarily requires that total lighting power is within a specified budget, and that lighting controls allows for the efficient operation of installed lighting. This ensures that energy efficient equipment is used to satisfy building lighting needs.

#### 5.1.1 What's New for the 2019 California Energy Code?

Significant changes for indoor lighting systems in the 2019 update to the Energy Standards include:

- Revisions to all indoor lighting power allowances so that the allowances are based on LED lighting technologies.
- Compliance with the standard is allowed for other appropriate lighting technologies.
- Revisions to Lighting Power Density (LPD) values in Tables 140.6-B thru 140.6-G.
- Revision and streamlining of luminaire classification and wattage requirements.
- New lighting power adjustment for small aperture tunable white LED and dim-to-warm LED luminaires.
- New mandatory occupancy sensing controls for restrooms.
- Clarification and streamlining of manual area control requirements, multi-level lighting control requirements, and automatic daylighting control requirements.
- New Power Adjustment Factors (PAFs) for advanced daylighting devices including clerestories, horizontal slats, and light shelves.
- Revisions and streamlining of alteration requirements. Changes include merging three sections into a single "Altered Indoor Lighting Systems" section and aligning two reduced power options on controls. Table 141.0-F was also revised and consolidated.
- Elimination of the installation certification requirements for line voltage track lighting current limiters and supplementary overcurrent protection panels.

- Healthcare facilities overseen by the California Office of Statewide Health Planning and Development (OSHPD) must comply with some applicable indoor lighting controls requirements as well as the indoor lighting power requirements under the “prescriptive method.”

### **5.1.2 Scope**

- The Energy Standards nonresidential indoor lighting requirements are contained in §100.0, §110.9, §110.12, §120.8, §130.0, §130.1, §130.4, §140.0, §140.1, §140.3, §140.6, and §141.0. Their supporting definitions are in §100.1.
- The nonresidential indoor lighting requirements apply to nonresidential buildings, high-rise residential buildings (except dwelling units), and hotel/motel occupancies (including guest rooms).
- The nonresidential indoor lighting requirements are the same for unconditioned spaces and conditioned spaces. Trade-offs are not allowed between unconditioned and conditioned spaces.
- Interior common areas in low-rise multi-family residential buildings are required to comply with the nonresidential indoor lighting requirements if the common area exceeds 20 percent of the building floor area (See §150.0(k)6B).
- High-rise residential dwelling units are required to comply with low-rise residential lighting requirements. The low-rise residential lighting requirements are covered in chapter 6 of the 2019 Residential Compliance Manual.
- Hotel/motel guest rooms are covered by portions of both the nonresidential indoor lighting requirements and the low-rise residential indoor lighting requirements. The low-rise residential indoor lighting requirements are covered in chapter 6 of the 2019 Residential Compliance Manual.
- Qualified historic buildings are not covered by the Energy Standards, as stated in exception 1 to §100.0(a). They are regulated by the California Historical Building Code. However, non-historical components of the buildings such as lighting equipment may need to comply with the Energy Standards. For more information about energy compliance requirements for historic buildings, see Section 1.7.2 of this manual.
- All section (§) and table references in this chapter refer to sections and tables contained in Title 24 California Code of Regulations, Part 6, also known as the Energy Standards or California Energy Code.

### **5.1.3 Residential Functional Areas in Nonresidential Buildings**

The following functional areas in nonresidential, high-rise residential, and hotel/motel occupancies are required to comply with the low-rise residential lighting standards as defined in §130.0(b):

- High-rise residential dwelling units.

- Outdoor lighting attached to a high-rise residential or hotel/motel building and separately controlled from inside of a dwelling unit or guest room.
- Fire station dwelling accommodations.
- Hotel and motel guest rooms. Note that hotel and motel guest rooms are also required to comply with the nonresidential lighting requirements in §130.1(c)8, which require captive card key controls, occupant sensing controls, or automatic controls. In addition, hotel and motel guest rooms shall meet the controlled receptacle requirements of §130.5(d)4.
- Dormitory and senior housing dwelling accommodations.

Note that the above requirements also apply to additions and alterations to functional areas of existing buildings specified above.

All other functional areas in nonresidential, high-rise residential, and hotel/motel occupancies such as common areas, shall comply with the applicable nonresidential lighting standards.

### 5.1.4 Indoor Lighting Power Allotments

Lighting power allotments are the established maximum lighting power that can be installed based on the compliance approach used, the building type, and building area. Lighting power allotments for an application are determined by one of the following four compliance approaches:

- A. Prescriptive approach – Complete Building Method:** applicable when the entire building's lighting system is designed and permitted at one time and when at least 90 percent of the building is one nonresidential building occupancy type (as defined in §100.1). The complete building method may also be used for a tenant space in a multi-tenant building if at least 90 percent of the tenant space is one building occupancy type. A single lighting power density value governs the entire building or tenant space.
- B. Prescriptive approach – Area Category Method:** applicable for any permit situation including tenant improvements. Lighting power density values are assigned to each of the primary function areas of a building (offices, lobbies, corridors, etc., as defined in §100.1). This approach provides some flexibility to accommodate special tasks by providing an additional power allowance under some circumstances.
- C. Prescriptive approach – Tailored Method:** applicable for a limited number of defined primary function areas when additional flexibility is needed to accommodate special task lighting needs. Several layers of lighting power allotments may be allowed depending on the space and tasks. Lighting power allotments are determined room-by-room and task-by-task. The Tailored Method and the Area Category Method can be used in conjunction when some areas in a building use the Tailored Method while others use the Area Category Method.

- D. **Performance approach:** applicable when the designer uses an Energy Commission-certified compliance software program to demonstrate that the proposed building's energy consumption (including indoor lighting power) meets the energy budget. The performance approach incorporates one or more of the three previous methods which set the appropriate lighting power allotment used in calculating the building's custom energy budget.

The performance approach allows energy allotments to be traded between space conditioning, mechanical ventilation, indoor lighting, service water heating, envelope, and covered process loads. Such trade-offs can only be made when permit applications are sought for those systems involved. For example, under the performance approach, a building with an envelope or mechanical ventilation system that is more efficient than the prescriptive efficiency requirements, may be able to meet the energy budget for a standard designed building with more lighting power than allowed under the three prescriptive lighting approaches.

No additional lighting power allotment is gained by using the performance method unless it is traded from the space conditioning, mechanical ventilation, service water heating, envelope, or covered process systems. Therefore, the performance approach is not applicable to lighting compliance alone. The performance approach may only be used to model the performance of indoor lighting systems that are covered under the building permit application.

### **5.1.5 Compliance Process - Forms, Plan Check, Inspection, Installation, and Acceptance Tests**

The compliance process begins with the builder submitting certificates of compliance to the responsible code enforcement agency. The certificates provide all design information necessary to show that the proposed project will comply with the Energy Standards. Construction may not begin until all certificates of compliance are reviewed and approved by the agency.

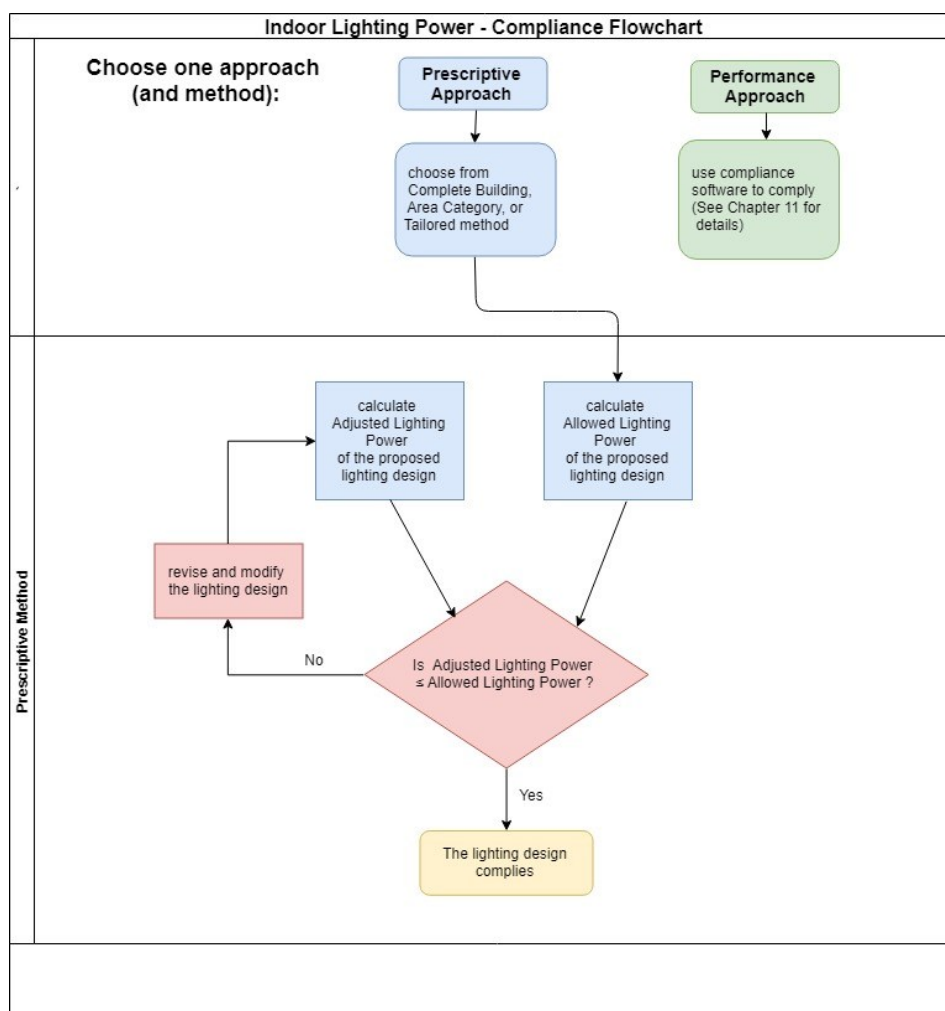
As construction proceeds, builders must submit certificates of installation certifying that installed equipment and systems meet or exceed the design criteria specified in the approved certificates of compliance. Code enforcement officials may conduct field inspections to verify information submitted by builders. At the end of construction, acceptance tests must be performed by qualified contractors on all specified systems to ensure they are installed correctly and function per code requirements.

If inspections or acceptance tests identify noncompliant or nonfunctional systems, these defects must be fixed. Once the code enforcement agency determines the project complies with all building code requirements, including the energy code, the building will receive a certificate of occupancy that certifies that the building is in compliance with the building code.

## 5.1.6 Compliance Process - Overview

Figure 5-1 below, shows the process for complying with the nonresidential indoor lighting requirements.

**Figure 5-1: Lighting Compliance Flowchart**



### A. Choose a compliance method (refer to the top part of Figure 5-1):

First, select either the prescriptive or performance approach for complying with the nonresidential indoor lighting power requirements of the Energy Standards.

For the performance approach method, lighting power calculations can be performed using an approved software program (such as CBECC-Com). Refer to the compliance software documentation for details.

For the prescriptive approach, choose from among the complete building method, the area category method, or the tailored method.

Next, calculate the “allowed” lighting power and the “adjusted” lighting power.

Allowed lighting power is the total of all of the lighting allowed (using lighting power values from Table 140.6-B, C and D).

Adjusted lighting power is design lighting power *minus* lighting control credits *minus* lighting power reduction.

### **B. Evaluate the calculations – allowed lighting power vs adjusted lighting power**

If you calculate that the adjusted lighting power is less than or equal to the allowed lighting power, the proposed lighting complies with the Energy Standards.

If you calculate that the adjusted lighting power is greater than the allowed lighting power, the proposed lighting does not comply with the Energy Standards. In that case, either the proposed lighting power must be reduced, or additional lighting credits must be acquired through improved efficiency in other systems.

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## **5.2 General Requirements**

Some requirements in the nonresidential lighting standards are classified as “mandatory requirements” because they are required regardless of the compliance approach used. All projects must comply with all mandatory requirements.

It is the responsibility of the designer to design the lighting system and specify products that meet these requirements. It is the responsibility of the installer to install the lighting and controls specified on the plans. It is the responsibility of code enforcement officials to verify that the mandatory features and specified devices are included on the plans and installed in the field.

The mandatory measures for nonresidential indoor lighting include:

- Certain functional areas in nonresidential buildings must comply with the low-rise residential lighting Energy Standards (§130.0(b)).
- Manufactured lighting equipment, products, and devices must be appropriately certified (§110.0(b), §110.1, and §110.9(a)).
- Requirements for how luminaires shall be classified (according to technology), and how installed lighting power shall be determined (§130.0).
- Required indoor lighting controls (§130.1).
- Lighting control acceptance testing (§130.4(a)).
- Lighting control Certificates of Installation (§130.4(b)).

Although not related exclusively to lighting, the Energy Standards impose mandatory measures for electrical power distribution systems. See Chapter 8 of this manual for additional information about mandatory measures for electrical power distribution systems.



## 5.3 Luminaire Classification and Determination of Power

### §130.0(c)

Luminaires and light sources emit light and provide illumination to spaces. The Energy Standards include a system of classification to account for the power of luminaires and lighting systems and to use the information for compliance purpose.

Below is the list of various types of luminaires as described and classified in Section 130.0(c) of the Energy Standards:

- Luminaires with line-voltage lamp holders
- Luminaires with ballasts
- Inseparable solid-state lighting (SSL) luminaires and SSL luminaires with remote ballasts
- LED tape lighting and LED linear lighting
- Modular lighting systems
- Other lighting equipment

For meeting the prescriptive or performance requirements for indoor lighting, the wattage of all planned lighting systems, including permanent lighting and portable lighting, shall be determined as follows.

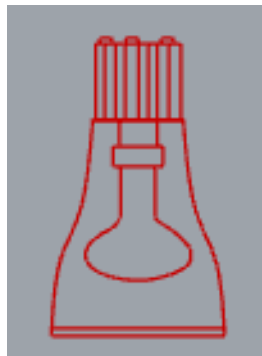
#### A. Luminaires with line-voltage lamp holders

The wattage of luminaires with line-voltage lamp holders not containing permanently installed ballast or transformers shall be the maximum rated wattage of the luminaire.

For recessed luminaires with line-voltage medium base sockets, wattage shall not be less than 50 watts per socket, or the rated wattage of the installed JA8 compliant lamps.

The 2019 Energy Standards allow the wattage of JA8 lamps to be used as the wattage of recessed luminaires. This provides another option for designers, engineers and installers for their compliance use of luminaires with line-voltage lamp holders.

Figure 5-2 Sample of Luminaire with line-voltage lamp holders



Source: CEC Staff

**B. Luminaires with ballasts**

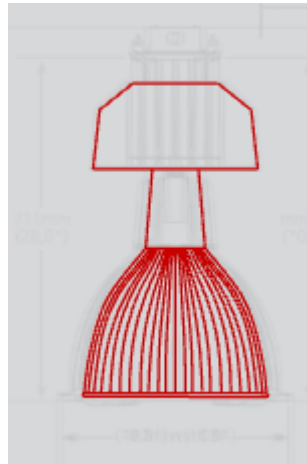
The wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the rated lamp/ballast combination.

This wattage information can be found in the ballast manufacturer's catalogs based on independent testing lab report as specified in UL 1598.

**Figure 5-3 Samples of Luminaires with ballasts:**  
**Fluorescent-lamp luminaire (Left); HID-lamp luminaire (Right)**



Source: Acuity Brands Lighting, Inc.;



Source: CEC Staff

**C. Inseparable Solid-State Lighting (SSL) luminaires and SSL luminaires with remotely mounted drivers**

The wattage of inseparable SSL luminaires and SSL luminaires with remote ballasts shall be the maximum rated input wattage of the SSL luminaires.

Inseparable SSL luminaires are luminaires manufactured with the solid-state lighting components which are not readily removed or replaced from the luminaires by the end users.

SSL luminaires shall be tested in accordance with UL 1598, 2108, 8750 or IES LM-79.

**Figure 5-4 Samples of SSL Luminaires:  
Recessed Downlight Luminaires (Left; Right)**



Source: © 2018 Lutron Electronics Co., Inc. All rights Reserved

#### **D. LED tape lighting and LED linear lighting**

LED tape lighting can be installed in length by installers on a project site as determined by the lighting design requirements. LED tape lighting is not like legacy luminaires which are manufactured in a pre-determined dimension per customer order.

The wattage of the luminaire or lighting system shall be the sum of the installed length of the tape lighting *times* its rated linear power density in W/ft (or the maximum rated input wattage of the driver or power supply providing power to the lighting system).

Tape lighting shall be tested in accordance with UL 2108, 8750, or IES LM-79.

**Figure 5-5 Samples of Tape Lighting**



Source: NORA Lighting

#### **E. Modular lighting systems**

Track mounted luminaires as well as rail mounted luminaires are examples of modular lighting systems. The wattage of modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the systems shall be determined as follows.

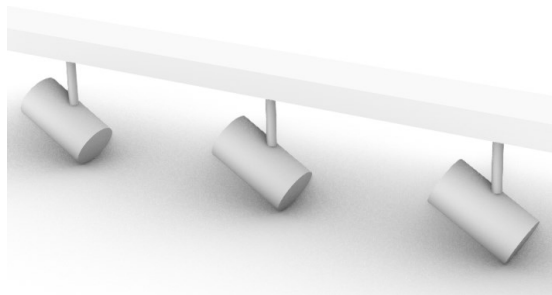
The wattage shall be the greater of 30 watts per linear foot of track or plug-in busway; or, the rated wattage of all of the luminaires in the system (where the luminaire wattage is as specified by UL 1574, 1598, 2108, or 8750)

1. For line-voltage track lighting and plug-in busway served by a track lighting current limiter, the wattage shall be the volt-ampere rating of current limiter as specified by UL 1077
2. For line-voltage track lighting and plug-in busway served by a track lighting protection panel, the wattage shall be the sum of ampere rating of all of the overcurrent protection devices times the branch circuit voltage for the track lighting protection panel; or
3. For other modular systems with power supplied by a driver, power supply or transformer, including low-voltage lighting systems, the wattage shall be the maximum rated input wattage of the driver, power supply or transformer as specified by UL 2108 or 8750
4. For power-over-Ethernet lighting system, the wattage shall be the total power rating of the system less any installed non-lighting devices.

**Figure 5-6 Samples of Modular Lighting Systems:**

**A Track Lighting System 3D View (Top);**

**Track Lighting Systems in a Lobby Lighting Application (Bottom)**



Source: CEC



Source: Acuity Brands Lighting, Inc.

## F. Other lighting equipment

For all other lighting equipment not addressed by item A through E, the wattage of the lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, based on independent testing lab reports as specified by UL1547, 1598, 2108, 8750, or IES LM-79.

### Example 5-1 Power-over-Ethernet (PoE) Lighting

#### Question

What is a Power-over-Ethernet (PoE) lighting system?

#### Answers

A Power-over-Ethernet (PoE) lighting system is an emerging lighting technology which provides low-voltage direct current (DC) and communication over ethernet cabling. The direct current powers the luminaires of the system. Most conventional lighting systems use alternating current (AC) to power luminaires.

A PoE lighting system usually contains three main components – a powered device (PD), ethernet cabling, and power sourcing equipment (PSE) such as ethernet switches. PSE is a general term used for PoE power supply.

PSEs supply power via Ethernet cabling to PD's, such as PoE luminaires.

### Example 5-2 Power-over-Ethernet (PoE) Lighting

#### Question

What is the wattage of a PoE lighting system that contains a PoE switch, PoE luminaires, occupancy sensors, one daylight sensors, wall switch stations?

#### Answers

One way to determine the answer is to account for the wattage of all of the luminaires in the lighting system as the wattage of the PoE lighting system. Since there are nine PoE luminaires plus other non-lighting loads (sensors and switches), the wattage of the PoE lighting system is the sum of the wattage of all PoE luminaires excluding the sensors and switches.

Another way is to account for the total power rating of the system less any non-lighting devices such as occupancy sensors, sensing devices and switch controls.

## 5.4 Mandatory Lighting Controls

### §131.0

This section contains information about lighting controls that must be installed, regardless of the method, to comply with the lighting power requirements.

All lighting controls and equipment must comply with the applicable requirements in §110.9 and must be installed in accordance with the manufacturer's instructions (§130.0(d)).

Mandatory nonresidential indoor lighting controls include the following:

1. Manual area controls. Manual on and off controls separately controlling lighting in each area.
2. Multi-level controls. Providing occupants with the ability to use all of the light, some of the light, or none of the light in an area.
3. Shut-off controls. Automatically shutting off or reducing light output of lighting when the space is vacant.
4. Automatic daylighting controls. Separately controlling general lighting in the day lit area based on amount of daylight in the space.
5. Demand responsive lighting controls. Installing controls that are capable of receiving and automatically responding to a demand response signal.

### 5.4.1 Manual Area Controls

#### §130.1(a) of Part 6; §10-103(a)2 of Part 1

Each building area shall provide lighting controls that allow lighting in that area to be manually turned on and off. The manual area controls provide the building users and occupants a mean to control the light while they are in the space.

For egress lighting required by the Building Code (California Building Code), there is a provision that allows the egress lighting to be continuously on for up to 0.2 W/sq ft. of indoor lighting power during occupancy.

Egress lighting that complies with this wattage limitation is not required to comply with manual area control requirements if:

1. The means of egress area is shown on the building plans (including specifications) and is submitted to the enforcement agency.
2. The egress lighting controls are inaccessible to unauthorized personnel.

#### 5.4.1.1 Requirements for On and Off Controls

The manual on and off lighting controls shall meet all of the following requirements:

1. Be readily accessible.

EXCEPTION: Public restrooms having two or more stalls, parking areas, stairwells, and corridors may use a manual control not accessible to unauthorized personnel.

2. Be located in the same enclosed area with the lighting it controls.

EXCEPTION:

- i. For malls and atria, auditorium areas, retail merchandise sales areas, wholesale showroom areas, commercial and industrial storage areas, general commercial and industrial work areas, convention centers, arenas, psychiatric and secure areas in healthcare facilities, and other areas where placement of a manual area control poses a health and safety hazard, the manual area control shall instead be located so that a person using the control can see the lights or area controlled by that control, or visually signal or display the current state of the controlled lighting.
  - ii. Healthcare facility restrooms and bathing rooms that are intended for a single occupant can have lighting controls located outside the enclosed area but directly adjacent to the door.
3. General, floor display, wall display, window display, case display, ornamental, and special effects lighting require separate controls that allow each type of lighting to be turned on and off but without turning on or off other types of lighting or other equipment.

#### 5.4.2 Multi-Level Lighting Controls

##### *§130.1(b) & Table 130.1-A*

Multi-level lighting control requirements allow the lighting level to be adjusted to accommodate the activities of a room.

This requirement applies to general lighting in enclosed spaces 100 sq. ft. or larger and with a connected general lighting load greater than 0.5 W/sq. ft. General lighting does not include task lights, display, or ornamental lighting.

The lighting also must have the required number of control steps and meet the uniformity requirements in accordance with Table 130.1-A.

Dimming can be implemented in steps or over a continuous range. Continuous dimming provides a smoother transition of light levels in comparison to stepped dimming and is one factor to consider when choosing one dimming technology over another.

EXCEPTION: The following applications are not required to comply with the multi-level lighting control requirements.

1. An area enclosed by ceiling height partitions with only one luminaire containing no more than two lamps.

2. Restrooms.

3. Healthcare facilities.

Note that there are two exceptions to part of the requirements of Table 130.1-A for classrooms and other space types. Refer to end of Table 5-1 appeared on next two pages.

**Table 5-1 (Table 130.1-A): Multi-Level Lighting Controls and Uniformity Requirements**

<b>Luminaire Type</b>	<b>Minimum Required Control Steps (percent of full rated power<sup>1</sup>)</b>	<b>Uniform level of illuminance shall be achieved by:</b>
Line-voltage sockets except GU-24	Continuous dimming 10-100%	Continuous dimming 10-100%
Low-voltage incandescent systems	Continuous dimming 10-100%	Continuous dimming 10-100%
LED luminaires and LED source systems	Continuous dimming 10-100%	Continuous dimming 10-100%
GU-24 rated for LED	Continuous dimming 10-100%	Continuous dimming 10-100%
GU-24 sockets rated for fluorescent > 20 watts	Continuous dimming 20-100%	Continuous dimming 20-100%
Pin-based compact fluorescent > 20 watts <sup>2</sup>	Continuous dimming 20-100%	Continuous dimming 20-100%
GU-24 sockets rated for fluorescent ≤ 20 watts	Minimum one step between 30-70%	Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Pin-based compact fluorescent ≤ 20 watts <sup>2</sup>	Minimum one step between 30-70%	Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Linear fluorescent and U-bent fluorescent ≤ 13 watts	Minimum one step between 30-70%	Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Linear fluorescent and U-bent fluorescent > 13 watts	Minimum one step in each range: 20-40% 50-70% 75-85% 100%	Stepped dimming; or Continuous dimming; or  Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire, illuminating the same area and in the same manner
Track Lighting	Minimum one step between 30 – 70%	Step dimming; or Continuous dimming; or



		Separately switching circuits in multi-circuit track with a minimum of two circuits.
HID > 20 watts	Minimum one step between 50 – 70%	Stepped dimming; or Continuous dimming; or  Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
Induction > 25 watts	Minimum one step between 50 – 70%	Stepped dimming; or Continuous dimming; or  Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
Other light sources	Minimum one step between 50 – 70%	Stepped dimming; or Continuous dimming; or  Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.

1. Full rated input power of ballast and lamp, corresponding to maximum ballast factor
2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps

**EXCEPTION 1 to Table 130.1-A** Minimum Required Control Steps: Classrooms with a connected general lighting load of 0.7 watts per square feet or less shall have a minimum of one control step between 30-70 percent of full rated power, regardless of luminaire type.

**EXCEPTION 2 to Table 130.1-A** Minimum Required Control Steps: Library stack aisles, aisle ways and open areas in warehouses, parking garages, parking areas, loading and unloading areas, stairwells, and corridors shall have a minimum of one control step between 20-60 percent of full rated power, regardless of luminaire type.

### 5.4.3 Shut-Off Controls

#### §130.1(c)

All installed indoor lighting shall be equipped with controls that are able to automatically reduce lighting power when the space is typically unoccupied.

**EXCEPTION:** Healthcare facilities are not required to meet the shut-off control requirements.

In addition to lighting controls installed to comply with §130.1(a) (manual on and off controls located in each area); §130.1(b) (multi-level lighting controls); §130.1(d)

(automatic daylighting controls); and §130.1(e) (demand responsive controls), all installed indoor lighting shall be equipped with shut-off controls that meet the following requirements (§130.1(c)1):

- A. Shall be controlled with one or more of the following automatic shut-OFF controls:
  - 1. Occupant sensing control.
  - 2. Automatic time-switch control.
  - 3. Other control capable of automatically shutting off all of the lights when the space is typically unoccupied.
- B. Separate controls for lighting on each floor, other than lighting in stairwells.
- C. Separate controls for a space enclosed by ceiling height partitions not exceeding 5,000 square feet.
- D. Spaces larger than 5,000 square feet will have more than one separately controlled zone (where each zone does not exceed 5,000 square feet).

EXCEPTION: In the following functional areas, the area controlled may exceed 5,000 square feet, but may not exceed 20,000 square feet:

- a. Mall
  - b. Auditorium
  - c. Single tenant retail
  - d. Industrial
  - e. Convention center
  - f. Arena
- E. Separate controls for general, display, ornamental, and display case lighting.
- Automatic time-switch controls may include a manual-on mode.

#### 5.4.3.1 General Exceptions to §130.1(c)1:

The following applications are exempted from the shut-off controls requirements of §130.1(c)1:

- 1. An area that is in 24-hour use every day of the year.
- 2. Lighting complying with occupant sensing control requirements of §130.1(c)5 instead of §130.1(c)1.

This exception applies to those areas where occupant sensing controls are required to shut off all lighting. These areas include offices 250 sq. ft. or smaller, multipurpose rooms of less than 1,000 sq. ft., classrooms of any size, conference rooms of any size, or restrooms of any size in accordance with §130.1(c)5.

- 3. Lighting complying with partial off occupant sensing controls requirements of §130.1(c)7 instead of §130.1(c)1.

This exception applies to those areas where partial off occupant sensing controls are required. These areas include stairwells and common area corridors that provide access to guestrooms and dwelling units in accordance with §130.1(c)7A, or parking garages, parking areas and loading and unloading areas in accordance with §130.1(c)7B.

4. Up to 0.1 watts per sq. ft. of lighting may be continuously illuminated for egress lighting purpose.
5. Electrical equipment rooms.
6. Lighting that is designated as emergency lighting and connected to an emergency power source or battery supply and is intended to function in emergency mode only when normal power is absent.

#### **5.4.3.2 Use of Countdown Timer Switches**

Countdown timer switches may be used to comply with the automatic shut-off control requirements in §130.1(c)1 only in closets smaller than 70 sq. ft., and server aisles in server rooms.

The maximum timer setting shall be 10 minutes for closets, and 30 minutes for server aisles.

#### **5.4.3.3 Automatic Time-Switch Controls**

Automatic time-switch controls other than an occupant sensing control, shall include manual override and holiday shut-off.

##### **A. Manual Override Feature**

A manual override shall be incorporated with lighting controls that meet all of the following:

1. Complies with §130.1(a); and
2. Allows the lighting to remain on for no more than two hours when an override is initiated.

**EXCEPTIONS:** The following functional areas may have exceeded the override time by two hours when a captive-key override is utilized:

- Malls
- Auditoriums
- Single tenant retail
- Industrial
- Arenas

##### **B. Holiday “Shut-off” Feature**

An automatic holiday shut-off feature shall be incorporated with the automatic time-switch control and will turn off all loads for at least 24 hours before resuming the normally scheduled operation.

**EXCEPTIONS:** The following functional areas are not required to incorporate the holiday shut-OFF feature:

- Retail stores and associated malls
- Restaurants
- Grocery stores
- Churches
- Theaters

#### 5.4.3.4 Occupant Sensing Controls

##### **A. Part 1 - Areas where Occupant Sensing Controls are required to shut OFF ALL Lighting**

###### **§130.1(c)5**

Lighting in the following function areas shall be controlled with occupant sensing controls to automatically shut off all of the lighting when the room is unoccupied. In addition, controls shall be provided that allow the lights to be manually shut-off in accordance with §130.1(a) regardless of the sensor status:

- a. Offices 250 sq. ft. or smaller.
- b. Multipurpose rooms of less than 1,000 sq. ft.
- c. Classrooms of any size.
- d. Conference rooms of any size.
- e. Restrooms of any size.

In areas required by §130.1(b) to have multi-level lighting controls, the occupant sensing controls shall function either as a:

- a. Partial-on occupant sensor capable of automatically activating between 50-70 percent of controlled lighting power.
- b. Vacancy sensor that automatically turns lights off after an area is vacated of occupants (but requires lights to be turned ON manually).

For areas not required by §130.1(b) to have multi-level lighting controls, occupant sensing controls may function as one of the following:

- a. A normal occupant sensor.
- b. A partial-on occupancy sensor.
- c. A vacancy sensor.

Note that multipurpose rooms less than 1,000 sq. ft., classrooms greater than 750 sq ft. and conference rooms greater than 750 sq. ft. are required to be equipped with an occupancy sensor that controls the HVAC thermostat setup and setback and ventilation (§120.2(e)3). That means the occupancy sensor or lighting control system in the space must be capable of triggering the HVAC without fully triggering the lighting load.

In addition to the cost benefit to having the occupancy sensor used to control the lighting also control the HVAC system, it would become immediately apparent if the occupancy sensor fails.

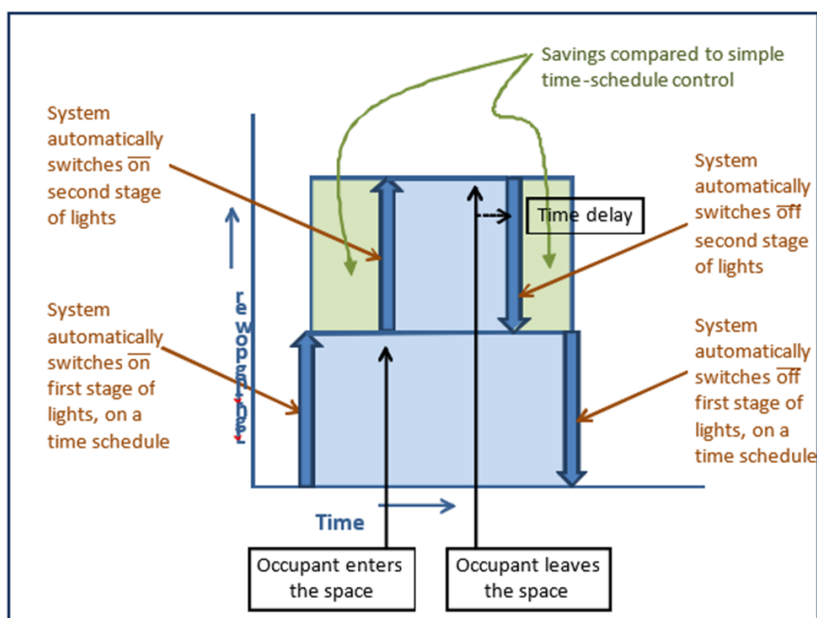
This method of controlling cooling, ventilation and lighting satisfies the requirements of §120.2(e)3 and §130.1(c), so no additional shutoff controls are required in these spaces (except with lighting associated with the egress path. That may remain energized until the building is scheduled to normally be unoccupied).

## B. Part 2 - Full or partial off occupant sensing controls – areas where the controls are required in addition to complying with §130.1(c)1

### §130.1(c)6

In addition to the basic shutoff requirements in §130.1(c)1, §130.1(c)6 requires a full or partial off occupancy sensor to reduce or turn off lighting when an area is unoccupied. Lighting in the listed spaces (warehouses, library book stack aisles, and stairwells and corridors) must reduce lighting power by at least 50 percent when they are unoccupied.

**Figure 5-7: Functional Diagram for Partial-OFF Occupant Sensor**



Egress lighting equipment is exempted and may remain at full power until the building is beyond the “normally occupied” schedule. At that time, it may be placed on occupancy sensors and turned OFF completely.

- A. In aisle ways and open areas in warehouses, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls

must have independent zoning for each aisle, and the aisle zones must not extend beyond the aisle into the open area of the warehouse.

EXCEPTIONS: The following conditions exempt the lighting system from this requirement, but it must meet the additional listed requirements:

1. In aisle ways and open areas in warehouses in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce lighting power by at least 40 percent (instead of the 50 percent required above).
2. When metal halide lighting or high-pressure sodium lighting is installed in warehouses, occupant sensing controls shall reduce lighting power by at least 40 percent (instead of the 50 percent required above). This is caused by a limitation of the dimming or bi-level ballast technology for high-intensity discharge (HID) light sources.

Note that even if the exemptions apply, these only result in a lighting power reduction associated with aisles and open areas during “normally occupied” periods. These spaces are still required to comply with the applicable automatic shut-off controls in §130.1(c) and will produce deeper savings during the “after hours” periods.

- B. In certain library book stack aisles, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied:
1. Library book stack aisles 10 feet or longer that are accessible from only one end.
  2. Library book stack aisles 20 feet or longer that are accessible from both ends.

The occupant sensing controls will independently control lighting in each aisle way and will not control lighting beyond the aisle way being controlled by the sensor.

*Note:* This lighting is required to comply with the applicable automatic shut-off controls in §130.1(c).

- C. Lighting installed in corridors and stairwells shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully on only in the separately controlled space, and automatically activated from all designed paths of egress.

Note: These subsections indicate that the lighting power must be reduced by *at least* 50 percent, but the decision to turn off the lights fully may be made by the designer.

The lighting in this section must also comply with the other portions of §130.1(c) that require lighting to be fully shutoff when the building is typically unoccupied. If a partial-off occupancy sensor is used to reduce lighting when a

space is unoccupied, it can be paired with an automatic time switch to turn lighting off fully when the building is unoccupied.

**C. Part 3 - Partial off occupant sensing controls – areas where the controls are required instead of complying with §130.1(c)1**

**§130.1(c)7**

The listed areas are required to have a partial-off lighting control system instead of meeting the shutoff requirements of §130.1(c)1. This means that lighting in stairwells and corridors of hotels/motels and parking garages may operate on a full-time basis at the minimum setback level and are not required to be shut off in the “after hours” periods like the requirement for the majority of building lighting.

- A. Lighting in stairwells and common area corridors that provide access to guestrooms and dwelling units in high-rise residential buildings and hotel/motels shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully on only in the separately controlled space and shall be automatically activated from all designed paths of egress. This permits the lights to remain on at a setback level continuously. Note that the zoning of the controls requires careful consideration of paths of egress to ensure that the sensor coverage in the zone is adequate.

EXCEPTION: In common area corridors and stairwells in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce power by at least 40 percent (instead of the 50 percent required above).

- B. The following apply to general lighting in parking garages, parking areas and loading and unloading areas, general lighting shall be controlled:
1. Lighting shall be controlled by occupant sensing controls having at least one control step between 20 percent and 50 percent of design lighting power.
  2. Lighting shall be controlled using no more than 500 watts of rated lighting power controlled together as a single zone.
  3. A reasonably uniform level of illuminance shall be achieved in accordance with the applicable requirements in Table 5-1 (Table 130.1-A of the Energy Standards).
  4. Occupant sensing controls shall be capable of automatically turning the lighting fully on only in each separately controlled space.
  5. The occupant sensing controls shall be automatically activated from all designed paths of egress.

For these spaces, lighting power must be reduced by at least 50 percent of the design lighting power, and the lighting must be reduced while maintaining similar levels of uniformity to the full power conditions. Note that the zoning of the controls requires careful consideration of paths of egress to ensure that the sensor

coverage in the zone is adequate. The wattage limits per zone will typically not permit entire floors of a garage to be on a single zone.

EXCEPTION: Metal halide luminaires meeting both of the following criteria shall be controlled by occupant sensing controls having at least one control step between 20 percent and 60 percent of design lighting power:

- Must have a lamp plus ballast mean system efficacy of greater than 75 lumens per watt. (The lamp plus ballast mean system efficacy is the rated mean lamp lumens at 40 percent of lamp life<sup>1</sup> divided by the ballast rated input watts.)
- Must be used for general lighting in parking garages, parking areas and loading and unloading areas.

The requirement for metal halide luminaires to have a control step between 20 percent and 60 percent is a limitation of the dimming or bi-level ballast technology for HID light sources.

Note that interior areas of parking garages are classified as indoor lighting for compliance with §130.1(c)7B.

The parking areas on the roof of a parking structure are classified as outdoor hardscape and shall comply with the applicable provisions in §130.2. Controls provisions in §130.1(c)7B do not apply to open rooftop parking.

§130.1(c)7 indicates that the controls must turn off the lights by at least 50 percent, but the decision to turn the lights off fully may be made by the designer.

The spaces listed in §130.1(c)7 are not required to meet the other requirements in §130.1(c) for full shutoff capability (they do not need to be fully shutoff during unoccupied hours).

#### 5.4.3.5 Requirements and Applications for Hotel and Motel Guest Rooms

##### §130.1(c)8

In addition to complying with the low-rise residential lighting standards in accordance with §130.0(b), hotel and motel guest rooms shall have captive card key controls, occupancy sensing controls, or automatic controls that will switch off lighting power within 20 minutes after the room has been vacated.

EXCEPTION: One luminaire in a hotel or motel guest room that meets all the following criteria does not have to be controlled by a captive card key control, occupancy sensing control, or automatic controls:

- The luminaire must be classified as high efficacy (where high efficacy is defined in §150.0(k) and Table 150.0-A).
- The luminaire is switched separately from the other lighting in the room.

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<sup>1</sup> Illuminating Engineering Society. Section 13.3 "Life and Lumen Maintenance" in The Lighting Handbook: 10<sup>th</sup> Edition Reference and Application. 2011. New York.



- The switch for that luminaire is located within 6 feet of the entry door.

This exception allows the occupant to manually control one luminaire. The switch must be located near the entry door to allow the occupant to turn the lighting on when entering the room.

#### 5.4.4 Automatic Daylighting Controls

##### §130.1(d)

Daylighting can be used as an effective strategy to reduce electric lighting energy use by reducing electric lighting power in response to available daylight. §130.1(d) addresses mandatory requirements for daylighting.

Automatic daylighting controls are required in daylit zones to automatically shut off lighting when sufficient daylight is available.

Prescriptive daylighting controls are covered in subchapter 5.5 of this chapter.

##### 5.4.4.1 Description of Terms

The following terms are used to describe the daylighting requirements in §100.1.

- A. General Lighting** - Electric lighting that provides a uniform level of illumination throughout an area exclusive of any provision for special visual tasks or decorative effect, and exclusive of daylighting (also known as ambient light).

Typical luminaires used for general lighting are troffers (prismatic, parabolic, or indirect diffusers), pendants (direct, indirect, or direct/indirect), high bay, low bay, and “aisle-lighter” fixtures. General lighting does not include display lighting (typically using directional MR, PAR, flood, spot, or wall washers) or ornamental lighting (such as drum fixtures, chandeliers, or projection lighting.)

- B. Window Head Height** - The vertical distance from the finished floor level to the top of a window.

- C. Daylit Zones** - A region of space considered to be close to a source of daylight such as a window, a clerestory, a roof monitor, or a skylight, where luminaires can be dimmed or switched in response to available daylight.

##### 5.4.4.2 Definitions of Daylit Zones

Areas having skylights and windows are classified according to daylit zones. The three different types of daylit zones are defined as follows:

- A. A Skylit Daylit Zone** is the rough area in plan view under each skylight, *plus* 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, *minus* any area on a plan beyond a permanent obstruction that is taller than one-half the distance from the floor to the bottom of the skylight.

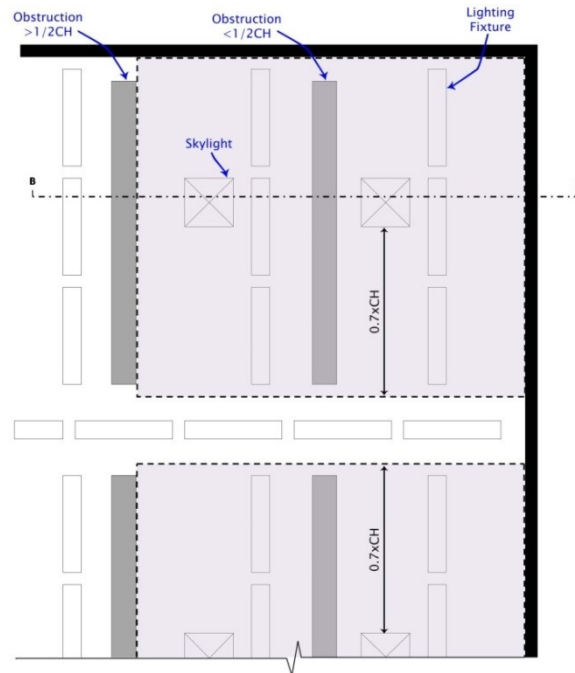
The bottom of the skylight is measured from the bottom of the skylight well (for skylights having wells), or the bottom of the skylight if no skylight well exists.

For the purpose of determining the skylit daylit zone, the geometric shape of the skylit daylit zone shall be identical to the plan view geometric shape of the rough

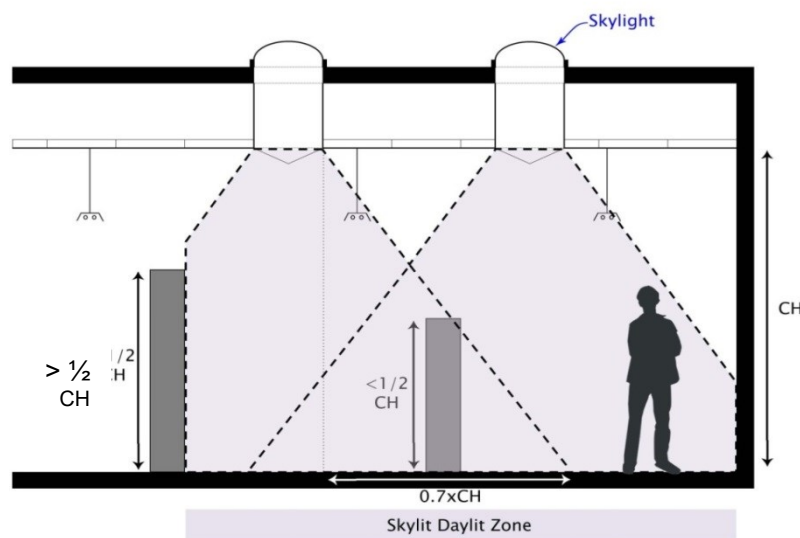
opening of the skylight; for example, the skylit daylit zone plan area for a rectangular skylight must be rectangular. For a circular skylight the zone plan area must be circular.

*Note:* Modular furniture walls should not be considered a permanent obstruction.

**Figure 5-8: Skylit Daylit Zone Diagram**



**Figure 5-9: Skylit Daylit Zone Diagram 2**

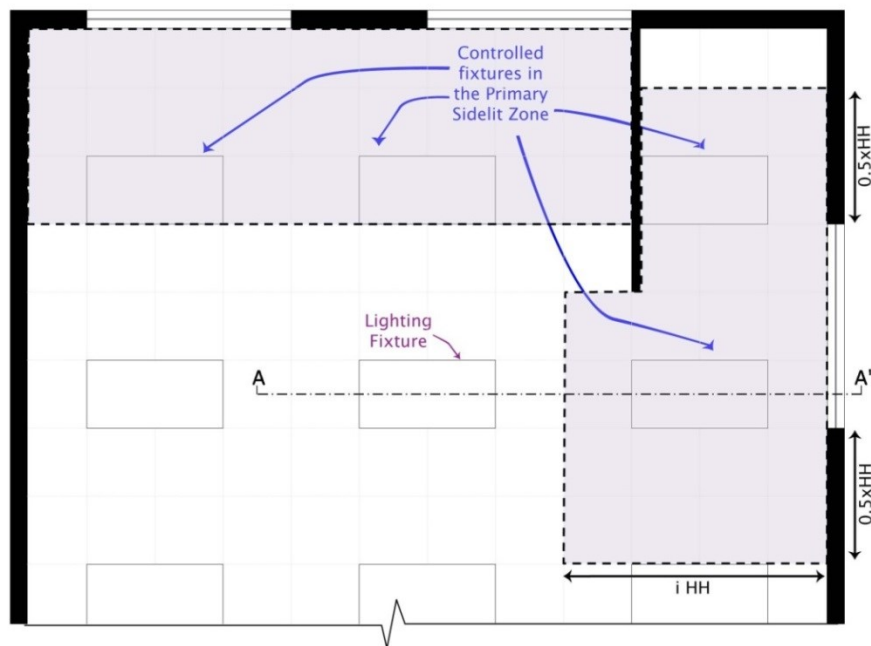


**B. PRIMARY SIDELIT DAYLIT ZONE** is the area in plan view and is directly adjacent to each vertical glazing, one window head height deep into the area,

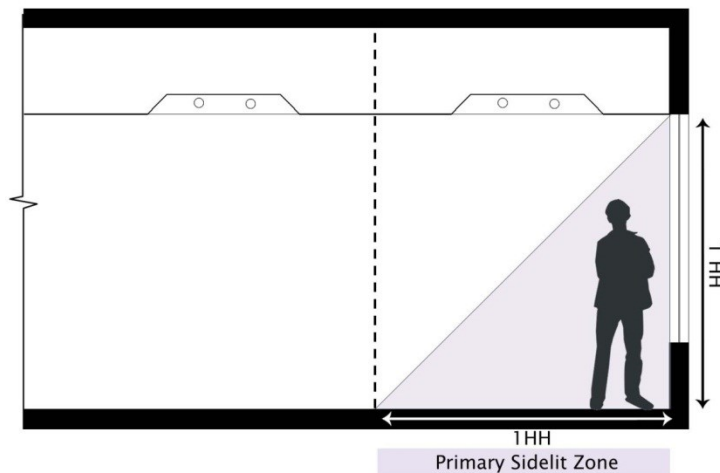
and window width *plus* 0.5 times window head height wide on each side of the rough opening of the window, *minus* any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

*Note:* Modular furniture walls should not be considered a permanent obstruction.

**Figure 5-10: Primary Sidelit Daylit Zone Diagram 1**



**Figure 5-11: Primary Sidelit Daylit Zone Diagram 2**



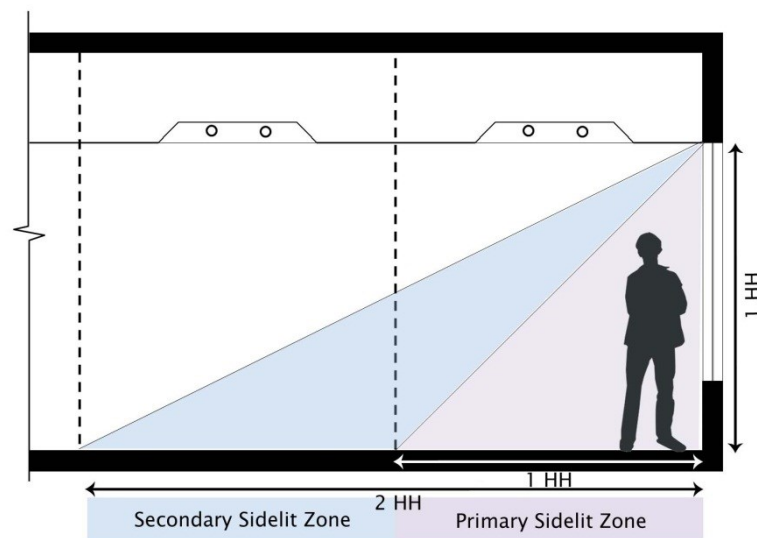
- C. SECONDARY SIDELIT DAYLIT ZONE** is the area in plan view and is directly adjacent to each vertical glazing, two window head heights deep into the area, and window width *plus* 0.5 times window head height wide on each side of the

rough opening of the window, *minus* any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

**Note:** Modular furniture walls should not be considered a permanent obstruction.

The daylighting controls in the skylit daylit zone and the primary sidelit daylit zone are mandatory and cannot be traded away for other efficiency measures when using the performance approach (whole building energy simulation). The daylighting controls requirements in the secondary sidelit daylit zone is prescriptive and can be traded away for other efficiency measures in the performance approach. If code compliance is accomplished with the prescriptive approach, then daylighting controls will be required in both the primary and secondary sidelit daylit zones, and these two zones must be controlled separately from each other.

**Figure 5-12: Secondary Sidelit Daylit Zone Diagram 1**





For luminaires in skylit daylit zones and primary sidelit daylit zones, automatic daylighting controls must be installed and configured to operate according to all of the following requirements:

1. When photosensors are within the daylit zone, at least one photosensor shall be located so it is not readily accessible to unauthorized personnel. The location where calibration adjustments are made to automatic daylighting controls shall be readily accessible to authorized personnel and may be inside a locked case or under a cover that requires a tool for access. Access to controls can be limited by placing locks or screws on enclosures or under a cover plate so a tool or key is needed to gain access. Though not required, commissioning and retrocommissioning of the control is simplified if the calibration adjustments are readily accessible to authorized personnel so that a lift or a ladder is not required to access the location where calibration adjustment are made.

Some controls have wireless remotes for adjusting settings. This convenience allows one person with a light meter and the wireless calibration tool to be located at the edge of the daylit zone and make the calibration adjustments without having to run back and forth between taking the measurement and making the adjustment

2. Automatic daylighting controls must provide functional multilevel lighting levels having at least the number of control steps specified in Table 5-1 (Table 130.1-A of the Energy Standards).

Note that when the requirements of §130.1(d) are triggered by the addition of skylights to an existing building and the lighting system is not re-circuited, the daylighting control is not required to meet the multi-level requirements in §130.1(d). This is in accordance with §141.0(b)2G for alterations.

3. For each space, the combined illuminance from the controlled lighting and daylight shall not be less than the illuminance from controlled lighting when no daylight is available.

In the darkest portion of the daylit zone (furthest away from windows or skylights) the control should not over-dim the lights; this portion of the daylit area should not get darker as daylight levels increase, due to incorrect calibration of the controls.

4. In areas served by lighting that is daylight controlled, and that 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.

The best control would fully dim the system when daylight levels in the darkest portion of the daylit zone are at 100 percent of design illuminance, but the 150 percent /65 percent requirement allows some tolerance for error while obtaining most of the energy savings.

**EXCEPTIONS:** Automatic daylighting controls are not required for any of the following conditions:

- 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 8 a.m. and 4 p.m.

- 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.
- Rooms in which the combined total installed general lighting power in the skylit daylit zone and primary sidelit daylit zone is less than 120 watts.
- Rooms which have a total glazing area of less than 24 square feet.
- Parking garages complying with §130.1(d)3.
- Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

#### 5.4.4.5 Parking Garage Daylighting Requirements

In a parking garage area having a combined total of 36 square feet or more of glazing or opening, luminaires providing general lighting (and that are in the combined Primary and Secondary Sidelit Daylit Zones) shall be controlled independently from other lighting in the parking garage by automatic daylighting controls and shall meet the following requirements as applicable:

- A. All Primary and Secondary Sidelit Daylit Zones must be shown on the building plans.
- B. Automatic Daylighting Control Installation and Operation.

Automatic daylighting control shall be installed and configured to operate according to all of the following requirements:

1. Automatic daylighting controls shall have photosensors that are located so that they are not readily accessible to unauthorized personnel. 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.
2. Automatic daylighting controls shall be multi-level, continuous dimming or on/off.
3. The combined illuminance from the controlled lighting and daylight shall not be less than the illuminance from controlled lighting when no daylight is available.
4. 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 shall be zero.

#### EXCEPTIONS:

1. Luminaires located in the daylight transition zone and luminaires for dedicated ramps. Daylight transition zone and dedicated ramps are defined in §100.1.

2. When the total combined general lighting power in the Primary Sidelit Daylight Zones is less than 60 watts.

The primary differences between the automatic daylight control requirements in parking garages and the rest of interior lighting spaces are:

- Primary and Secondary Zone are controlled together in parking garages whereas they must be separately controlled in other spaces. However, it is permissible that in either space type, a single sensor can be used if the control system is capable of making the appropriate light level adjustments in each individual zone.
- Daylighting controls in parking garages are permitted to use an on/off control strategy, whereas for all other interior spaces the control must be step switching or dimming.
- When sufficient daylight is present, controlled lighting in parking garages must be off whereas in other interior spaces the lighting power must be reduced by 65 percent. Egress lighting for the parking garage may be controlled, but the controls must employ a failsafe mechanism that ensures that the egress lighting is functioning and stays on if the photocell fails.

Examples for complying with the mandatory daylighting controls requirements, and the prescriptive daylighting requirements are covered in Section 5.5 of this chapter.

#### 5.4.5 Demand Responsive Lighting Controls

*§130.1(e); §110.12 (new for 2019)*

Nonresidential buildings larger than 10,000 sq. ft. must have lighting systems with demand responsive lighting controls.

Spaces with a lighting power density of 0.5 W/ft<sup>2</sup> or less do not count towards the 10,000 sq ft. threshold for triggering demand responsive lighting control requirements. Also, spaces not permitted by a health or life safety statute, ordinance, or regulation to be reduced, are exempted from the requirement.

See Appendix D of this compliance manual for guidance on compliance with the demand responsive control requirements.

#### 5.4.6 Lighting Control Interactions - Considerations for Spaces with Multiple Lighting Control Types

*§130.1(f)*

In indoor spaces, there can be more than one type of lighting control installed in the space to meet the Energy Code requirements for lighting controls. In the 2019 standards, Section 130.1(f) has been added to clarify interactions between two lighting control types.

#### Example 5-3 Interaction between manual dimming and automatic daylighting controls

##### Question



Is any acceptance test required for testing the interaction between manual dimming and automatic daylighting controls?

**Answers**

No, the interaction between manual dimming controls and automatic daylighting controls is not required for acceptance testing. Acceptance testing is required for automatic daylighting controls though.

**5.4.6.1 Practical Considerations**

For a space with both daylighting controls and dimming controls, the daylighting controls are likely to be the primary control most of the time. When the building user/occupant wants to use the dimming control to adjust the light level, the user/occupant should be able to do so. User should be able to manually override the level of light provided by the lighting system with manual dimming and a scene feature (switching the lighting in the zone to the predefined level) according to the needs of the activity in terms of duration of the activity.

One method that could be employed would have the occupant use the dimmer control to lower or raise the upper bound on the amount of light provided by the electric lighting. The dimming control would temporarily set a total lighting level that the daylighting control could then achieve by balancing the amount of electric lighting with the daylighting available in the space. This method allows the occupant to receive the benefits of both controls, rather than one control locking out the use of the other. When the activity is over, the lighting system should be restored to automatic control operation.

There is another method for spaces with all three control types – dimming, shutoff, and daylighting. If the occupancy sensing control is the shut-off control, the lighting should restore to automatic control mode (the occupancy sensing controls is triggered within 20 minutes after the area has been vacated). If there are no occupancy sensing controls and if an override is initiated, the automatic control should be overridden for no more than 20 minutes. After that, the automatic control resumes and the light level should be set by the daylighting controls.

**5.4.7 Lighting Control Functionality****§110.9(b)**

All installed lighting controls listed in §110.9(b) must comply with the requirements listed below. Additionally, all components of the system (considered together as installed) must meet all applicable requirements for which they are installed as required in §130.0 through §130.5, §140.6 through §140.8, §141.0, and §150.0(k).

To ensure they are meeting the requirements of Section 110.9(b), designers and installers are advised to review features of their specified lighting control products as part of the code compliance process.

**A. Time-Switch Lighting Controls**

Time-switch lighting control products shall provide the functionality listed in Section 110.9(b)1 of the Energy Code.

**B. Daylighting Controls**

Daylighting control products shall provide the functionality listed in Section 110.9(b)2 of the Energy Code.

**C. Dimmer**

Dimmer products shall provide the functionality listed in Section 110.9(b)3 of the Energy Code.

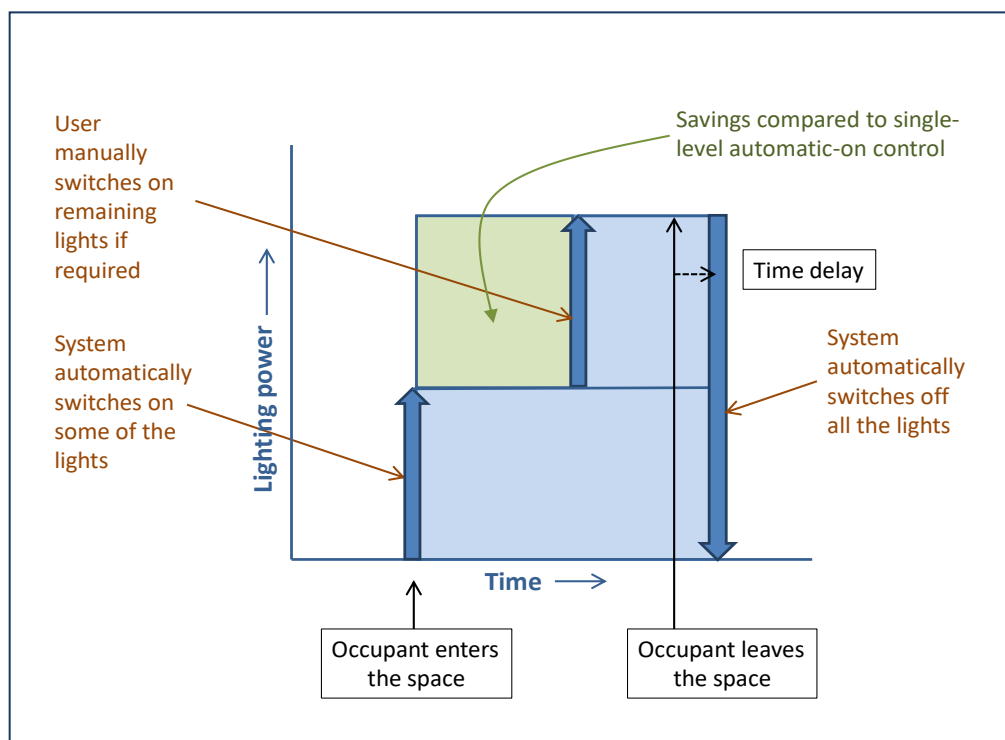
**D. Occupant Sensing Controls**

Occupant sensing control products (including occupant sensors, partial-on occupant sensors, partial-off occupant sensors, motion sensors, and vacancy sensor controls) shall provide the functionality listed in Section 110.9(b)4 of the Energy Code.

One important function is the capability to automatically turn lights either off or down within 20 minutes of an area being vacated.

**EXCEPTIONS:**

Occupant sensing control systems may consist of a combination of single or multi-level occupant, motion, or vacancy sensor controls provided that components installed to comply with manual-on requirements are not capable of being converted from manual-on to automatic-on functionality by occupants.

**Figure 5-14: Functional Diagram for Partial-ON Occupant Sensor**

#### 5.4.8 Track Lighting Limiter and Track Lighting Panel Functionality and Features

##### *§110.9(c) and (d)*

A **track lighting current limiter** is used to limit the rated power that can go through a section of track lighting. Without the current limiter, the “installed” wattage of a long section of track could be excessive and use up all of the allotted lighting power for a space. With track lighting and a current limiter, the track heads can be spread far apart and can use high efficacy sources to stay below the rated wattage of the current limiter. If the wattage exceeds the rated wattage of the current limiter, the limiter turns off current to the controlled lighting.

Track lighting integral current limiters must meet all of the requirements as specified in §110.9(c) and paraphrased below. The limiter

1. Must have the volt-ampere (VA) rating clearly marked so that it is visible for the enforcement agency's field inspection without opening coverplates, fixtures, or panels.
  - Must have the VA rating permanently marked on the circuit breaker.
  - Must have the VA rating printed on a factory-printed label permanently affixed to a non-removable baseplate inside the wiring compartment.
2. Must have a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring, or bypassing the device.

Each electrical panel feeding track lighting integral current limiters shall have a factory installed label prominently located.

A **track lighting supplementary overcurrent protection panel** is a subpanel that contains current limiters for use with multiple track lighting circuits only. A track lighting supplementary overcurrent protection panel shall be used only for line-voltage track lighting.

A track lighting supplementary overcurrent protection panel shall meet all of the requirements as specified in §110.9(d) and as paraphrased below:

1. Shall be listed as defined in Article 100 of the California Electric Code.
2. Shall be used only for line voltage track lighting.

Each track lighting supplementary overcurrent protection panel) shall have a factory installed label prominently located.

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## **5.5 Other Prescriptive Daylighting Requirements – Daylighting, Daylighting Devices, and Secondary Sidelit Daylit Zones**

This section contains daylighting requirements that are in addition to the mandatory automatic daylighting controls covered in Section 5.4 of this chapter.

They include the prescriptive requirements for daylighting in large enclosed spaces, for daylighting devices (clerestories, horizontal slats, light shelves) that are qualified for PAFs, and for automatic daylighting controls in secondary sidelit daylit zone.

### **5.5.1 Daylighting Devices (Clerestories, Horizontal Slat, Light Shelves) – Daylighting Design Power Adjustment Factors (PAFs)**

§140.6(a)2L
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Certain design features and technologies have the capacity to increase the daylighting potential of spaces. Some of these design features and technologies may be used in conjunction with automatic daylighting controls to receive PAFs from Table 140.6-A, or as a performance compliance option (PCO) in the performance method.

A careful analysis should be performed to ensure the avoidance of glare issues when including daylighting features in the design. An example where caution should be taken is specularly reflective (e.g. polished or mirror-finished) slats. These slats may redirect direct beam sunlight and cause uncomfortable glare. Since that is not the only consideration to make when considering daylighting design features, a careful daylighting analysis should be performed on a space-by-space, project-by-project basis.

For the PAF, daylight dimming plus off PAF and institutional tuning in daylit areas may be added to any of the daylighting design PAFs to create a combined total PAF.

In addition, the horizontal slat PAF can be added to the clerestory fenestration PAF if the requirements for both PAFs are met.

For the PCO, a variety of control strategies is available in the compliance software to take advantage of further savings.

For the PAF, at permit application, use form NRCC-LTI-E.

## **5.5.2 Minimum Daylighting Requirements for Large Enclosed Spaces**

### **§140.3(c)**

§140.3 has prescriptive requirements for building envelopes, including minimum daylighting for large enclosed spaces directly under roofs. Lighting installed in spaces complying with these prescriptive envelope measures are also required to comply with all lighting control requirements, including the mandatory and prescriptive lighting control requirements.

The mandatory daylighting control requirements are covered in Section 5.4.4 of this chapter.

If one prescriptively complies by installing daylight openings in large enclosed spaces directly under roofs, the daylit areas could have electric lighting systems with high enough lighting power to trigger the mandatory requirements for daylighting controls. However, if one complies using the performance approach, it is possible to displace the daylighting openings and daylighting controls with other building efficiency options

### **5.5.2.1 Large Enclosed Spaces Requiring Minimum Daylighting – Qualifying Criteria**

The minimum prescriptive daylighting requirements for large enclosed spaces apply to both conditioned and unconditioned nonresidential spaces that meet the following qualifying criteria:

1. Space is directly under a roof.
2. Is located in climate zones 2 through 15.
3. Has a floor area greater than 5,000 ft<sup>2</sup>.
4. Has a ceiling height greater than 15 ft.

#### **EXCEPTIONS:**

1. Auditoriums, churches, movie theaters, museums, or refrigerated warehouses.
2. Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 W/ft<sup>2</sup>.
3. In buildings with unfinished interiors, future enclosed spaces in which there are plans to have one of the following:
  - a. A floor area of less than or equal to 5,000 ft<sup>2</sup>.
  - b. Ceiling heights less than or equal to 15 feet. This exception shall not be used for S-1 or S-2 (storage) or F-1 or F-2 (factory) occupancies.

4. Enclosed spaces where it is documented that permanent architectural features of the building, existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

#### 5.5.2.2 Prescriptive Daylighting Requirements

In climate zones 2 thru 15, enclosed spaces larger than 5,000 sq ft. shall have at least 75 percent of the floor area within the primary sidelit daylit zone or skylit daylit zone.

For large enclosed spaces that are required to comply, following are details of the minimum prescriptive daylighting requirements:

1. A combined total of at least 75 percent of the floor area, as shown on the plans, shall be within the skylit daylit zone or primary sidelit daylit zone. The calculation of the daylit zone area to show compliance with this minimum daylighting requirement does not need to account for the presence of partitions, stacks or racks other than those that are ceiling high partitions. The design of the envelope may be developed before there is any knowledge of the location of the partial height partitions or shelves as is often the case for core and shell buildings. Thus, the architectural daylit zone requirement of 75 percent of the area of the enclosed space indicates the possibility of the architectural space being mostly daylit.

The daylit zone and controls specification in §130.1(d) describe which luminaires are controlled. The obstructing effects of tall racks, shelves and partitions must be taken into consideration while determining the specifications. There is a greater likelihood that the electrical design will occur later than the architectural design and thus greater planning for these obstructions can be built into the lighting circuiting design. With addressable luminaires, the opportunity is available to the contractor to incorporate the latest as built modifications into the daylight control grouping of luminaires according to unobstructed access to daylight.

2. The total skylight area is at least 3 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of the rough opening of the skylights; or the product of the total skylight area and the average skylight visible transmittance is no less than 1.5 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of the rough opening of skylights.

The above two requirements can be translated and represented by the following equations.

$$\frac{\text{Skylight Area}}{\text{Daylit Zone under skylights}} \geq 3 \text{ percent} \quad (\text{Equation 5 – 1})$$

$$\text{Skylight Area} \times VT \geq 1.5 \text{ percent} \times \text{Daylit Zone under skylights}$$

(Equation 5 – 2)

*Definitions of the above equation terms:*

*Skylight Area* = total skylight area on the roof

*Daylit Zone under skylights* = total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of the rough opening of skylights

*VT* = Visible Transmittance

3. General lighting in daylit zones shall be controlled in accordance with §130.1(d).
4. Skylights shall have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D1003, or a Commission approved test method.

Skylights must also meet the maximum glazing area, thermal transmittance (U-factor), solar heat gain coefficient (SHGC), and visible transmittance (VT) requirements of §140.3(a). Plastic skylights are required to have a VT of 0.64 and glass skylights are required to have a VT of 0.49. Currently plastics are not accompanied by low emissivity films which transmit light but block most of the rest of the solar spectrum. As a result, there is no maximum SHGC for plastic skylights. Glass skylights are required to have a maximum SHGC of 0.25. With a minimum VT of 0.49 and a maximum SHGC of 0.25, glass skylights must utilize low emissivity films or coatings that have a high light-to-solar gain ratio.

5. All skylit daylit zones and primary sidelit daylit zones shall be shown on building plans.

The total skylight area on the roof a building is prescriptively limited to a maximum of 5 percent of the gross roof area (§140.3(a)6A). If one fully daylight the space with skylights and the skylights meet the prescriptive requirements of 64 percent visible light transmittance, a minimum skylight area of at least 3 percent of the roof area is needed to optimize energy cost savings according to several simulation studies.<sup>2</sup>.

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#### **Example 5-4**

##### **Methods for buildings with large enclosed spaces in compliance with the minimum daylighting requirement**

In buildings with large enclosed spaces that must meet the minimum daylighting requirement, the core zone of many of these spaces will be daylit with skylights. Skylighting 75 percent of the floor area is achieved by evenly spacing skylights across the roof of the zone. A space can be fully skylit by having skylights spaced so that the edges of the skylights are not further apart than 1.4 times the ceiling height. Therefore, in a space having a ceiling height of 20 feet, the space will be fully skylit if the skylights are spaced so there is no more than 28 feet of opaque ceiling between the skylights.

### Example 5-5

#### Large enclosed spaces in a warehouse building

A warehouse with 40,000 sq ft. area and a 30-foot tall ceiling (roof deck).

Maximum skylight spacing distance and recommended range of skylight area.

The maximum spacing of skylights that results in the space being fully skylit is:

Maximum skylight spacing =  $1.4 \times \text{ceiling height} + \text{skylight width}$

Spacing skylights closer together results in more lighting uniformity and thus better lighting quality – but at an increased cost since more skylights are needed. However, as a first approximation one can space the skylights 1.4 times the ceiling height. For this example, skylights can be spaced  $1.4 \times 30 = 42$  feet. In general, the design will also be dictated by the size of roof decking materials (such as 4' by 8' plywood decking) and the spacing of roof purlins so the edge of the skylights line up with roof purlins. For this example, we assume that roof deck material is 4' by 8' and skylights are spaced on 40-foot centers.

Each skylight is serving a 40 foot by 40-foot area of 1,600 square foot. A standard skylight size for warehouses is often 4' by 8' (so it displaces one piece of roof decking). The ratio of skylight area to daylit area is 2 percent ( $32/1600 = 0.02$ ). Assuming this is a plastic skylight and it has a minimally compliant visible light transmittance of 0.65 the product of skylight transmittance and skylight area to daylit area ratio is;

$$(0.65)(32/1,600) = 0.013 = 1.3 \text{ percent}$$

This is shy of the 2 percent rule of thumb described earlier for the product of skylight transmittance and skylight area to daylit area ratio. If one installed an 8 ft. by 8 ft. skylight (two 4 ft. by 8 ft. skylights) on a 40-foot spacing would yield a 2.6 percent product of skylight transmittance and skylight area to daylit area ratio. With 64 square feet of skylight area for each 1,600 square feet of roof area, the skylight to roof area ratio (SRR) is 4 percent which is less than the maximum SRR of 5 percent allowed by §140.3(a).

An alternate approach would be to space 4 ft. by 8 ft. skylights closer together which would provide more uniform daylight distribution in the space and could more closely approach the desired minimum VT skylight area product. By taking the product of the skylight VT and the skylight area and dividing by 0.02 (the desired ratio) yields the approximate area the skylight should serve. In this case with a VT of 0.65 and a skylight area of 32 square feet, each skylight should serve around  $(0.65 \times 32 / 0.02) = 1,040$  square feet. A 32-foot center to center spacing of skylights results in  $(32 \times 32) = 1,024$  square feet of daylit area per skylight.

For the minimally compliant 4 ft. by 8 ft. plastic skylight with a visible light transmittance of 0.65 the product of skylight transmittance and skylight area to daylit area ratio is;

$$(0.65) \times (32/1,024) = 0.0203 = 2.03 \text{ percent.}$$

### Example 5-6

#### Methods for complying with the mandatory daylight control requirements for a space with HID lighting

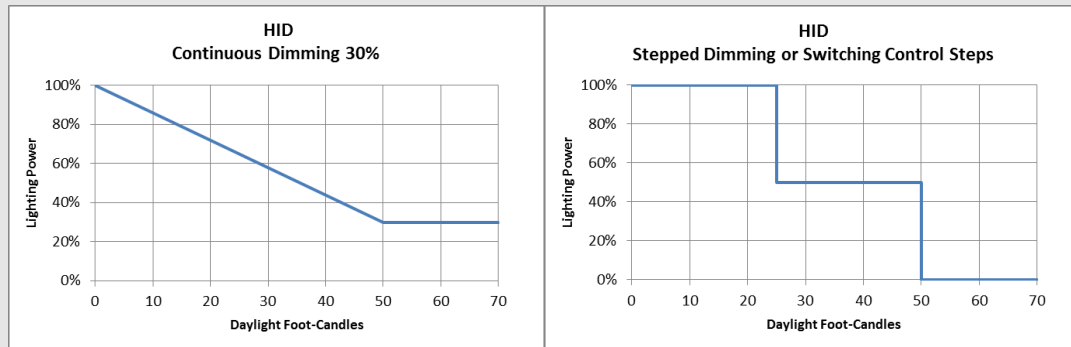
The Standards require that automatic daylighting controls shall provide functional multi-level lighting levels having at least the number of control steps specified in Table 130.1-A.

A space with HID luminaires that are greater than 20 watts, shall have a minimum of 1-step between 50 percent and 70 percent.

This can be achieved in one of the following ways, using:



- A. Continuous dimming - Here the photocontrol gradually dims all luminaires in the daylit zone in response to the available daylight.
- B. Stepped dimming - Here the photocontrol signals the stepped dimming ballast to reduce power in incremental steps such that there is one control step between 50 percent and 70 percent as noted above.



### Example 5-7

#### Complying with the 150 percent of the design illuminance daylighting requirement

When the illuminance received from the daylight is greater than 150 percent of the design illuminance (or nighttime electric lighting illuminance), the general lighting power in the daylit zone must reduce by a minimum of 65 percent.

For example, a space has 500 watts of installed lighting power in daylit zones. The design illuminance for the space is 50 foot-candle (fc). When the available daylight in the space reaches 75 fc (i.e. 150 percent of 50 fc), then the power consumed by the general lighting in the daylit zones should be 175 watts or lower.

Without checking all points in the daylit zone served by controlled lighting, verifying that the requirements are met at a worst-case location far away from windows or skylights is sufficient. This location is called the "Reference Location"

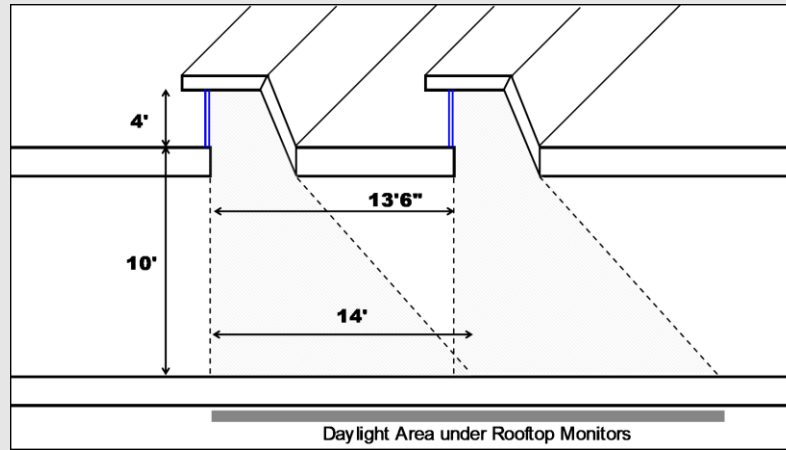
### Example 5-8

#### Question

Draw the daylit zone for two roof top monitors with four 4-foot long windows projecting over a 10-foot tall roof. The two monitors are 13.5 feet apart.

#### Answer

Standards currently define skylights as glazing having a slope less than 60 degrees from the horizontal with conditioned or unconditioned space below. Because rooftop monitors have a slope greater than 60 degrees, they are therefore considered to be windows.



### 5.5.3 Prescriptive Automatic Daylighting Control Requirements in Secondary Daylit Zones

#### §140.6(d)

The daylighting control requirements for secondary daylit zones are not mandatory but prescriptive.

All luminaires providing general lighting that is in, or at least half of the luminaires are in, a secondary sidelit daylit zone as defined in §130.1(d)1C, and that is not in a primary sidelit daylit zone shall comply with the following:

1. The general lighting shall be controlled independently from all other luminaires (including those in the primary sidelit daylit zone, the skylit daylit zone and lights that are not in daylit zones) by automatic daylighting controls that meet the applicable requirements of §110.9.
2. The general lighting shall be controlled in accordance with the applicable requirements in §130.1(d)2 (see Section 5.4.2 of this chapter).
3. All secondary sidelit daylit zones shall be shown on the plans submitted to the enforcing agency.

#### EXCEPTIONS:

1. Luminaires in secondary sidelit daylit zone(s) in areas where the total wattage of general lighting is less than 120 watts.
2. Luminaires in parking garages complying with §130.1(d)3.

## 5.6 Prescriptive Compliance Approach for Indoor Lighting – Part 1, Adjusted Indoor Lighting Power

See Section 5.5 of this chapter for the prescriptive daylighting requirements.

### 5.6.1 Requirements for a Compliant Building

A building complies with §140.6 if:

1. The adjusted indoor lighting power of all proposed building areas combined, when calculated in accordance with §140.6(a), is no greater than the allowed indoor lighting power, calculated in accordance with §140.6(c).
2. The calculation of allowed indoor lighting power meets the general rules requirements in §140.6(b).
3. General lighting complies with the automatic daylighting controls in secondary sidelit zones requirements in §140.6(d).

### **5.6.2 Calculation of Adjusted Indoor Lighting Power**

The adjusted indoor lighting power of all building areas is the total watts of all planned permanent and portable lighting systems in all areas of the proposed building.

Some adjustments are available to reduce the indoor lighting power that must be reported. These adjustments are discussed below.

#### **A. Power Adjustment Factors (PAFs) or Reduction of Wattage Through Controls**

The Energy Standards provide an option for a lighting power reduction credit when specific lighting controls are installed, provided those lighting controls are not required.

A power adjustment factor (PAF) is an adjustment to the installed lighting power in an area so that some of the installed lighting power is not counted toward the building's total installed lighting load.

In calculating adjusted indoor lighting power, the installed watts of a luminaire providing general lighting in a functional area listed in Table 140.6-C may be reduced by multiplying the watts controlled by the applicable power adjustment factor (PAF), per Table 140.6-A.

To qualify for a PAF, the following conditions are required to be met:

1. Before a power adjustment factor will be allowed for compliance with §140.6, the person who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the construction or installation of features, materials, components, or manufactured devices, shall sign and submit the Certificate of Installation.

If any of the requirements in this Certificate of Installation are not met, the installation shall not be eligible to use the PAF.

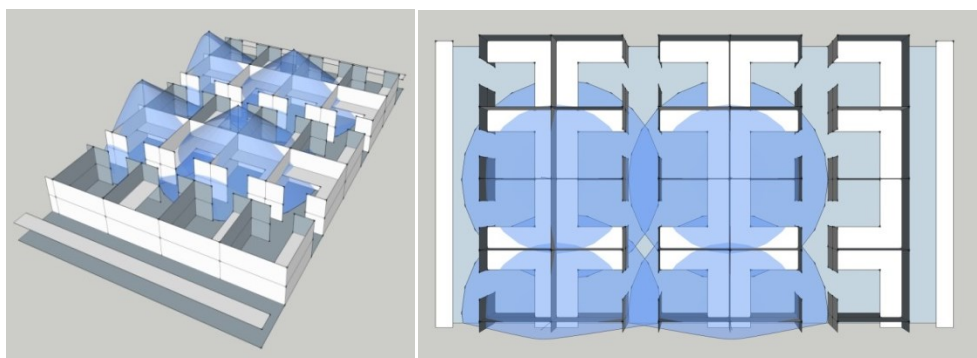
2. Luminaires and controls meet the applicable requirements of §110.9, and §130.0 through §130.5.
3. The controlled lighting is permanently installed general lighting systems and the controls are permanently installed nonresidential-rated lighting controls. (Thus, for example, portable lighting, portable lighting controls, and residential rated lighting controls shall not qualify for PAFs.)

There are furniture mounted lighting systems that are installed to provide general lighting. When used for determining PAFs for general lighting in offices, furniture mounted luminaires that comply with all of the following conditions shall qualify as permanently installed general lighting systems:

- a. The furniture mounted luminaires shall be permanently installed no later than the time of building permit inspection.
  - b. The furniture mounted luminaires shall be permanently hardwired.
  - c. The furniture mounted lighting system shall be designed to provide indirect general lighting. It may also have elements that provide direct task lighting.
  - d. Before multiplying the installed watts of the furniture mounted luminaire by the applicable PAF, 0.3 watts per square foot of the area illuminated by the furniture mounted luminaires shall be subtracted from installed watts of the furniture mounted luminaires to account for portable lighting.
  - e. The lighting control for the furniture mounted luminaire complies with all other applicable requirements in §140.6(a)2.
4. At least 50 percent of the light output of the controlled luminaire is within the applicable area listed in Table 140.6-A. Luminaires on lighting tracks shall be within the applicable area in order to qualify for a PAF.
  5. Only one PAF from Table 140.6-A may be used for each qualifying luminaire. PAFs shall not be added together unless specifically allowed in Table 140.6-A.
  6. Only lighting wattage directly controlled in accordance with §140.6(a)2 shall be used to reduce the calculated adjusted indoor lighting power as allowed by §140.6(a)2. If only a portion of the wattage in a luminaire is controlled in accordance with §140.6(a)2, then only that portion of controlled wattage may be reduced in calculating adjusted indoor lighting power.
  7. Lighting controls used to qualify for a PAF shall be designed and installed in addition to manual, multi-level, and automatic lighting controls required in §130.1, and in addition to any other lighting controls required by the Energy Standards.
  8. To qualify for the PAF for daylight dimming plus OFF control, the following requirements must be met:
    - a. The lighting controls system shall meet all of the requirements of §130.1(d)
    - b. The lighting control system shall turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power.
    - c. The controlled luminaires must be within the skylit daylit or primary sidelit daylit zones only.
    - d. This PAF shall not be available for atria or any other areas that operate with a photocell ON/OFF control that does not include intermediate steps.

- e. The OFF step must be demonstrated in the acceptance testing of the automatic daylighting controls.
- 9. To qualify for the PAF for an occupant sensing control controlling the general lighting in large open plan office areas above workstations, in accordance with Table 140.6-A, the following requirements shall be met:
  - a. The open plan office area shall be greater than 250 square feet.
  - b. This PAF shall be available only in office areas which contain workstations.
  - c. Controlled luminaires shall only be those which provide general lighting directly above the controlled area or furniture mounted luminaires that comply with §140.6(a)2 and provide general lighting directly above the controlled area.
  - d. Qualifying luminaires shall be controlled by occupant sensing controls that meet the following requirements, as applicable:
    - i. Infrared sensors shall be equipped (either by the manufacturer or in the field by the installer) with lenses or shrouds to prevent them from being triggered by movement outside of the controlled area.
    - ii. Ultrasonic sensors shall be tuned to reduce their sensitivity to prevent them from being triggered by movements outside of the controlled area.
    - iii. All other sensors shall be installed and adjusted as necessary to prevent them from being triggered by movements outside of the controlled area.
  - e. The PAF shall be applied only to the portion of the installed lighting power that is controlled by the occupant sensors, not to the total installed lighting power.
  - f. The value of the PAF (0.2, 0.3 or 0.4) depends on the square footage controlled by each occupant sensor.

**Figure 5-15: To Qualify for the PAF for Occupancy Sensing Controls in Open-Plan Offices, Sensors Must be Tuned to the Controlled Area**



- 10. The following requirements must be met to qualify the PAF for institutional tuning:

- a. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw.
  - b. The means of setting the limit is accessible only to authorized personnel.
  - c. The setting of the limit is verified by the acceptance test required by §130.4(a)7.
  - d. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85 percent of full light output or full power draw.
11. To qualify for the PAF for a demand responsive control in Table 140.6-A, a demand responsive control shall meet all of the following requirements:
  - a. Because buildings larger than 10,000 sq. ft. are required to have demand responsive controls, to qualify for the PAF, the building shall be 10,000 sq ft or smaller.
  - b. The controlled lighting shall be capable of being automatically reduced in response to a demand response signal.
  - c. Lighting shall be reduced in a manner consistent with the uniform level of illumination requirements in Table 130.1-A.
  - d. Spaces that are non-habitable shall not be used to comply with this requirement, and spaces with a lighting power of less than 0.5 watts per square foot shall not be counted toward the building's total lighting power.
12. Daylighting devices for PAFs are newly introduced in the 2019 standards.

To qualify for the PAF for daylighting devices (including clerestories, light shelves and horizontal slats in Table 140.6-A), the daylighting devices must meet the requirements in Section 140.3(d). Refer to Chapter 3 of the Nonresidential Compliance Manual about Section 140.3(d).

Also note that the PAFs shall only apply to luminaires in the daylit areas adjacent to the daylighting devices, and to the lighting system meeting the automatic daylighting controls requirements of Section 130.1(d).

## **B. Luminaire Power Adjustment**

Color-tunable LED lighting technologies are adopted for lighting applications including hospitality and healthcare and other built environments. Those luminaires offer the benefits of producing different correlated color temperatures (CCT) to match the functionality and occasions of a space.

Two categories of the color tunable luminaires -- tunable-white LED and dim-to-warm LED luminaires -- can be qualified for luminaire lighting power adjustment by a multiplier of 0.75 if the luminaires meet all of the requirements of Section 140.6(a)4B. The requirements are paraphrased below.

- Small Aperture – no wider than 4 inches for luminaires longer than 18 inches; no wider than 8 inches otherwise.

- Color Changing Capability– capable of color change greater than or equal to 2000K CCT for tunable-white LED luminaires; capable of color change greater than or equal to 500K CCT for dim-to-warm LED luminaires.
- Control Capability – the luminaires must be connected with controls enabling color-changing.

**Figure 5-16 Dim-to-warm luminaires in Lighting Applications**



Source: NORA Lighting

### **C. Portable Lighting in Office Areas**

The Energy Standards (§140.6(a)) require that all planned portable lighting be counted toward the building's lighting energy use, regardless of when it is planned to be installed.

Because office cubicles (including their portable lighting) are typically not installed until after the building inspection is complete, the portable lighting power is accounted together with permanent lighting system as the adjusted lighting power for compliance purpose.

The Energy Standards define portable lighting as lighting with plug-in connections for electric power. That includes table and freestanding floor lamps; those attached to modular furniture; workstation task luminaires; luminaires attached to workstation panels; those attached to movable displays; or those attached to other personal property.

### **D. Two Interlocked Lighting Systems**

- I. Within the following five functional areas, as defined in §100.1, two lighting systems may be installed provided they are interlocked so that both lighting systems cannot operate simultaneously. All other functional areas are permitted to install only one lighting system.

1. Auditorium

2. Convention center
  3. Conference room
  4. Multipurpose room
  5. Theater
- II. No more than two lighting systems may be used for these five specifically defined functional areas, and if there are two lighting systems, they must be interlocked.
- III. Where there are two interlocked lighting systems, the wattage of the lower system may be excluded from determining the adjusted indoor lighting power if:
1. Before two interlocked lighting systems will be recognized for compliance with the lighting requirements in Part 6 of Title 24, the person who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the construction or installation of features, materials, components, or manufactured devices shall sign and submit the Certificate of Installation.  
  
If any of the requirements in the Certificate of Installation are not met, the two interlocked lighting systems shall not be recognized for compliance with the lighting standards.
  2. The two lighting systems shall be interlocked with a nonprogrammable double-throw switch to prevent simultaneous operation of both systems.
  3. For compliance with the Energy Standards a nonprogrammable double-throw switch is an electrical switch commonly called a "single pole double throw" or "three-way" switch that is wired as a selector switch allowing one of two loads to be enabled. It can be a line voltage switch or a low voltage switch selecting between two relays. It cannot be overridden or changed in any manner that would permit both loads to operate simultaneously.

### **E. Lighting Wattage Not Counted Toward Building Load**

The Energy Standards do not require lighting power of certain types of luminaires in specific functional areas or for specific purposes, to be counted toward a building's installed lighting power.

Any nonresidential indoor lighting function not specifically listed below shall comply with all applicable nonresidential indoor lighting requirements. For example, lighting in guestrooms of hotels is not required to be counted for compliance with §140.6. However, lighting in all other function areas within a hotel are required to comply with all applicable requirements in §140.6. Also, lighting within guestrooms is regulated by the low-rise residential lighting standards.

The wattage of the following indoor lighting applications are not required to be counted toward the adjusted (installed) indoor lighting power:



- In theme parks: lighting for themes and special effects.
- Studio lighting for film or photography provided that these lighting systems are in addition to, and separately switched from a general lighting system.
- Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for religious worship provided that these lighting systems are additions to a general lighting system and are separately controlled by a multi-scene or theatrical cross-fade control station accessible only to authorized operators.

Lighting intended for makeup, hair, and costume preparation in performance arts facility dressing rooms. That lighting must be separately switched from the general lighting system, switched independently at each dressing station, and controlled with a vacancy sensor.

- In civic facilities, transportation facilities, convention centers, and hotel function areas: Lighting for temporary exhibits, if the lighting is an addition to a general lighting system and is separately controlled from a panel accessible only to authorized operators.
- Lighting installed by the manufacturer in walk-in freezers, vending machines, food preparation equipment, and scientific and industrial equipment.
- In medical and clinical buildings: Examination and surgical lights, low-ambient night-lights, and lighting integral to medical equipment, provided that these lighting systems are additions to and separately switched from a general lighting system.
- Lighting for plant growth or maintenance, if it is controlled by a multi-level astronomical time-switch control that complies with the applicable provisions of §110.9.
- Lighting equipment that is for sale.
- Lighting demonstration equipment in lighting education facilities.
- Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.
- Exit way or egress illumination that is normally off and that is subject to the CBC.
- In hotel/motel buildings: Lighting in guestrooms (lighting in hotel/motel guestrooms shall comply with §130.0(b). (Indoor lighting not in guestrooms shall comply with all applicable nonresidential lighting requirements in Part 6.)
- In high-rise residential buildings: Lighting in dwelling units (Lighting in high-rise residential dwelling units shall comply with §130.0(b).) (Indoor lighting not in dwelling units shall comply with all applicable nonresidential lighting requirements in Part 6.)

- Temporary lighting systems. Temporary Lighting is defined in §100.1 as a lighting installation with plug-in connections, which does not persist beyond 60 consecutive days or more than 120 days per year.
- Lighting in occupancy group U buildings less than 1,000 sq. ft.
- Lighting in unconditioned agricultural buildings less than 2,500 sq. ft.
- Lighting systems in qualified historic buildings, as defined in the State Historic Building Code (Title 24, Part 8), are exempt from the Lighting Power allowances if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other lighting systems in qualified historic buildings shall comply with the lighting power allowances.
- Lighting in nonresidential parking garages for seven or fewer vehicles: Lighting in nonresidential parking garages for seven or fewer vehicles shall comply with the applicable residential parking garage provisions of §150.0(k).
- Lighting for signs: Lighting for signs shall comply with §140.8.
- Lighting in refrigerated cases less than 3,000 square feet. (Lighting in refrigerated cases less than 3,000 sq ft. shall comply with Title 20 Appliance Efficiency Regulations).
- Lighting in elevators where the lighting meets the requirements in §120.6(f).

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## **5.7 Prescriptive Compliance Approach for Indoor Lighting – Part 2, Allowed Lighting Power**

Following are the three methods permitted for the prescriptive compliance approach for calculating the allowed lighting power:

1. Complete Building Method
2. Area Category Method
3. Tailored Method

### **5.7.1 Complete Building Method (one of the Prescriptive Compliance Approaches)**

§140.6(c)1
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The Complete Building Method shall only be applied when lighting will be installed throughout the entire building. The building must consist of one type of use for a minimum of 90 percent of the floor area of the entire building.

The allowed indoor lighting power allotment for the entire building shall be calculated as follows:

1. For a conditioned building, multiply the entire conditioned floor area of the building by the applicable lighting power density (LPD, watts per sq. ft.) provided in Table 140.6-B.
2. For an unconditioned building, multiply the entire unconditioned floor area of the building by the applicable LPD provided in Table 140.6-B.

#### 5.7.1.1 Requirements for Using the Complete Building Method

The Complete Building Method shall be used only for building types, as defined in §100.1, that are specifically listed in Table 140.6-B (for example, retail and wholesale stores, hotel/motel, and high-rise residential buildings.)

The Complete Building Method shall be used only on projects involving:

- a. Entire buildings with one type of use occupancy.
- b. Mixed occupancy buildings where one type of use makes up at least 90 percent of the entire building (in which case, when applying the Complete Building Method, it shall be assumed that the primary use is 100 percent of the building).
- c. A tenant space where one type of use makes up at least 90 percent of the entire tenant space (in which case, when applying the Complete Building Method, it shall be assumed that the primary use is 100 percent of the tenant space).

A few more notes as follows:

- Use the Complete Building Method only when the applicant is applying for a lighting permit and submits plans and specifications for the entire building or the entire tenant space.
- Use the Complete Building Method only when the lighting power allotment in Table 140.6-B is available for the entire building. There are no additional lighting power allowances available when using Complete Building Method. Also, there are no mounting height multipliers available when using the Complete Building Method.
- For buildings including a parking garage plus another type of use listed in Table 140.6-B, the parking garage portion of the building and other type of use portion of the building shall each separately use the Complete Building Method.

#### **Example 5-9 Mixed occupancy building – a parking garage building**

##### **Question**

A building is to be constructed with 95 percent of it consisting of a parking garage, and the remaining 5 percent consisting of offices and support spaces such as an electrical room. What is the assumed building type under the complete building method?

##### **Answer**

Since parking garage makes up at least 90 percent of the entire building, the building shall be considered a parking garage when applying the Complete Building Method.

### 5.7.1.2 Definitions of Complete Building Types

When using the Complete Building Method, qualifying building types are those in which a minimum of 90 percent of the building floor area functions as one of the building types listed in Table 140.6-B, (as defined below), and which do not qualify as any other building occupancy type more specifically defined in §100.1, and which do not have a combined total of more than 10 percent of the area functioning as any nonresidential function areas specifically defined in §100.1:

- **Assembly Building** is a building with meeting halls in which people gather for civic, social, or recreational activities. These include civic centers, convention centers and auditoriums.
- **Commercial and Industrial Storage Building** is a building with building floor areas used for storing items
- **Financial Institution Building** is a building with building floor areas used by an institution which collects funds from the public and places them in financial assets, such as deposits, loans, and bonds.
- **Industrial/Manufacturing Facility Building** is a building with building floor areas used for performing a craft, assembly or manufacturing operation.
- **Grocery Store Building** is a building with building floor areas used for the display and sale of food.
- **Gymnasium Building** is a building with building floor areas used for physical exercises and recreational sport events and activities.
- **Library Building** is a building with building floor area used for repository of literary materials, and for reading books, periodicals, newspapers, pamphlets and prints.
- **Office Building** is a building of CBC Group B occupancy with building floor areas in which business, clerical or professional activities are conducted.
- **Parking Garage Building** is a building with building floor areas, parking vehicles, and consists of at least a roof over the parking area enclosed with walls on all sides. The building includes areas for vehicle maneuvering to reach designated parking spaces. If the roof of a parking structure is also used for parking, the portion without an overhead roof is considered an outdoor parking lot instead of a parking garage.
- **Religious Facility Building** is a building with building floor areas used for assembly of people to worship.
- **Restaurant Building** is a building with building floor areas in which food and drink are prepared and served to customers in return for money.
- **Retail Store Building** is a building with building floor area used for the display and sale of merchandise except food.
- **School Building** is a building used by an educational institution. The building floor area can include classrooms or educational laboratories, and may include

an auditorium, gymnasium, kitchen, library, multi-purpose room, cafeteria, student union, or workroom. A maintenance or storage building is not a school building.

- **Sports Arena Building** is a building with building floor areas used for public viewing of sporting events and activities. Sports arena are classified according to the number of spectators they are able to accommodate, as follows:
  - Class I Facility is used for competition play for 5,000 or more spectators.
  - Class II Facility is used for competition play for up to 5,000 spectators.
  - Class III Facility is used for competition play for up to 2,000 spectators.
  - Class IV Facility is normally used for recreational play and there is limited or no provision for spectators.
- **Motion Picture Theater Building** is a building with building floor areas used for showing motion pictures to audiences.
- **Performance Arts Theater Building** is a building with building floor areas used for hosting performing arts such as plays, music or dance to audiences.

#### Example 5-10 Calculating allowed lighting power using the Complete Building Method

##### Question

A 10,000-ft<sup>2</sup> healthcare facility building is to be built. What is the allowed lighting power under the complete building method?

##### Answer

From Table 140.6-B, a healthcare facility building is allowed 0.9 W/ft<sup>2</sup>. The allowed lighting power for the entire building is 10,000 x 0.9 = 9,000 W.

## 5.7.2 Area Category Method (one of the Prescriptive Compliance Approaches)

§140.6(c)2

### 5.7.2.1 Area Category Method General Lighting Power Allotment

The Area Category Method is more flexible than the Complete Building Method because it can be used for multiple tenants or partially completed buildings. Under the Area Category Method, an "area" is defined as all contiguous spaces that accommodate or are associated with a single primary function as listed in Table 140.6-C. For primary function areas not listed, selection of a reasonably equivalent type shall be permitted. When the lighting in these areas is completed later under a new permit, the applicant may show compliance with any of the lighting options except the Complete Building Method.

The Area Category Method divides a building into primary function areas. Each function area is defined under occupancy type in §100.1. The allowed lighting power is determined by multiplying the area of each function times the lighting power density for that function. Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall be included in

any area. The total allowed watts are the summation of the allowed lighting power for each area covered by the permit application.

When using this method, each function area in the building must be included as a separate area. Boundaries between primary function areas may or may not consist of walls or partitions. For example, kitchen and dining areas within a fast food restaurant may or may not be separated by walls. For purposes of compliance, they must still be separated into two different function areas. However, it is not necessary to separate aisles or entries within primary function areas. When the Area Category Method is used to calculate the allowed total lighting power for an entire building however, the main entry lobbies, corridors, restrooms, and support functions shall each be treated as separate function areas.

A. Requirements for using the Area Category Method include all of the following:

1. The Area Category Method shall be used only for primary function areas, as defined in §100.1, that are listed in Table 140.6-C.
2. Primary Function Areas in Table 140.6-C shall not apply to a complete building. Each primary function area shall be determined as a separate area.
3. For purposes of compliance with §140.6(c)2, an "area" shall be defined as all contiguous areas which accommodate or are associated with a single primary function area listed in Table 146.0-C.
4. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a Primary Function Area.
5. If at the time of permitting for a newly constructed building, a tenant is not identified for a multi-tenant area, a maximum of 0.4 watts per sq. ft. shall be allowed for the lighting in each area in which a tenant has not been identified. The area shall be classified as Unleased Tenant Area.
6. Under the Area Category Method, the allowed indoor lighting power for each primary function area is the lighting power density value in Table 140.6-C multiplied by the square footage of the primary function area. The total allowed indoor lighting power for the building is the sum of the allowed indoor lighting power for all areas in the building.

#### **5.7.2.2 Additional Lighting Power - Area Category Method**

In addition to the allowed indoor lighting power calculated according to §140.6(c)2A thru F, the building may add additional lighting power allowances for qualifying lighting systems as specified in the Qualifying Lighting Systems column in Table 140.6-C under the following conditions:

1. Only primary function areas having a lighting system as specified in the Qualifying Lighting Systems column in Table 140.6-C and in accordance with the corresponding footnote of the table shall qualify for the additional lighting power allowances.

2. The additional lighting power allowances shall be used only if the plans clearly identify all applicable task areas and the lighting equipment designed to illuminate these tasks.
3. Tasks that are performed less than two hours per day or poor-quality tasks that can be improved are not eligible for the additional lighting power allowances.
4. The additional lighting power allowances shall not utilize any type of luminaires that are used for general lighting in the building.
5. The additional lighting power allowances shall not be used when using the Complete Building Method, or when the Tailored Method is used for any area in the building.
6. The additional lighting power allowed is the smaller of:
  - i. The lighting power density listed in the “Allowed Additional Lighting LPD” column in Table 140.6-C, times the sq. ft. of the primary function, or
  - ii. the adjusted indoor lighting power of the applicable lighting.
7. In addition to the lighting power allowed under §140.6(c)2G(i through vi), up to 1.0 watts per square foot of additional lighting power shall be allowed in a videoconferencing studio, as defined in §100.1, provided the following conditions are met:
  - i. Before the Additional Videoconference Studio Lighting power allotment will be allowed for compliance with §140.6 of the Energy Standards, the person who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the construction or installation of features, materials, components, or manufactured devices shall sign and submit the Certificate of Installation.

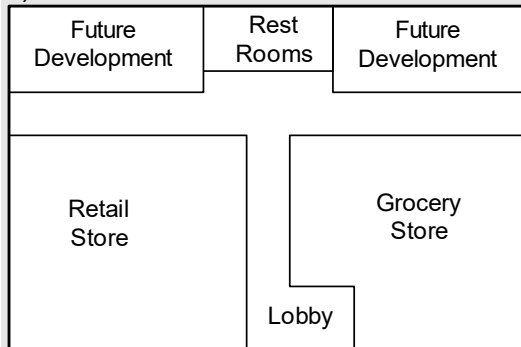
If any of the requirements in this Certificate of Installation are not met, the Additional Videoconference Studio Lighting installation shall not be eligible for the additional lighting power allotment.
  - ii. The Videoconferencing Studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites.
  - iii. General lighting is controlled in accordance with Table 130.1-A.
  - iv. Wall wash lighting is separately switched from the general lighting system.
  - v. All of the lighting in the studio, including general lighting and additional lighting power allowed by §140.6(c)2Gvii is controlled by a multi-scene programmable control system (also known as a scene preset control system).

### Example 5-11 Calculating the allowed lighting power using Area Category Method

#### Question

A 10,000-ft<sup>2</sup> multi-use building is to be built consisting of:

- A) 500 ft<sup>2</sup> main entry lobby,
- B) 1,500 ft<sup>2</sup> corridors,
- C) 3,000 ft<sup>2</sup> grocery store (Grocery Sales),
- D) 2,500 ft<sup>2</sup> retail store (Retail Merchandise Sales), and
- E) 2,000 ft<sup>2</sup> future development.
- F) 500 ft<sup>2</sup> restrooms



What is the allowed lighting power under the area category method?

#### Answer

Most of the functional area types can be identified from Table 140.6-C for their designated lighting power density values.

The future development area is unknown and with no built-out plan at the time of permitting and “All other” (with 0.4 W/ft<sup>2</sup>) is designated as its primary function area type.

Space	LPD	Area	Allowed Lighting Power
A) Main Entry	0.85 W/ft <sup>2</sup>	500 ft <sup>2</sup>	425 W
B) Corridors and Restrooms	0.6 W/ft <sup>2</sup>	1,500 ft <sup>2</sup>	900 W
C) Grocery Store (Grocery Sales)	1.05 W/ft <sup>2</sup>	3,000 ft <sup>2</sup>	3,150 W
D) Retail Store(Merchandise Sales)	1.00 W/ft <sup>2</sup>	2,500 ft <sup>2</sup>	2,500 W
E) Restrooms	0.65 W/ft <sup>2</sup>	500 ft <sup>2</sup>	325 W
F) Future Development (All other)	0.4 W/ft <sup>2</sup>	2,000 ft <sup>2</sup>	800 W
TOTAL		10,000 ft <sup>2</sup>	8,100 watts

### Example 5-12 Calculating allowed lighting power for spaces with display lighting and decorative lighting

#### Question

What if in the multi-use building (example 5-11), the retail store is planning floor displays and wall displays, as well as decorative chandeliers. How do you determine the allowed lighting power for the retail store with display lighting and decorative lighting?

#### Answer

A) As in the above example, determine the total area of the retail store (2,500 ft<sup>2</sup>)

B) As in the above example multiply the allowed LPD (1.0 W/ft<sup>2</sup>) X 2,500 ft<sup>2</sup> = 2,500 W (allowed lighting power)



C) Determine the additional allowed lighting power for display and accent lighting by multiplying the retail store size of 2,500 ft<sup>2</sup> by 0.2 W/ft<sup>2</sup> (Qualifying Lighting Column of Table 140.6-C) = 500 W

D) Determine the additional allowed lighting power for ornamental lighting (for chandeliers) by multiplying the retail store size of 2,500 ft<sup>2</sup> by 0.15 W/ft<sup>2</sup> (Qualifying Lighting Column of Table 140.6-C) = 350 W

E) Add the 2,500 W plus 500 W for display and 350 W for ornamental = 3,375 W

The allowed lighting power for this retail store, under the area category method, is 3,375 W.

Note: The allowed lighting power may be less than the theoretical 3,375 W since the display/accent lighting and ornamental lighting components are “use-it or-lose it”. This means that the lesser of the adjusted additional lighting power for display/ornamental lighting and the calculated additional allowed lighting power (500 W and 375 W) is used. Also, for the added power to be allowed, it must be in addition to general lighting and must use the appropriate luminaires for the task as defined in Table 140.6-C.

### **Example 5-13 Calculating additional lighting power for ornamental lighting**

#### **Question**

What is the allowed lighting power for an ornamental chandelier with five 50 W lamps in a 300 ft<sup>2</sup> bank entry lobby?

#### **Answer**

The allowed lighting power for ornamental lighting is  $0.3 \text{ W/ft}^2 \times 300 \text{ ft}^2 = 90 \text{ W}$  (0.3 W/ft<sup>2</sup> is based on Qualifying Lighting Column of Table 140.6-C.)

The wattage of the chandelier is  $5 \text{ lamps} \times 50 \text{ W} = 250 \text{ W}$ .

If there are no applicable PAF or luminaire power reduction for the chandelier, the total wattage of the chandelier is the adjusted indoor lighting power or 90W.

The allowed lighting power for the chandelier is the smaller of the two values, or 90 W.

### **Example 5-14 Calculating additional lighting power for ornamental LED lighting**

#### **Question**

What is the allowed lighting power for an LED chandelier with five 10 W LED lamps in a 300 ft<sup>2</sup> bank entry lobby?

#### **Answer**

The allowed lighting power for ornamental lighting is  $0.3 \text{ W/ft}^2 \times 300 \text{ ft}^2 = 90 \text{ W}$

The wattage of the chandelier  $5 \text{ lamps} \times 10 \text{ W} = 50 \text{ W}$ .

If there are no applicable PAF or luminaire power reduction for the chandelier, the total wattage of the chandelier is the adjusted indoor lighting power or 50W.

The allowed lighting power for the chandelier is the smaller of the two values, or 50 W.

### **Example 5-15 Tunable-White and Dim-to-Warm Luminaires**

#### **Question**

Which tunable-white and dim-to-warm luminaires qualify for the allowed additional lighting power for applications in healthcare facilities?

#### Answer

There are allowed additional lighting power for tunable-white and dim-to-warm luminaires for most of the healthcare/hospital function areas as specified in Table 140.6-C.

The qualified tunable-white luminaires shall be capable of color change  $\geq 2000\text{K CCT}$ .

The qualified dim-to-warm luminaires shall be capable of color change  $\geq 500\text{K CCT}$ .

A dim-to-warm luminaire product capable of color tune from 2700K to 1800K is acceptable and qualifies for the additional light power.

### 5.7.3 Tailored Method (one of the Prescriptive Compliance Approaches)

§140.6(c)3

#### 5.7.3.1 Tailored Method Application and General Rules

The Tailored Method is a lighting compliance approach which establishes an allowed lighting power budget on a room-by-room or area-by-area basis.

Use of tailored method could be helpful when more general lighting power is required for the listed primary function areas<sup>2</sup> in Table 140.6-D and for the listed area that has a high room cavity ratio (RCR).

In addition to providing a lighting power budget for general illumination, the tailored method provides additional lighting power budgets for illuminating wall displays, floor displays, task lighting, and ornamental/special effects lighting. These additional layers of lighting power have been informally referred to as “use-it-or-lose-it” lighting power allowances because these additional allowances cannot be traded-off to other areas or applications. If a lighting design does not include these additional layers of lighting power, the total lighting power budget using the Tailored Method may be less than if the Area Category Method or Complete Building Method of compliance is used.

1. There shall be no lighting power allotment trade-offs between the separate conditioned and unconditioned indoor function areas. Indoor conditioned and indoor unconditioned lighting power allotments must each be separately determined on compliance documentation
2. There shall be no lighting power allotment trade-offs between the separate indoor and outdoor function areas. Indoor and outdoor lighting power allotments must each be separately determined on compliance documentation.
3. Some areas of a building may use the Tailored Method, while other areas of the same building may use the Area Category Method. However, no single area in a building shall be allowed to use both the Tailored Method and the Area Category Method.

<sup>2</sup> Definitions of the primary function areas can be found in Section 100.1.

4. The Tailored Method shall not be used in any building using the Complete Building method for compliance.

#### **5.7.3.2 Determining Allowed General Lighting Power for Tailored Method**

*§140.6(c)3G thru 3H; Table 140.6-D, F, G*

##### **A. Tailored Method Trade-Off Allowances**

Compliance forms shall be used to document trading-off Tailored Method lighting power allotments. Trade-offs are available only for general lighting, and only under the following circumstances:

1. From one conditioned primary function area using the Tailored Method, to another conditioned primary function area using the Tailored Method.
2. From one conditioned primary function area using the Tailored Method, to another conditioned primary function area using the Area Category Method.
3. From one unconditioned primary function area using the Tailored Method, to another unconditioned primary function area using the Tailored Method.
4. From one unconditioned primary function area using the Tailored Method, to another unconditioned primary function area using the Area Category Method.

##### **B. Determine Lighting Power Allotments for Conditioned and Unconditioned Primary Function Areas**

The allowed Tailored Method Indoor Lighting Power allotment for general lighting shall be separately calculated for conditioned and unconditioned primary functions are as follows:

1. For a conditioned primary function area, multiply the conditioned square feet of that area times the applicable allotment of watts per square feet for the area shown in Table 140.6-D.
2. For an unconditioned primary function area, multiply the unconditioned square feet of that area times the applicable allotment of watts per square feet for the area shown in Table 140.6-D.

An "area" is defined as all contiguous areas which accommodate or are associated with a single primary function area, listed in Table 140.6-D. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a primary function area.

##### **C. Calculating Tailored Method General Lighting Power Allotments**

The Energy Standards define general lighting as installed electric lighting that provides a uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect, exclusive of daylighting. To qualify as general lighting for the Tailored Method, the lighting system shall not use narrow beam direction lamps, wall-washers, valance, direct cove or perimeter linear slot types of lighting systems.

§140.6(c)3H shall be used to determine the general lighting power density allotments as follows:

**1. Using Table 140.6-D and 140.6-G to Determine General Lighting Power Allotments:**

- a. Find the appropriate Primary Function Area in column 1 that fits one of the Nonresidential Function Area definitions in §100.1.
- b. Find the corresponding General Illumination Level (Lux) in column 2.
- c. Determine the room cavity ratio (RCR) for that primary function area, according to the applicable equation in Table 140.6-F. Use the nonresidential certificate of compliance to document the RCR calculation.
- d. Refer to Table 140.6-G, using the General Illumination Level (Lux, determined according to item b), and the RCR (determined according to item c), to determine the allowed lighting power density value.
- e. Multiply the allowed general lighting power density value by the square footage of the primary function area. The product is the allowed general lighting power for general lighting for that primary function area.

**2. How to calculate Room Cavity Ratio (RCR)**

- The room cavity ratio must be determined for any primary function area using the Tailored Lighting Method.
- The lighting level in a room is affected in part by the configuration of the room, expressed as the room cavity ratio (RCR). Rooms with relatively high ceilings typically are more difficult to light and have a high RCR. Because luminaires are not as effective in a room with a high RCR, §140.6 allows a greater LPD to compensate for this effect.
- The RCR is based on the entire space bounded by floor-to-ceiling partitions. If a task area within a larger space is not bounded by floor to ceiling partitions, the RCR of the entire space must be used for the task area. The exception to this rule allows for imaginary or virtual walls when the boundaries are established by “high stack” elements (close to the ceiling structure and high storage shelves) or high partial walls defined as “permanent full height partitions” described in §140.6(c)3liv wall display. These permanent full height partitions are only applicable when claiming additional lighting power for wall display lighting.
  - *Note:* For use in calculating the RCR of the space, the walls are not required to be display walls as is required under §140.6(c)3liv.
  - The RCR is calculated from one of the following formulas:

**Equation 5-3 (Table 140.6-F) Rectangular Shaped Rooms**

$$RCR = \frac{5 \times H \times (L + W)}{A}$$

*Where:*

RCR = The room cavity ratio  
H = The room cavity height, vertical distance measured from the work plane to the center line of the luminaire  
L = The room length using interior dimensions  
W = The room width using interior dimensions  
A = The room area

**Equation 5-4 (Table 140.6-F) Non-Rectangular Shaped Rooms**

$$RCR = \frac{[2.5 \times H \times P]}{A}$$

*Where:*

RCR = The room cavity ratio  
H = The room cavity height (see equation above)  
A = The room area  
P = The room perimeter length

- For rectangular rooms, these two methods yield the same result and the second more general form of calculating RCR may be used in all instances, if desirable.
- It is not necessary to document RCR values for rooms with an RCR less than 2.0. Rooms with a RCR higher than 2.0 are allowed higher LPDs under the Tailored Method. The figure below gives example RCR values calculated for rooms with the task surface at desk height (2.5 ft above the floor). This is useful in assessing whether or not a room is likely to have an RCR greater than 2.0.
- A special situation occurs when illuminating stacks of shelves in libraries, warehouses, and similar spaces. In this situation, the lighting requirements are to illuminate the vertical stack rather than the horizontal floor area. In stack areas the RCR is assumed to be greater than seven. The non-stack areas are treated normally.

**Example 5-15 Calculating Room Cavity Ratio (RCR)**

**Question**

A small retail shop “Personal Shopper” room is 14 ft. wide by 20 ft. long by 8 ft. high. The lighting system uses recessed ceiling fixtures. The task surface is at desk height (2.5 ft. above the floor). What is the room cavity ratio?

**Answer**

The room cavity height is the distance from the ceiling (center line of luminaires) to the task surface (desk height). This is 8 ft. - 2.5 ft. = 5.5 ft.

$$\text{RCR} = 5 \times H \times (L + W) / \text{Area}$$

$$\text{RCR} = 5 \times 5.5 (14+20) / (14 \times 20) = 3.34$$

### 5.7.3.3 Determine Additional Allowed Power for Tailored Method

#### *§140.6(c)3G thru 3J; Table 140.6-D and E*

When using the Tailored Method for lighting compliance, the additional allowed lighting power values and adjustment factor values are listed in Table 140.6-D, E, F, and G, for the special applications below:

- Wall display lighting,
- Floor display lighting and task lighting,
- Ornamental/special effects lighting, and
- Very valuable display case lighting.

These additional layers of lighting power are not available when using §140.6(c)3F to determine the general Lighting Power allotment and are not available for any primary function areas using the Complete Building or Area Category methods of compliance.

All of the additional lighting power allowances are “use-it-or-lose-it” allowances that cannot be traded-off. That is, if the installed watts are less than the allowed watts, the difference in watts is not available to trade off anywhere else in the building.

Use the appropriate compliance form to document the additional lighting power for wall display lighting, floor display lighting and task lighting, ornamental/special effects lighting, and very valuable display case lighting.

#### **A. Additional Wall Display Lighting Power:**

Wall display lighting is defined as supplementary lighting required to highlight features such as merchandise on a shelf, which is displayed on perimeter walls; and that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance.

Additional allowed power for wall display lighting is available only for lighting that illuminates walls having wall displays, and only when there is a watt per linear foot allowance in column 3 of Table 140.6-D for the primary function area.

1. The additional allowed power for wall display lighting shall be the smaller of:
  - i. The wall display lighting power density values (Column 3 of Table 140.6-D) times the wall display length (determined from item #3);
  - ii. The adjusted lighting power used for the wall display luminaires.

Calculate the adjusted lighting power by multiplying the maximum rated wattage of the display luminaires with the appropriate mounting height adjustment factor from Table 140.6-E.

Note that mounting height adjustment factor is available for wall display luminaires mounted at height greater than 10 feet 6 inches from the finished floor. Mounting height is the distance from the finished floor to the bottom of the luminaire.

2. To qualify for the additional wall display lighting power:
  - i. The lighting system shall be a type that is appropriate for creating a higher level of illuminance on the wall display. Lighting systems appropriate for wall display lighting are lighting track adjacent to the wall, wall-washer luminaires, luminaires behind a wall valance or wall cove, or accent light. (Accent luminaires are adjustable or fixed luminaires with PAR, R, MR, AR, or luminaires providing directional display lighting.)
  - ii. The qualifying wall display lighting shall be mounted within 10 feet of the wall having the wall display.
  - iii. The lighting system shall not be a general lighting system type.

**Note:** Lighting internal to display cases that are attached to a wall or directly adjacent to a wall are counted as wall display. All other lighting internal to display cases are counted as floor display lighting, or as very valuable display case lighting.

3. The length of display walls shall include the length of the perimeter walls including but not limited to closable openings and permanent full height interior partitions.

Permanent full height interior partitions are those that meet the following conditions:

- i. Extend from the floor to within two feet of the ceiling or are taller than ten feet; and
  - ii. Are permanently anchored to the floor.
4. The additional wall display lighting power is not available for the following:
  - i. For any function areas using the Complete Building or Area Category methods of compliance.
  - ii. General lighting systems.

Note that floor displays shall not qualify for wall display lighting power allowances.

## **B. Additional Floor Display and Task Lighting Power:**

Floor display lighting is defined as supplementary lighting required to highlight features, such as merchandise on a clothing rack, which is not displayed against a wall; and provides a higher level of illuminance to this specific area than the level of surrounding ambient illuminance.

Task Lighting is defined as lighting that specifically illuminates a location where a task is performed, but not general lighting.

Additional allowed power for floor display lighting and additional allowed power for task lighting may be used only for qualifying floor display lighting systems, qualifying task lighting systems, or a combination of both, for the listed primary function areas in Table 140.6-D.

Lighting internal to display cases that are not attached to a wall and not directly adjacent to a wall, shall be counted as floor display lighting or very valuable display case lighting.

1. The additional allowed power for the floor display and task lighting shall be the smaller of:
  - a. The floor display and task lighting power density values (Column 4 of Table 140.6-D) times the square footage of floor display or task area.
  - b. The adjusted lighting power used for floor display lighting or task lighting.

Calculate the adjusted lighting power by multiplying the maximum rated wattage of the floor display or task luminaires with the appropriate mounting height adjustment factor from Table 140.6-E.

Note that mounting height adjustment factor is available for floor display luminaires mounted at height greater than 10 feet 6 inches from the finished floor. Mounting height is the distance from the finished floor to the bottom of the luminaire.

2. To qualify for additional floor display lighting power:
  - a. The floor display lighting system shall be mounted no closer than 2 feet to a wall. When track lighting is used for floor display lighting, and where portions of that lighting track are more than 2 feet from the wall and other portions are within 2 feet of the wall, only those portions of track more than 2 feet from the wall shall qualify for the floor display lighting power allowance.
  - b. The floor display lighting system consists of only directional lamp types, such as PAR, R, MR, AR; or of luminaires providing directional display light.
  - c. If track lighting is used, only track heads that are classified as directional lighting types.
3. To qualify for additional task lighting power:
  - a. The task lighting system shall be located immediately adjacent to and capable of illuminating the task for which it is installed.
  - b. The lighting system shall be of a type different from the general lighting system.
  - c. The lighting system shall be separately switched from the general lighting system



4. To qualify for the additional power for floor display and task lighting, the lighting system shall be a type that is appropriate for creating a higher level of illuminance on the floor display or task.
5. The additional power for floor display and task lighting are not available for the following:
  - a. For any function areas using the Complete Building or Area Category methods of compliance.
  - b. Displays that are installed against a wall shall not qualify for the floor display lighting power allowances.
  - c. Any floor area designed to not have floor displays or tasks, such as floor areas designated as a path of egress, shall not be included for the floor display allowance.
6. For floor areas qualifying for both floor display and task lighting power allowances, the additional allowed power shall be used only once for the same floor area so that the allowance shall not be additive.

**C. Additional Ornamental/Special Effects Lighting Power:**

Special effects lighting is defined as lighting installed to give off luminance instead of providing illuminance.

Qualifying ornamental lighting to include luminaires such as chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights, and light color panels when any of those lights are used in a decorative manner that does not serve as display lighting or general lighting.

Additional allowed power for ornamental/special effects lighting may be used only for the listed primary function areas in Table 140.6-D.

1. The additional allowed power for ornamental/special effects lighting shall be the smaller of:
  - a. The allowed ornamental/special effects lighting power values (Column 5 of Table 140.6-D) times the square footage of the floor areas having ornamental/special effects lighting;
  - b. The adjusted lighting power used for ornamental/special effects lighting.
2. Additional ornamental and special effects lighting power is not available for any function area using the Complete Building or Area Category methods of compliance.
3. Additional ornamental/special effects lighting power shall be used only in areas having ornamental/special effects lighting.

Any floor area not designed to have ornamental or special effects lighting shall not be included for the ornamental/special effects lighting allowance.

#### **D. Additional Very Valuable Display Case Lighting Power:**

Case lighting is defined as lighting of small art objects, artifacts, or valuable collections which involves customer inspection of very fine detail from outside of a glass enclosed display case.

Additional allowed lighting power for very valuable display case lighting shall be available only for display cases in retail merchandise sales, museum, and religious worship areas.

1. The additional allowed power for very valuable display case lighting shall be the smallest of:
  - a. The product of the area of the primary function and 0.55 watt per sq. ft.; or
  - b. The product of the area of the display case and 8 watts per sq. ft.; or
  - c. The adjusted lighting power used for very valuable display case lighting.
2. To qualify for additional allowed power for very valuable display case lighting, a case shall contain jewelry, coins, fine china, fine crystal, precious stones, silver, small art objects and artifacts, and/or valuable collections the display of which involves customer inspection of very fine detail from outside of a locked case.
3. The additional very valuable display case lighting is not available for any function areas using the complete building or area Category methods of compliance.
4. Qualifying lighting includes internal display case lighting or external lighting employing highly directional luminaires specifically designed to illuminate the case or inspection area without spill light and shall not be fluorescent lighting unless installed inside of a display case.

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#### **Example 5-17 Ornamental lighting and very valuable display lighting - Tailored Method (Five parts) (Part 1)**

##### **Question**

A 5,500-ft<sup>2</sup> retail store has:

- 5,000 ft<sup>2</sup> of gross retail sales area (merchandise sales) with a RCR of 2.5
- 200 ft<sup>2</sup> of restrooms (with a RCR of 6.0)
- 300 ft<sup>2</sup> of corridors (with a RCR of 6.5)
- 100 ft<sup>2</sup> of very valuable merchandise case top with 1,200 W of light sources

As part of the retail scheme in the sales floor area, the following lighting is being used.

- Wall display lighting of 300 linear feet of perimeter wall including closeable openings;
- Floor display lighting;
- Ornamental/special effects lighting.

What are the allowed lighting power for general lighting in this store using the Tailored Method?

### Answer

The general illumination for merchandise sales and showroom area in retail is 500 Lux per column 3 of Table 140.6-D.

Per Table 140.6-G, the Lighting Power Density (LPD) is 1.05 W/ft<sup>2</sup> for a 500 Lux space with an RCR of 2.5. Therefore, the allowed general lighting power for the retail store is 1.05 W/ft<sup>2</sup> X 5,000 ft<sup>2</sup> = **5,250 W**.

Corridors and restrooms are not included in the Tailored Method tables and therefore must comply under the area category method. Look up Table 140.6-C for the allowed LPD for these spaces. Table 140.6-C contains LPD values for primary functional areas and it allows 0.6 W/ft<sup>2</sup> of LPD for corridors and 0.65 W/ft<sup>2</sup> for restrooms. *(RCR is irrelevant in looking up LPD values in Table 140.6-C. This is different from how to look up values from Table 140.6-G)*

The allowed power for the restrooms is 200 ft<sup>2</sup> x 0.65 W/ft<sup>2</sup> = **130 W**.

The allowed power for the corridors is 300 ft<sup>2</sup> x 0.6 W/ft<sup>2</sup> = **180 W**.

Note that in the Tailored Method, the allowed wattage for each lighting task other than general lighting is of the use-it-or-lose-it variety, which prohibits trade-offs among these wattages and different tasks or areas. Only the General Lighting component of the Tailored Method is tradable between areas using tailored compliance or areas using Area compliance.

### Example 5-18 Wall display lighting – Tailored method (Continue – Part 2)

#### Question

If the adjusted lighting power of the floor display luminaires is 3,000 watts, what is the allowed wall display lighting power for the retail sales area in this store?

#### Answer

The wall display lighting is computed from the entire wall perimeter, including all closeable openings, times the wall display power allowance. Therefore, the wall display lighting is 300 ft. x 11.8 W/ft. = **3,540 W**. The allowed lighting power density value of 11.8 W/ft. is taken from column 3 of Table 140.6-D.

Note that in the Tailored Method, it is a use-it-or-lose-it allowance.

The additional allowed power for wall display lighting is the smaller of:

- The wall display lighting power of 3,540W, as calculated from above;
- The adjusted lighting power used for the wall display lighting, 3,000W.

Since the smaller of 3,540W and 3,000W is 3,000W, the additional allowed power for wall display lighting is 3,000W for the retail sales area in this store.

### Example 5-19 Floor display lighting – Tailored method (Continue – Part 3)

#### Question

If the adjusted lighting power of the floor display luminaires is 4,000 watts, what is the allowed floor display lighting power for this store?

#### Answer

The floor display allowance is computed from the area of the entire space with floor displays multiplied by the floor display lighting power density. Therefore, the allowed wattage is 5,000 ft<sup>2</sup> x 0.8 W/ft<sup>2</sup> = **4,000 W**. The allowance is taken from column 4 of Table 140.6-D.

Note that in the Tailored Method, it is a use-it-or-lose-it allowance.

The additional allowed power for floor display lighting is the smaller of:

- the floor display lighting power of 4,000W, as calculated from above;

- the adjusted lighting power used for the floor display lighting, 4,000W.

Since the smaller of 4,000W and 4,000W is 4,000W, the additional allowed power for floor display lighting is 4,000W for the retail sales area in this store.

#### **Example 5-20 Ornamental/special effect lighting – Tailored method (Continue – Part 4)**

##### **Question**

If the adjusted lighting power of the ornamental/special effect luminaires is 4,000 watts, what is the allowed ornamental/special effect lighting power for this store?

##### **Answer**

The ornamental/special effect allowance is computed from the area of the entire space with floor displays times the ornamental/special effect lighting power density. Therefore, the allowed wattage is  $5,000 \text{ ft}^2 \times 0.4 \text{ W/ft}^2 = \mathbf{2,000 \text{ W}}$ . The allowance is taken from column 5 of Table 140.6-D.

Note that in the Tailored Method, it is a use-it-or-lose-it allowance.

The additional allowed power for ornamental/special effect lighting is the smaller of:

- The ornamental/special effect lighting power of 2,000W, as calculated from above;
- The adjusted lighting power used for the ornamental/special effect lighting, 4,000W.

As the smaller of 2,000W and 4,000W is 2,000W, the additional allowed power for ornamental/special effect lighting is 2,000W for the retail sales area in this store.

The ornamental/special effect luminaires have to be re-selected for a lesser adjusted wattage so that it is no more than 2,000W.

#### **Example 5-21 Very valuable display lighting – Tailored method (Continue – Part 5 of 5)**

##### **Question**

What are the allowed very valuable display lighting power for this store?

##### **Answer**

The allowed wattage for very valuable display case top is smaller of the product of  $0.55 \text{ W/ft}^2$  and the gross sales area ( $5,000 \text{ ft}^2$ ) or the product of  $14 \text{ W/ft}^2$  and the actual area of the case tops ( $100 \text{ ft}^2$ ). The allowed lighting power is the smaller of  $0.55 \text{ W/ft}^2 \times 5,000 \text{ ft}^2 = 2,750 \text{ watts}$ , or  $8 \text{ W/ft}^2 \times 100 \text{ ft}^2 = 1,200 \text{ watts}$ . Therefore, the maximum allowed power is **1,200 W**.

Because the floor display and very valuable display allowances are use-it-or-lose-it allowances, the maximum power allowed is the smallest of primary function area lighting power (2,750 W) and very valuable display case lighting power (800 W) or the adjusted lighting power for very valuable display case lighting (1,200 W). Therefore, the allowed watts for very valuable display lighting is 800 W.

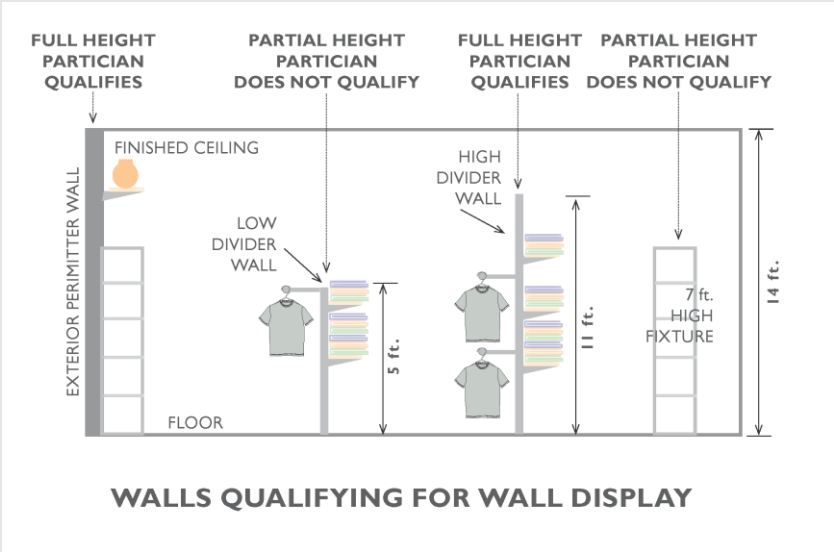
#### **Example 5-22 Retail space – determination on partitions**

##### **Question**

A large retail store with a sales area that has a 14-foot high ceiling and full height perimeter wall also has several other walls and a high fixture element in the space. Based on the definition of “full-height” partitions (per §140.6(c)3iv), which components qualify for the wall display allocation?

Answer

The sketch below shows full height partitions and non-full height partitions.

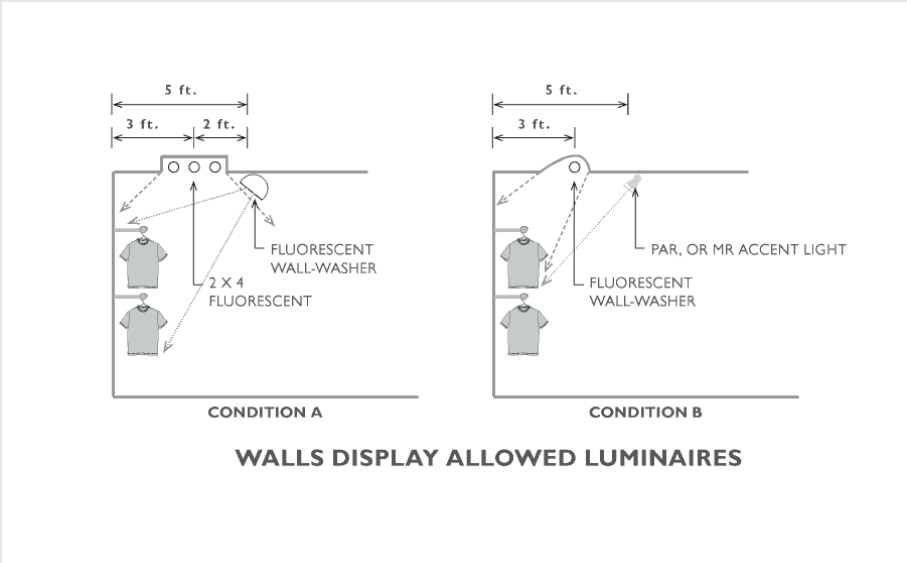


Example 5-23 Wall display lighting in a retail store– Tailored Method

Question

In this question, Condition A has 2 x 4 troffers placed 3 feet from a perimeter sales wall as well as fluorescent wall-washers 5 feet from the sales wall. Condition B has fluorescent wall-washers 3 feet from the wall and PAR adjustable accent lights 5 feet from the wall. Which luminaires qualify for the wall display lighting allocation?

Answers



Per §140.6(c)3liia, qualifying lighting must be mounted within 10 feet of the wall and must be an appropriate wall lighting luminaires. (Luminaires with asymmetric distribution toward the wall or adjustable directed toward the wall).

#### CONDITION A

While both luminaires are within 10 feet of the wall only the wall-washer qualifies for the wall display allocation. The 2 x 4 troffer is a general lighting luminaire with symmetric distribution and does not qualify for the allocation.

#### CONDITION B

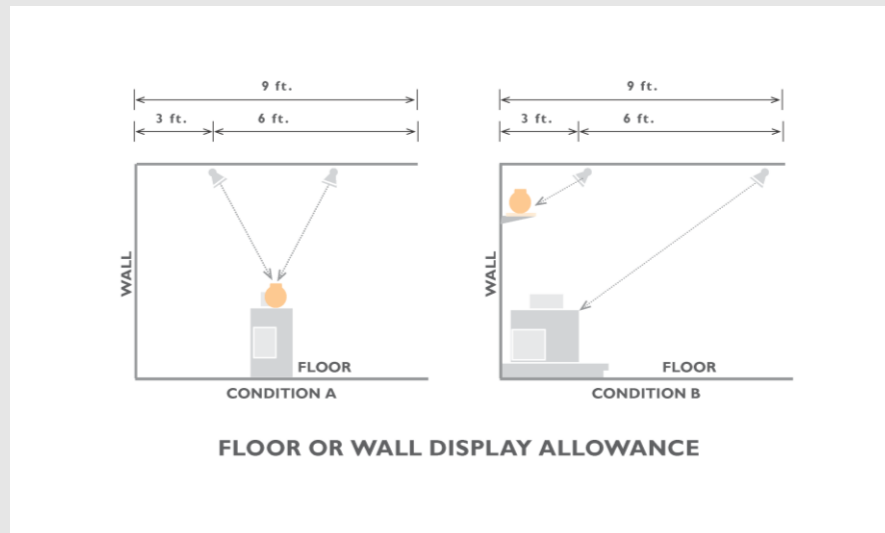
Both luminaires are within 10 feet of the wall and both qualify for the wall display allocation. The fluorescent wall-washer has an asymmetric distribution and the PAR accent light at 5 feet from the wall provides directional light.

### Example 5-24 Display lighting in a museum – Tailored Method

#### Question

A museum space has directional accent lighting luminaires on a track mounted to the ceiling. The first track is 3 feet from the perimeter wall of the exhibit space and the second track is 9 feet from the wall. There is a third track (not shown) that is 15 feet into the space. To what display category should these luminaires be assigned under §140.6(c) 3I and 3J

#### Answers



Per §140.6(c)3G & 3H, wall display luminaires must be within 10 feet of the wall and directional, and floor display luminaires must be at least two feet away from the wall and also directional. Using these criteria, the allocations for the two conditions shown are as follows:

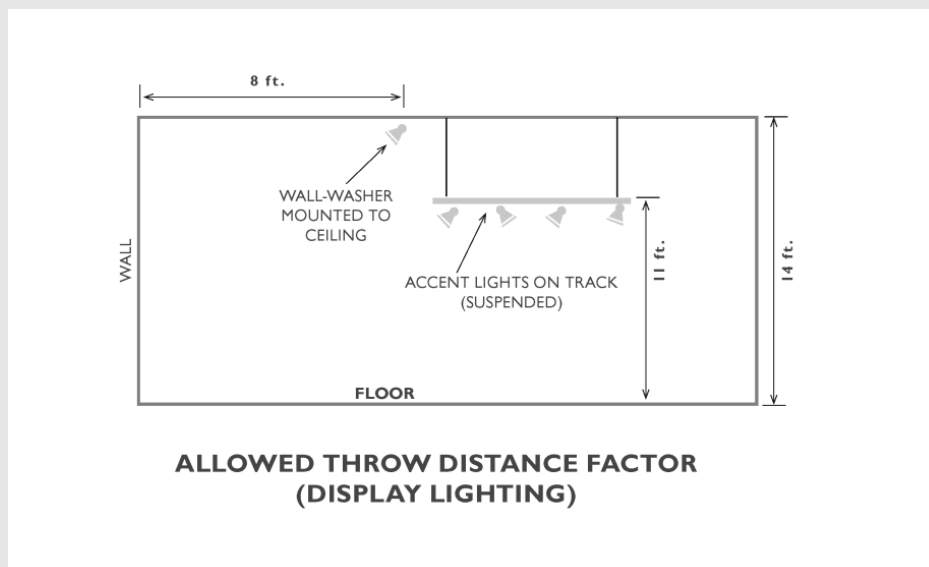
#### CONDITION A

Both sets of luminaires (3 feet and 9 feet away from the wall) shown are at least 2 feet away from the wall and are directed onto a floor exhibit (display) therefore they both qualify for the floor display allocation. The third track (15 feet away from the wall) with directional luminaires also can qualify as floor display.

#### CONDITION B

Both sets of luminaires shown are closer than 10 feet to the wall and are directed onto a wall exhibit (display) therefore they both, when directed toward the wall qualify for the wall display allocation. The third track with directional luminaire (15 feet from the wall) does not qualify for wall display, only floor display.

**Note:** Luminaires within a 2 foot to 10-foot zone may be assigned to either wall or floor display depending on the focus direction of the luminaires. However only one classification – either wall or floor – can be used for luminaire compliance, not both.

**Example 5-25 Lighting Power Adjustments for luminaire mounting height – Tailored Method****Question**

A high ceiling space with allowed display lighting has wall-washers mounted on the ceiling near the wall and accent lights mounted on suspended track in the center of the space. Because of the 14-foot high ceiling, does the display lighting qualify for a mounting height factor adjustment?

**Answer**

Per §140.6(c) 3Giv and 3Hviii, both the wall-washers and accent lights qualify for the mounting height adjustment as they are mounted at height greater than 10 feet 6 inches and they also provide directional light.

If the track is suspended at 10 feet instead of 11 feet, it is excluded from an adjustment factor and must use the default factor of one with the allowed LPD as shown in column four in Table 140.6-E.

## 5.8 Performance Compliance Approaches

The performance approach is an alternative to the prescriptive approach. The allowed lighting power is calculated as part of the energy budget for the proposed design building. A building complies with the performance approach if the energy budget calculated for the proposed design building is no greater than the energy budget calculated for the standard design building.

Under the performance approach, the energy use of the building is modeled using a compliance software program approved by the Energy Commission. In this energy analysis, the standard lighting power density for the building is determined by the compliance software program based on occupancy type, in accordance with either the complete building, area category, or tailored method described above. This standard lighting power density is used to determine the energy budget for the building.

When a lighting permit is sought under the performance approach, the applicant uses a proposed lighting power density to determine whether or not the building meets the energy budget. If it does, this proposed lighting power density is

automatically translated into the allowed lighting power for the building (by multiplying by the area of the building).

If the building envelope or mechanical systems are included in the performance analysis (because they are part of the current permit application), then the performance approach allows energy trade-offs between systems that can let the allowed lighting power go higher than any other method. Alternatively, it allows lighting power to be traded away to other systems, which would result in a lower allowed lighting power. This flexibility in establishing allowed lighting power is one of the more attractive benefits of the performance approach.

General lighting power is the power used by installed electric lighting that provides a uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect, exclusive of daylighting, and also known as ambient lighting.

Trade-offs in general lighting power are allowed between all spaces using the Area Category Method, between all spaces using the Tailored Method, and between all spaces using the Area Category and Tailored Methods.

Also, with the Area Category Method and the Tailored Method, the Energy Standards provide an additional lighting power allowance for special cases. Each of these lighting system cases are treated separately as “use-it-or-lose-it” lighting. The user receives no credit (standard design matches proposed), but there is a maximum power allowance for each item).

See the 2019 Nonresidential ACM Reference Manual for additional information.

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## **5.9 Lighting Control Installation and Acceptance Requirements – for Installers and Acceptance Test Technicians**

With the onset of the construction phase of projects, two types of documentation have to be prepared for showing compliance to the Energy Standards - certificate of installation and certificate of acceptance (for acceptance tests).

The following sections layout their scope and the related parts of the Nonresidential Appendix which contains the acceptance test procedures. Refers to Section 5.11 for a list of the certificate mentioned.

### **5.9.1 Lighting Installation Certificate Requirements (§130.4(b))**

The person who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the installation or construction of features, materials, components, or manufactured devices shall sign and submit the Certificate of Installation for installation of the following items, before any of the following applications will be recognized for compliance with the lighting requirements,

1. Lighting Control System.
2. Energy Management Control System.
3. Interlocked lighting systems service a single space.



4. Lighting controls installed to earn a lighting Power Adjustment Factor (PAF).
5. Additional lighting wattage available for a videoconference studio.

If any of the requirements in the Certificate of Installation are not met, that application shall not be recognized for compliance with the Energy Standards.

### **5.9.2 Lighting Control Acceptance Requirements (§130.4(a))**

Acceptance testing must be performed by a certified lighting controls acceptance test technician to certify the indoor and outdoor lighting controls serving the building, area, or site will meet the acceptance requirements.

A Certificate of Acceptance shall be submitted to the enforcement agency under §10-103(a) of Part 1 and §130.4(a), that:

1. Certifies that all of the lighting acceptance testing necessary to meet the requirements of Part 6 is completed.
2. Certifies that the applicable procedures in Reference Nonresidential Appendix NA7.6 and NA7.8 have been followed.
3. Certifies that automatic daylight controls comply with §130.1(d) and Reference Nonresidential Appendix NA7.6.1.
4. Certifies that lighting shut-OFF controls comply with §130.1(c) and Reference Nonresidential Appendix NA7.6.2.
5. Certifies that demand responsive controls comply with §130.1(e) and Reference Nonresidential Appendix NA7.6.3.
6. Certifies that outdoor lighting controls comply with the applicable requirements of §130.2(c) and Reference Nonresidential Appendix NA7.8.
7. Certifies that lighting systems receiving the institutional tuning power adjustment factor comply with §140.6(a)2J and Reference Nonresidential Appendix NA7.7.6.2.

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## **5.10 Additions and Alterations**

### **5.10.1 Overview**

New additions, similar to newly constructed buildings, must meet all mandatory measures for both the prescriptive and performance method of compliance.

Prescriptive requirements, including the lighting power densities, must be met if the prescriptive method of compliance is used. If the performance approach is used and the new addition includes envelope or mechanical systems in the performance analysis, the lighting power densities may be traded-off against other system energy budgets.

Any space with a lighting system installed for the first time must meet the same lighting requirements as a newly constructed building.

Entire luminaire alterations include removing and reinstalling more than 10 percent of the existing luminaires, replacing or removing and adding luminaires, and redesign of the lighting system that includes adding, removing, or replacing walls or ceilings.

Luminaire component modifications include replacing the ballasts or drivers and the associated lamps, permanently changing the light source, and changing the optical system such as reflectors.

Lighting Wiring alterations include wiring alterations that add a circuit feeding luminaires; that relocate, modify, or replace wiring between a switch or panel board and luminaires; or that replace lighting control panels, panel boards or branch circuit wiring.

### 5.10.2 Additions

#### §141.0(a)

The nonresidential indoor lighting of the addition shall meet either the prescriptive approach or the performance approach.

When using the prescriptive approach, the indoor lighting in the addition must meet the lighting requirements of §110.0; §110.9, §130.0 through §130.5, §140.3, and §140.6.

When using the performance approach, the indoor lighting in the addition must meet the lighting requirements of §110.0; §110.9; §130.0 through §130.5; and one of the following two options of the performance requirements:

1. The addition alone with §140.1; or
2. The existing building plus the addition plus the alteration.

### 5.10.3 Alterations – General Information

#### §141.0(b)

#### 5.10.3.1 Scope

Alterations to existing nonresidential, high-rise residential, hotel/motel, or re-locatable public-school buildings; or alterations in conjunction with a change in building occupancy to a nonresidential, high-rise residential, or hotel/motel occupancy; shall meet the following requirements:

- i. Comply with the requirements for additions, or
- ii. Comply with the Prescriptive lighting requirements, or
- iii. Comply with the Performance approach.

An alteration is defined by the Energy Standards as follows:

- i. Any change to a building's water-heating system, space-conditioning system, lighting system, electrical power distribution system, or envelope that is not an addition; and

- ii. Any regulated change to an outdoor lighting system that is not an addition; and
- iii. Any regulated change to signs located either indoors or outdoors; and
- iv. Any regulated change to a covered process that is not an addition.

An altered component is defined by the Energy Standards as a component that has undergone an alteration and is subject to all applicable requirements.

#### 5.10.3.2 Indoor Lighting Exceptions

The following indoor lighting alterations are not required to comply with the lighting requirements in the Energy Standards:

1. Alterations where less than 10 percent of existing luminaires are being altered.
2. Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded by §140.6(a)3.
3. In an enclosed space where there is only one luminaire.
4. Disturbance of asbestos directly caused by any alterations, unless the alterations are made in conjunction with asbestos abatement.
5. One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.
6. Alteration limited to addition of lighting controls or replacing lamps, ballasts, or drivers

#### 5.10.3.3 Skylight Exception

When the daylighting control requirements of §130.1(d) are triggered by the addition of skylights to an existing building and the lighting system is not re-circuited, the daylighting control need not meet the multi-level requirements in §130.1(d). Daylit areas must be controlled separately from non-daylit areas. An automatic control must be able to reduce lighting power by at least 65 percent when the daylit area is fully illuminated by daylight.

#### 5.10.3.4 Alterations – Performance Approach

When using the Performance Approach (using a software program certified to the Energy Commission) the altered envelope, space-conditioning system, lighting and water heating components, and any newly installed equipment serving the alteration, shall meet the applicable requirements of §110.0 through §110.9, §120.0 through §120.6, and §120.9 through §130.5.

#### 5.10.3.5 Alterations – Prescriptive Approach

When using the Prescriptive Approach, the altered lighting shall meet the applicable requirements of §110.0, §110.9, and §130.0 through §130.4.

### 5.10.4 Lighting Alterations

§141.0(b)2I, §141.0(b)2J
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The 2019 edition of Title 24, Part 6 restructured the lighting alterations language to improve clarity. The three previous types of lighting alterations (entire luminaire, luminaire component, and wiring) have been unified into a single section (Section 141.0(b)2I), and the three compliance options have been clearly stated.

Alterations to the lighting systems must comply with the requirements in Section 141.0(b)2I when 10 percent or more of the luminaires serving an enclosed space are altered.

The Energy Standards compliance goals for the lighting alterations are twofold. First, the installation must meet the lighting power level specified in the Energy Standards, and second, the installation must provide the lighting controls functionality specified in the Energy Standards.

The 2019 Energy Standards allow the same three options for meeting the installed power and associated control requirements as the 2016 standards, and specify a set of requirements for lighting power allowance and controls for each of the following cases:

1. The altered lighting power that does not exceed Table 140.6-C,
2. The altered lighting power that is equal to or less than 80 percent of Table 140.6-C, or
3. Where the alteration is within a building or tenant space of 5,000 sq. ft. or less, and the total rated power of the existing luminaires in the occupancy, have 40 percent lower power than the pre-alteration total luminaire rate power.

Altered lighting systems must meet one of the three requirements above. Option 3 allows the maximum installed lighting power to be determined by totaling and taking a percentage of the currently installed lighting power, rather than by measuring the square footage of the space and multiplying it by a lighting power allowance.

Options 2 and 3 are likely to result in a lower lighting power than option 1, and therefore multi-level lighting controls (Section 130.1(b)), daylighting controls (Section 130.1(d)), and demand responsive controls (Section 130.1(e)) are not required for these options. The control requirements for each option are described in Table 5-4.

Alterations to indoor lighting systems should be such that they do not prevent the operation of existing, unaltered controls, and do not alter controls to remove functions specified in Section 130.1. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display, or ornamental lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Section 130.1(a)4 and 130.1(c)1D.

**Table 5-2 (Modified Table 141.0-F): Control Requirement for Indoor Lighting Alterations**

<u>Control Specifications</u>	<u>Control Specifications</u>	<u>Projects complying with Section 141.0(b)2Ii</u>	<u>Projects complying with Sections 141.0(b)2Iii and 141.0(b)2Iiii</u>

<b><u>Manual Area Controls</u></b>	<u>130.1(a)1</u>	<u>Required</u>	<u>Required</u>
<b><u>Manual Area Controls</u></b>	<u>130.1(a)2</u>	<u>Required</u>	<u>Required</u>
<b><u>Manual Area Controls</u></b>	<u>130.1(a)3</u>	<u>Only required for new or completely replaced circuits</u>	<u>Only required for new or completely replaced circuits</u>
<b><u>Multi-Level Controls</u></b>	<u>130.1(b)</u>	<u>Required</u>	<u>Not Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)1</u>	<u>Required; 130.1(c)1D only required for new or completely replaced circuits</u>	<u>Required; 130.1(c)1D only required for new or completely replaced circuits</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)2</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)3</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)4</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)5</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)6</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)7</u>	<u>Required</u>	<u>Required</u>
<b><u>Automatic Shut Off Controls</u></b>	<u>130.1(c)8</u>	<u>Required</u>	<u>Required</u>
<b><u>Daylighting Controls</u></b>	<u>130.1(d)</u>	<u>Required</u>	<u>Not Required</u>

<u>Demand Responsive Controls</u>	<u>130.1(e)</u>	<u>Required</u>	<u>Not Required</u>
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The following lighting alterations are not required to comply with §141.0(b)2I:

1. Alterations where less than 10 percent of existing luminaires are altered (such as removed and reinstalled, or modified).
2. Alterations of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded by §140.6(a)3.
3. Alterations in an enclosed space with only one luminaire.
4. Alterations that would directly cause the disturbance of asbestos, unless the alterations are made in conjunction with asbestos abatement.
5. One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.
6. Lamp replacements alone, ballast or driver replacements alone, and addition of lighting controls are exempted. Such alterations shall not be considered a modification of the luminaire provided that the replacement lamps, ballasts, drivers, or controls are installed and powered without modifying the luminaire.

The acceptance testing requirement of §130.4 is not required for alterations where lighting controls are added to control 20 or fewer luminaires.

#### **Example 5-26 Tenant Space Lighting Alterations**

All 100 light fixtures are being removed and replaced in an enclosed room of a commercial tenant space of less than 5,000 sq. ft. A total of 40 new light fixtures will be installed in the altered-lighting room. Which Energy Standards requirements must the project comply with?

#### **Answer**

Since all existing luminaires (fixtures) within the enclosed area (room) are being replaced with 40 new ones, the project must comply with one of the two requirements of i, or ii of §141.0(b)2I. Since this is not a one-for-one alteration, section iii of §141.0(b)2I is not available as an option for compliance.

#### **Example 5-27 Warehouse Luminaire Alteration With 40 Percent Lighting Power Reduction**

#### **Question**

All existing luminaires in a warehouse facility of 5,000 sq. ft. are proposed to be replaced by LED luminaires (shown below). There are 100 existing metal halide luminaires and each uses 250 watts, all of which will be replaced. The replacement LED luminaires use 150 watts each. How is compliance being determined, and what controls are required?



A lamp taken from an existing luminaire  
Source: EcologyAction



Label of an existing luminaire  
Source: EcologyAction



Picture of one of the new LED luminaire  
Source: EcologyAction

### Answer

The compliance option of §141.0(b)2liii requires a 40 percent reduction in installed lighting power for one-to-one luminaire alterations within a building or tenant space of 5,000 square feet or less. Thus, enter the number and wattage of the existing luminaires into NRCC-LTI, and use the form to calculate both the existing installed lighting power ( $100 \times 250 = 25,000$ ) and the maximum allowance based on a 40 percent reduction ( $25,000 \times 0.6 = 15,000$ ). Enter the number and wattage of the new luminaires into NRCC-LTI, just like any other project. This is a one-for-one replacement, so the total lighting power of the new luminaires would be at the allowance ( $100 \times 150 = 15,000$ ).

Since the alteration meets §141.0(b)2liii, only manual area controls and automatic shutoff controls are mandatory as specified in Table 141.0-F (Table 5-2 in this manual).

### Example 5-28 Lighting Wiring Projects

#### Question

If the lighting system is being rewired as part of a lighting alteration project, which Energy Standards requirements must be complied with?

#### Answer

Alterations to lighting wiring are considered alterations to the lighting system, so the requirements are the same as for the lighting system alterations.

Altered lighting circuits must comply with the control requirements as specified in §130.1(a)3 and 130.1(c)1D.

The acceptance testing requirements are triggered if controls are added to control more than 20 luminaires.

**Example 5-29 Alterations Projects Replacing Both Lamps and Ballasts of the Luminaires****Question**

There are 100 lighting fixtures in an existing office space. For 20 fixtures, the internal components (lamps and ballasts) are being replaced with new kits.

Which Energy Standards requirements apply?

**Answer**

Because 20 out of 100 (or 20 percent) of the luminaires are altered which is more than the 10 percent threshold to trigger that the alteration meet either §141.0(b)2li or §141.0(b)2lii requirements. Moreover, removing and replacing both lamps and ballasts with retrofit kits are considered one-for-one luminaire alterations. Therefore, the alteration could meet §141.0(b)2liii instead of §141.0(b)2li or §141.0(b)2lii if the total wattage of the altered luminaires has been reduced by at least 40 percent and if the altered building or tenant space is 5,000 square feet or less.

**Example 5-30 One-for-One Alterations in Enclosed Spaces With One Luminaire****Question**

A project includes more than 50 luminaires with one-for-one alterations on a floor, but a portion of those altered luminaires are in enclosed spaces containing one luminaire.

How are the luminaires in the enclosed spaces counted toward the trigger threshold of 50 luminaires under §141.0(b)2l in a one-for-one luminaire alteration)?

**Answer**

Although Exception 2 to §141.0(b)2l exempts enclosed spaces with one luminaire from the requirements of Section 141.0(b)2l, it does not reduce the total luminaire count on a floor or a tenant space. Therefore, the altered luminaires on the floor that are not in the one-luminaire spaces are required to meet the requirements of either §141.0(b)2li, §141.0(b)2lii, or §141.0(b)2liii.

**Example 5-31 Lamp replacements as part of a project****Question**

A single-story retail store has 50 T12 linear fluorescent strip luminaires and two sections of track lighting. One of the tracks has 10 screw-in incandescent flood lights and the other track has 10 pin-based halogen PAR lamps. The linear luminaires are being retrofitted with T8 lamps and premium ballasts. In the track luminaires the screw-in and pin-based incandescent lamps are being replaced with equivalent screw-in and pin-based LED lamps. There are no other alterations done to the lighting system of that tenant space in the calendar year.

What are the Energy Standards requirements for this job?

**Answer**

There is a total of 70 luminaires ( $50+10+10 = 70$  luminaires).

The Energy Standards are not triggered for this project because fewer than 50 fixtures are being modified.



Out of the 70 fixtures included in the project, the 20 incandescent fixtures have lamp replacement and they do not count toward the trigger threshold of 50 luminaires under §141.0(b)2I (one-for-one luminaire alteration). Only 50 luminaires are being altered in this job.

**Example 5-32 Standards for Lighting Wiring Alterations****Question**

If occupancy sensing controls are added to a suite of office spaces, does this addition trigger the requirements of §141.0(b)2I (Indoor Lighting Alterations)?

**Answer**

No, since the alterations are limited to the addition of occupancy sensing controls, it does not trigger any of the requirements of §141.0(b)2I.

**Example 5-33 Skylights****Question**

A 30,000 ft<sup>2</sup> addition has a 16,000 ft<sup>2</sup> space with an 18 ft. high ceiling and a separate 14,000 ft<sup>2</sup> space with a 13 ft high ceiling. The lighting power density in this building is 1 W/ft<sup>2</sup>. Do skylights have to be installed in the portion of the building with 18-foot ceiling?

**Answer**

Yes. §140.3(c) requires skylights in enclosed spaces that are greater than 5,000 ft<sup>2</sup> directly under a roof with a ceiling height over 15 feet. In this example the area with a ceiling height greater than 15 feet is 16,000 ft<sup>2</sup>; therefore, there are mandatory skylight requirements. (Note: skylight requirements do not apply in climate zones 1 and 16).

**Example 5-34 Skylighting requirements for alterations****Question**

A pre-existing air-conditioned 30,000 ft<sup>2</sup> warehouse with a 30 ft. ceiling and no skylights will have its general lighting system replaced as part of a conversion to a big box retail store. Are skylights prescriptively required?

**Answer**

No. The general lighting system is being replaced and is not “installed for the first time.” Thus, §141.0(b)2F does not apply and therefore does not trigger the requirements in §140.3(c) for sky lighting.

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## 5.11 Indoor Lighting Compliance Documents

### 5.11.1 Overview

This subchapter describes the documentation (compliance forms) required for compliance with the nonresidential indoor lighting requirements of the Energy Standards.

### 5.11.2 Submitting Compliance Documentation

At the time a building permit application is submitted to the enforcement agency, the applicant also submits building plans and energy compliance documentation. This section describes the recommended compliance documentation (forms) for

complying with the nonresidential indoor lighting Energy Standards. It does not describe the details of the requirements.

This section is addressed to the person preparing building plans and compliance documents, and to the enforcement agency plan checkers who are examining those documents for compliance.

### **5.11.3 Separately Documenting Conditioned and Unconditioned Spaces**

The nonresidential indoor lighting requirements are the same for conditioned and unconditioned spaces. However, the Energy Standards do not allow lighting power trade-offs to occur between conditioned and unconditioned spaces. Therefore, most nonresidential indoor lighting compliance forms are required to be separately completed for conditioned and unconditioned spaces.

### **5.11.4 Compliance Documentation Numbering**

Following is an explanation of the nonresidential lighting compliance documentation numbering:

- NRCC Nonresidential Certificate of Compliance.
- NRCA Nonresidential Certificate of Acceptance.
- NRCI Nonresidential Certificate of Installation.
- LTI Lighting, Indoor.
- LTO Lighting, Outdoor.
- LTS Lighting, Sign.
- E Primarily used by enforcement authority.
- A Primarily used by acceptance tester.

### **5.11.5 Certificate of Compliance Documents**

There is only one nonresidential indoor lighting Certificate of Compliance documentation (form) required to be filled out for each project.

- NRCC-LTI-E; Certificate of Compliance; Indoor Lighting.

### **5.11.6 Certificates of Installation Documents**

There are six different Certificates of Installation listed as follows. See Section 5.4.7 of this chapter for additional information.

- NRCI-LTI-01-E, Certificate of Installation, Indoor Lighting.
- NRCI-LTI-02-E, Certificate of Installation, Lighting Control Systems.
- NRCI-LTI-04-E, Certificate of Installation, Two Interlocked Lighting Systems.
- NRCI-LTI-05-E, Certificate of Installation, Power Adjustment Factors.
- NRCI-LTI-06-E, Certificate of Installation, Additional Video Conference Studio Lighting.

The Certificates of Installation are primarily used as declarations, signed by a person with an approved license, that what was claimed on the Certificates of Compliance is actually what was installed.

The required nonresidential indoor lighting Certificates of Installation include the following:

- NRCI-LTI-01-E - must be submitted for all buildings. This is the general Certificate of Installation used to declare that what was proposed in the Certificates of Compliance is actually what was installed.

In addition to the NRCI-LTI-01-E, the following Certificates of Installation are also required if the job includes any of the measures covered by these Certificates of Installation. If any of the requirements in any of these Certificates of Installation fail the respective installation requirements, then that application shall not be recognized for compliance with the lighting standards.

These additional Certificates of Installation are different than Certificates of Acceptance, in that Certificates of Installation consist primarily of declarations that each of the minimum requirements has been met, while Certificates of Acceptance include tests which must be conducted.

- NRCI-LTI-02-E - Must be submitted whenever a lighting control system, and whenever an Energy Management Control System (EMCS), have been installed to comply with any of the lighting control requirements.
- NRCI-LTI-04-E - Must be submitted for two interlocked systems serving an auditorium, a convention center, a conference room, a multipurpose room, or a theater to be recognized for compliance.

See Section 5.6.4 of this chapter for two interlocked system requirements.

- NRCI-LTI-05-E - Must be submitted for a Power Adjustment Factor (PAF) to be recognized for compliance.

See Section 5.6.5 of this chapter for requirements of PAFs.

- NRCI-LTI-06-E - Must be submitted for additional wattage installed in a video conferencing studio to be recognized for compliance

### **5.11.7 Certificate of Acceptance**

Acceptance requirements ensure that equipment, controls, and systems operate as required and specified. There are three steps to acceptance testing:

- Visual inspection of the equipment and installation.
- Review of the certification requirements.
- Functional tests of the systems and controls.

Third-party review of the information provided on the Certificate of Acceptance forms is not required for lighting.

Individual acceptance tests may be performed by one or more field technicians under the responsible charge of a licensed contractor or design professional,

(responsible person) eligible under Division 3 of the Business and Professions Code, in the applicable classification, to accept responsibility for the scope of work specified by the Certificate of Acceptance document. The responsible person must review the information on the Certificate of Acceptance form and sign the form to certify compliance with the acceptance requirements. Typically, the individuals who participate in the acceptance testing/verification procedures are contractors, engineers, or commissioning agents. The individuals who perform the field testing/verification work and provide the information required for completion of the acceptance form (field technicians) are not required to be licensed contractors or licensed design professionals. Only the responsible person who signs the Certificate of Acceptance form certifying compliance must be licensed.

The acceptance tests required for nonresidential indoor lighting include the following:

- Lighting controls.
- Automatic daylighting controls.
- Demand responsive lighting controls.
- Institutional tuning for power adjustment factor.

Instructions for completing the Certificates of Acceptance are imbedded in the certificates.

See Chapter 13 of this manual for additional information about acceptance requirements.

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## 5.12 For Manufacturers and Installers

### 5.12.1 Luminaires Labeling

130.0(c)1
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Luminaires shall be labelled with its wattage as follows.

1. 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; and
2. Peel-off and peel-down labels that allow the maximum labeled wattage to be changed are prohibited, except for luminaires meeting all of the following requirements:
  - a. The luminaires can accommodate a range of lamp wattages without changing the luminaire housing, ballast, transformer or wiring.
  - b. They have a single lamp.
  - c. They have an integrated ballast or transformer.
  - d. Peel-down labels are layered such that the rated wattage reduces as successive layers are removed.
  - e. Qualifies as one of the following three types of luminaires:

- i. High intensity discharge luminaires having an integral electronic ballast with a maximum relamping rated wattage of 150 watts.
- ii. Low-voltage luminaires (does not apply to low voltage track systems)  $\leq 24$  volts with a maximum relamping rated wattage of 50 watts.
- iii. Compact fluorescent luminaires having an integral electronic ballast with a maximum relamping rated wattage of 42 watts.