5.3 Mandatory Requirements for Classification of Installed Luminaires and Determination of Luminaire Power

§130.0(c); NA8

The requirements for classifying the type of lighting technology of a luminaire, and the requirements for determining how many watts of power is used per luminaire, are contained in §130.0(c).

While residential luminaires are required to be classified as high or low efficacy, there are no requirements to classify nonresidential luminaires as high or low efficacy,

Following are the requirements in §130.0(c) for determining luminaire classification and power:

1. Manufacturer labeling of luminaires. Following are the requirements for labeling luminaires:

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

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

        Peel-down labels may be used only for a luminaire meeting ALL of the following requirements:

        a. It can accommodate a range of lamp wattages without changing the luminaire housing, ballast, transformer or wiring, and

        b. It has a single lamp, and

        c. It has an integrated ballast or transformer, and

        d. Peel-down labels must be layered such that the rated wattage reduces as successive layers are removed, and

        e. The Standards will recognize peel-down labels only for the following three types of luminaires, and only when they meet all of the following conditions:

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

            ii. Low-voltage luminaires (this shall not apply to low voltage track systems), ≤ 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.

2. Luminaires with line voltage lamp holders not containing permanently installed ballasts are always classified as incandescent luminaires. The wattage of such luminaires shall be determined as follows:

    a. The maximum relamping rated wattage of the luminaire; and

    b. For recessed luminaires with line-voltage medium screw base sockets, wattage shall not be less than 50 watts per socket.

        For example, if a recessed luminaire has a relamping rated wattage on a permanent, pre-printed, factory-installed label of 30 watts, it shall be counted as 50 watts; if a recessed luminaire has a relamping rated wattage of 90 watts, it shall be counted as 90 watts.

        Peel-down labels are never recognized for any type of incandescent luminaire.

3. Luminaires and luminaire housings designed to accommodate a variety of trims or modular components that allow the conversion between incandescent and any other lighting technology without changing the luminaire housing or wiring shall be classified as incandescent.
4. Screw-based adaptors shall not be used to convert an incandescent luminaire to any type of non-incandescent technology. Screw-based adaptors, including screw-base adaptors classified as permanent by the manufacturer, shall not be recognized for compliance with the Standards.
5. Luminaires and luminaire housings manufactured with incandescent screw base sockets shall be classified only as incandescent. Field modifications, including hard wiring of an LED module, shall not be recognized as converting an incandescent luminaire or luminaire housing to a non-incandescent technology for compliance with the Standards.
6. Luminaires with permanently installed or remotely installed ballasts will be either fluorescent or high intensity discharge. Wattage shall be determined as follows:

    a. Wattage shall be the operating input wattage of the rated lamp/ballast combination published in ballast manufacturer's catalogs based on independent testing lab reports as specified by UL 1598.

    b. Replacement of lamps in a luminaire manufactured or rated for use with linear fluorescent lamps, with linear lamps of a different technology such as linear LED lamps, shall not be recognized as converting the fluorescent luminaire to a different technology for compliance with the Standards.

7. The wattage of line-voltage lighting track and plug-in busway which allows the addition or relocation of luminaires without altering the wiring of the system shall be determined by one of the following methods:

    a. There is only one option for line voltage busway and track rated for more than 20 amperes. Wattage shall be the total volt-ampere rating of the branch circuit feeding the busway and track.

b. There are four options for determining the wattage of line voltage busway and track rated for 20 amperes or less, as follows:

i. Line Voltage Track Lighting Option 1:

The volt-ampere rating of the branch circuit feeding the track or busway; or

ii. Line Voltage Track Lighting Option 2

The higher of:

- The rated wattage of all of the luminaires included in the system, where luminaire classification and wattage is determined according to the applicable provisions in §130.0(c), or
- 45 watts per linear foot; or

iii. Line Voltage Track Lighting Option 3

When using a Line-Voltage Track Lighting Integral Current Limiter, the higher of:

- The volt-ampere rating of an integral current limiter controlling the track or busway, or
- 12.5 watts per linear foot of track or busway.

An Integral current limiter shall be certified to the Energy Commission in accordance with §110.9, and shall comply with the Lighting Control Installation Requirements.

Before a Line-Voltage Track Lighting Integral Current Limiter 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 fail the installation tests, the Line-Voltage Track Lighting Integral Current Limiter shall not be recognized for compliance with Title 24; or

iv. Line Voltage Track Lighting Option 4

When using a dedicated track lighting supplementary overcurrent protection panel, the sum of the ampere (A) rating of all of the overcurrent protection devices times the branch circuit voltages.

Track lighting supplementary overcurrent protection panels shall comply with the applicable requirements in §110.9, and shall comply with the Lighting Control Installation Requirements.

Before a dedicated track lighting supplementary overcurrent protection panel 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 fail the installation tests, the track lighting supplementary overcurrent protection panel shall not be recognized for compliance with Title 24

8. Luminaires and lighting systems with permanently installed or remotely installed transformers. The wattage of such luminaires shall be determined as follows:

   a. For low-voltage luminaires that do not allow the addition of lamps, lamp holders, or luminaires without rewiring, the wattage shall be the rated wattage of the lamp/transformer combination.

   b. For low-voltage lighting systems, including low voltage tracks and other low-voltage lighting systems which allow the addition of lamps, lamp holders, or luminaires without rewiring, the wattage shall be the maximum rated input wattage of the transformer, labeled in accordance with item 1, or the maximum rated wattage published in transformer manufacturer's catalogs, as specified by UL 2108.

9. Light emitting diode (LED) Luminaires, and LED Light Engine for nonresidential applications are not required to be certified to the Energy Commission. An LED light engine is a an integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, and other optical, thermal, mechanical and electrical components . The light engine is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard (screw) base. LED luminaires and light engines for residential applications shall be certified to the Energy Commission in order to be classified as high efficacy. See Chapter 5 in the 2013 Residential Compliance Manual for information on classifying residential LED luminaires as high efficacy.

   a. The wattage of such luminaires shall be the maximum rated input wattage of the system when tested in accordance with IES LM-79-08.

   b. The maximum rated input wattage shall be labeled on the luminaire, light engine, or luminaire housing in accordance with §130.0(c)1. Labels only on the power supply are not sufficient for compliance with this requirement.

   c. An LED lamp, integrated or non-integrated type in accordance with the definition in ANSI/IES RP-16-2010, shall not be classified as a LED lighting system for compliance with The Standards. LED modules having screw-bases including screw based pig-tails, screw-based sockets, or screw-based adaptors shall not be recognized as a LED lighting system

for compliance with The Standards. The intent of this requirement is to not give credit for screw based LED lamps. An ANSI/IES RP-16-2010 integrated or non-integrated LED lamp is one with a screw base. The governing wattage of a luminaire with a screw based lamp is the rated luminaire wattage and not the LED lamp. If one wants to take credit for the lower wattage afforded by a LED lamp then the luminaire must have a **GU-24 socket** or be a hard wired LED luminaire (i.e. contain a LED light engine) that is rated according to IES LM-79-08.

d. Luminaires and luminaire housings equipped with screw-base sockets shall not be classified as a LED lighting system for compliance with The Standards.

e. Luminaires manufactured or rated for use with low-voltage incandescent lamps, into which have been installed LED modules or LED lamps, shall not be recognized as a LED lighting system for compliance with the Standards.

f. For LED lighting systems which allow the addition of luminaires or light engines without rewiring, the wattage of such luminaires shall be the maximum rated input wattage of the power supply, labeled in accordance with §130.0(c)1 or published in the power supply manufacturer's catalog.

10. The wattage of all other miscellaneous lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, labeled in accordance with §130.0(c)1, or published in manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574 or UL 1598. Lighting technologies listed in subsections 2 through 9 shall be determined in accordance with the applicable requirements in subsections 1 through 9.

A. Summary of installed luminaire wattage

The installed wattage of indoor lighting luminaires are calculated as follows for the various type of systems

- Line voltage screw based luminaires (not including track lighting)
  - The maximum rated wattage of the luminaire, regardless of the wattage of the lamp that is installed.
    - Additional requirements for recessed luminaires: The wattage of recessed luminaires shall not be less than 50 watts
- Luminaires containing a hardwired ballasts
  - The rated input wattage of the lamp/ballast
- Line voltage track lighting one of the following:
  - The larger of the rated wattage of luminaires installed on the track or 45 Watts per linear foot
  - The volt-amps of the circuit serving the track

- The larger of the volt-amps of the integral current limiter serving the track or 12.5 Watts per linear foot of track
- The volt amps of the dedicated overcurrent protection in track lighting supplementary overcurrent protection panel

- Low voltage luminaires with hardwired or remotely installed transformers
  - If the lamps cannot be replaced without rewiring the rated wattage of lamp/transformer combination
  - If the lamps can be replaced without rewiring (i.e. the lamps fit into a socket), the maximum rated input wattage of the transformer.
- Light emitting diode (LED) with "light engine" wattage is the greater of:
  - the maximum rated input wattage of the system when tested in accordance with IES LM-79-08, or
  - the labeled wattage of the luminaire
- Screw-in LED or CFL lamps or screw-in assemblies are not recognized for their lower wattages, the rating for luminaires with screw-in lamps or assemblies is the labeled rating of the luminaire itself.

B. The 2013 Title 24, Part 6 Nonresidential Appendix NA8 provides an alternate option for determining how many watts of power is used per luminaire. NA8 provides tables that contain a limited list of lamp and ballast combinations. These tables in NA8 provide an alternate voluntary option to the provision in §130(c) for determining luminaire power for any lamp and ballast combination specifically listed in NA8. Appendix NA8 is not intended to list all possible lamp and ballast combinations, and shall not to be used to determine luminaire power for any lighting system not specifically listed in NA8.

When using NA8 to determine luminaire power, luminaire classification shall still be determined in accordance with §130.0(c).

Lamp ballast combinations included in Appendix NA8 are:

- Fluorescent U-Tubes
- Fluorescent Linear Lamps T5
- Fluorescent Rapid Start T-8
- Fluorescent Eight foot T-8 High Output (HO) with Rapid Start Ballasts
- High Intensity Discharge (Metal Halide and High Pressure Sodium)
- 12 Volt Tungsten Halogen Lamps Including MR16, Bi-pin, AR70, AR111, PAR36

5.4 Mandatory Lighting Controls

§130.1

The installations of lighting controls are mandatory measures. This section contains information about lighting controls that shall be installed, regardless of the method used to comply with the lighting power requirements.

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

Mandatory nonresidential indoor lighting controls include the following:

1. Area Controls. Manual 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. Shutoff Controls. Automatically shutting off or reducing light output of lighting when it is not needed.
4. Automatic Daylighting Controls. Separately controlling some or all of the lights in the daylight area from the lights that are not in the daylight area.
5. Demand Responsive Lighting Controls. Installing controls that are capable of receiving and automatically responding to a demand response signal.

5.4.1 Area Lighting Controls.

§130.1(a)

All luminaires in each area enclosed by ceiling-height partitions shall be independently controlled from luminaires in other areas, with fully functional manual ON and OFF lighting controls.

EXCEPTION: The exception to the mandatory area lighting control requirements is that up to 0.2 watts per square foot of lighting in any area within a building may be continuously illuminated during occupied times to allow for emergency egress, provided that the following conditions are met:

1. The area is designated an emergency egress area on the building plans and specifications submitted to the enforcement agency under §10-103(a)2 of Part 1; and
2. The control switches for the egress lighting are not accessible to unauthorized personnel.

A. Requirements for ON and OFF controls

The ON and OFF lighting controls shall meet the following requirements:

1. Be readily accessible to occupants; and
2. Be operated with a manual switch that is located in the same room or area with the lighting that is being controlled by that lighting control; and
3. If controlling dimmable luminaires, be a dimmer switch that allows manual ON and OFF functionality, and is capable of manually controlling lighting through all multi-level lighting control steps that are required in §130.1(b).

EXCEPTIONS: There are two exceptions to the requirements for these controls to be readily accessible and located in the same room:

a. In malls, auditoriums, retail and wholesale sales floors, industrial facilities, convention centers, and arenas, the lighting control shall be located so that a person using the lighting control can see the lights or area controlled by that lighting control, or so that the lighting control for the area is annunciated.

   Annunciated is defined in the Standards as a type of visual signaling device that indicates the on, off, or other status of a load.

b. Public restrooms having two or more stalls may use a manual switch that is not accessible to unauthorized personnel. However, all other lighting controls in accordance with §130.1 are still required.

B. Interaction of Manual ON and OFF Switches with Other Lighting Controls

1. In addition to the manual area lighting controls, other lighting controls may be installed provided they do not override the functionality of controls installed in accordance with §130.1(a)1 (functionally controlled with a manual switch), §130.1(a)2 (readily accessible), or §130.1(a)4 (separately controlled lighting systems).

C. Separately Controlled Lighting System

In addition to the requirements in §130.1(a)1, 2, and 3:

1. General lighting shall be separately controlled from all other lighting systems in an area.
2. Floor and wall display, window display, case display, ornamental, and special effects lighting shall each be separately controlled on circuits that are 20 amps or less.
3. When track lighting is used, general, display, ornamental, and special effects lighting shall each be separately controlled.

5.4.2 Multi-Level Lighting Controls.

§130.1(b)

The multi-level lighting control requirements allow a room to be occupied with all of the lights turned on, part of the lights turned on, and none of the lights turned on, whether the room is occupied or not. The number of required lighting control steps varies, depending on the type of lighting technology in each installed luminaire, in accordance with Table 5-2. The uniformity requirements in Table 5-2 require that multi-level control occur per luminaire so one cannot meet this requirement by controlling alternate luminaires or alternate rows of luminaires.

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

These spaces also must comply with the following:

1. Lighting shall have the required number of control steps and meet the uniformity requirements in accordance with TABLE 5-2; and
2. Multi-level lighting controls shall not override the functionally of other lighting controls required for compliance with Sections 130.1(a) [area controls], (c) [automatic shut-off controls] (d) [daylighting controls] and (e) [demand responsive controls]; and
3. In addition to the multi-level lighting controls required in Table 5-2, each luminaire shall be controlled by at least of one of the methods listed below.
    a. Manual dimming installed to meet the requirements of §130.1(a)
    b. Lumen maintenance, defined in the Standards *as "a strategy used to provide a precise, constant level of lighting from a lighting system regardless of the age of the lamps or the maintenance of the luminaires."* (§100.1)
    c. Tuning, defined in the Standards as *"the ability to set maximum light levels at a lower level than full lighting power."* (§100.1)
    d. Automatic daylighting control installed to meet the requirements in §130.1(d)
    e. Demand responsive lighting controls installed to comply with §130.1(e)

    NOTE: Some of the controls listed above may already need to be installed to comply with other lighting control requirements in §130.1.

A. Exceptions to multi-level lighting controls

The following applications are not required to comply with the requirements in Table 5-2:

1. Classrooms, with a connected general lighting load of 0.7 watts per square feet and less, instead of meeting the multi-level lighting control steps required in Table 5-2, shall have at least one control step between 30-70 percent of full rated power.
2. An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps in that one luminaire.

TABLE 5- 2- (Table 130.1-A in the Standards)
Multi-Level Lighting Controls and Uniformity Requirements

<table>
<tr><th>Luminaire Type</th><th colspan="4">Minimum Required Control Steps (percent of full rated power[1])</th><th>Uniform level of illuminance shall be achieved by:</th></tr>
<tr><td>Line-voltage sockets except GU-24</td><td colspan="5" rowspan="4">Continuous dimming 10-100 percent</td></tr>
<tr><td>Low-voltage incandescent systems</td></tr>
<tr><td>LED luminaires and LED source systems</td></tr>
<tr><td>GU-24 rated for LED</td></tr>
<tr><td>GU-24 sockets rated for fluorescent > 20 watts</td><td colspan="5" rowspan="2">Continuous dimming 20-100 percent</td></tr>
<tr><td>Pin-based compact fluorescent > 20 watts[2]</td></tr>
<tr><td>GU-24 sockets rated for fluorescent ≤ 20 watts</td><td colspan="4" rowspan="3">Minimum one step between 30-70 percent</td><td rowspan="3">• Stepped dimming; or
• Continuous dimming; or
• Switching alternate lamps in a luminaire</td></tr>
<tr><td>Pin-based compact fluorescent ≤ 20 watts[2]</td></tr>
<tr><td>Linear fluorescent and U-bent fluorescent ≤ 13 watts</td></tr>
<tr><td rowspan="2">Linear fluorescent and U-bent fluorescent > 13 watts</td><td colspan="4">Minimum one step in each range:</td><td rowspan="2">• 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</td></tr>
<tr><td>20% to 40%</td><td>50% to 70%</td><td>80% to 85%</td><td>100%</td></tr>
<tr><td>Track Lighting</td><td colspan="4">Minimum one step between 30 – 70 percent</td><td>• Step dimming; or
• Continuous dimming; or
• Separately switching circuits in multi-circuit track with a minimum of two circuits.</td></tr>
<tr><td>HID > 20 watts</td><td colspan="4" rowspan="3">Minimum one step between 50 - 70 percent</td><td rowspan="3">• 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.</td></tr>
<tr><td>Induction > 25 watts</td></tr>
<tr><td>Other light sources</td></tr>
<tr><td colspan="6">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</td></tr>
</table>

5.4.3 Automatic Shut-OFF Controls

§130.1(c)

In addition to lighting controls installed to comply with §130.1(a)(manual ON and OFF switches located in each room); §130.1(b)(multi-level lighting controls); §130.1(d)(daylighting controls); and §130.1(e)(demand responsive controls) - all installed indoor lighting shall be equipped with controls that meet the following requirements (§130.1(c)1):

1. Shall be controlled with one or more of the following automatic shut-OFF controls when the space is typically unoccupied:
   a. Occupant sensing control
   b. Automatic time-switch control
   c. Signal from another building system
   d. Other control capable of automatically shutting OFF all of the lights; and

   Note that there is no longer an exception for egress lighting, and that therefore all lighting in the building is required to be shut off when the building is unoccupied.
2. Separately controls for the lighting on each floor; and
3. Separately controls the lighting in each room (enclosed space) and a control can control up to 5,000 square feet; larger spaces will have more than one separately controlled zone where each zone does not exceed 5,000 square feet; and

   EXCEPTION: Only in the following function areas, the separately controlled space may exceed 5,000 square feet, but may not exceed 20,000 square feet per separately controlled space, and separately controls the lighting on each floor:
   a. Mall
   b. Auditorium
   c. Single tenant retail
   d. Industrial
   e. Convention center
   f. Arena
4. Separately controls the general, display, ornamental, and display case lighting.

A. General Exceptions to §130.1(c)1:

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

1. Where the lighting is serving an area that is in continuous use, 24 hours per day/365 days per year.
2. Lighting complying with §130.1(c)5 instead of §130.1(c)1

   This exception only applies to those areas where occupant sensing controls are required to shut OFF all lighting in offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, classrooms of any size, or conference rooms of any size, in accordance with §130.1(c)5.
3. Lighting complying with §130.1(c)7 instead of §130.1(c)1

This exception to §130.1(c)1 applies only to those areas where partial ON/OFF occupant sensing controls are required in common area stairwells and common area corridors that provide access to guestrooms and dwelling units (§130.1(c)7A); or partial ON/OFF occupancy sensing controlling parking garages lighting (§130.1(c)7B) .

4. In office buildings only, up to 0.05 watts per square foot of lighting may be continuously illuminated, provided that the area is designated an emergency egress area on the plans and specifications submitted to the enforcement agency under §10-103(a)2 of Part 1.
5. Electrical equipment rooms subject to Article 110.26(D) of the California Electric Code.

B. Use of Countdown Timer Switches

Countdown timer switches shall not be used to comply with the automatic shut-OFF control requirements in §130.1(c)1.

EXCEPTIONS: Only the following three function areas may use a countdown timer switch to comply with the automatic shut-OFF control requirements

1. Single-stall bathrooms smaller than 70 square feet may use countdown timer switches with a maximum setting capability of ten minutes.
2. Closets smaller than 70 square feet may use countdown timer switches with a maximum setting capability of ten minutes.
3. Lighting in a Server Aisle in a Server Room may use countdown timer switches with a maximum setting capability of 30 minutes.
   a. *A Server Aisle is defined by the Standards as an aisle of racks of Information Technology (IT) server equipment in a Server Room. While networking equipment may also be housed on these racks, it is largely a room to manage server equipment.*
   b. *A Server Room is defined by the Standards as a room smaller than 500 square feet, within a larger building, in which networking equipment and Information Technology (IT) server equipment is housed, and a minimum of five IT severs are installed in frame racks.*

C. Requirements for Occupant Sensing Controls

When an occupant sensing control is used to comply with the automatic shut-OFF requirements, the lights are automatically controlled in response to the presence or absence of occupants. However, when an automatic time-switch control is used to comply with the automatic shut-OFF requirements, such a control is not responsive to the presence or absence of occupants. Therefore, when any control other than an occupant sensing control is used (i.e.: automatic time-switch control, signal from another building system, or other control capable of automatically shutting OFF all of the lights), the lighting control system shall incorporate an override lighting control that:

1. Complies with §130.1(a) (Manual ON/OFF switch located in each room); and
2. Allows the lighting to remain ON for no more than 2 hours when an override is initiated.

EXCEPTIONS: In the following function areas, only when a captive-key override is utilized, the override time may exceed 2 hours:

a. Malls

b. Auditoriums

c. Single tenant retail

d. Industrial

e. Arenas.

D. Requirements for Automatic Time-Switch Controls

If an automatic time-switch control, other than an occupant sensing control, is installed to comply with §130.1(c)1, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

EXCEPTIONS: In only the following function areas, the automatic time-switch control is not required to incorporate an automatic holiday shut-OFF feature:

1. Retail stores and associated malls
2. Restaurants
3. Grocery stores
4. Churches
5. Theaters

E. Areas where Occupant Sensing Controls are required to shut OFF ALL Lighting

§130.1(c)5

1. 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 square feet or smaller

   b. Multipurpose rooms of less than 1,000 square feet

   c. Classrooms of any size

   d. Conference rooms of any size

   Note that in multipurpose rooms less than 1,000 square foot, classrooms greater than 750 square foot and conference rooms greater than 750 square foot, are required to be equipped with an occupancy sensor that controls the HVAC thermostat setup and setback and ventilation. (§120.2(e)3)

   The same occupancy sensor used to control the lighting can also control the HVAC system. Besides the cost advantage, advantage of using the lighting occupancy sensor to control the HVAC unit is that it is immediately apparent that the occupancy sensor is not working when it is controlled to the lighting and it may be less apparent if the sensor is failed if it is controlling the HVAC only.

F. Areas where partial ON/OFF occupant sensing controls are required in addition to complying with §130.1(c)1

§130.1(c)6

1. 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 shall independently control lighting in each aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

   EXCEPTIONS: The following spaces are not required to be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied, provided they also meet the following requirements:

   a. 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.

   b. 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.

      Note that even if the exemptions apply, these only result in a reduced lighting power reduction associated with aisle ways and open areas during occupied periods. These spaces are still required to comply with the applicable automatic shut-OFF controls in §130.1(c).

2. In library book stack aisles meeting the following criteria, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied:

   a. Library book stack aisles 10 feet or longer that are accessible from only one end; and

   b. Library book stack aisles 20 feet or longer that are accessible from both ends.

      The occupant sensing controls shall independently control lighting in each aisle way, and shall 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).

3. 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 shall be automatically activated from all designed paths of egress.

G. Areas where partial ON/OFF occupant sensing controls are required instead of complying with §130.1(c)1

§130.1(c)7

1. Lighting in common area stairwells and common area corridors which provide access to guestrooms and dwelling units of 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.

   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.

2. In parking garages, parking areas and loading and unloading areas, the general lighting shall be controlled as follows:

   a. By occupant sensing controls having at least one control step between 20 percent and 50 percent of design lighting power, and

   b. No more than 500 watts of rated lighting power shall be controlled together as a single zone, and

   c. A reasonably uniform level of illuminance shall be achieved in accordance with the applicable requirements in TABLE 5-2, and

   d. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and

   e. The occupant sensing controls shall be automatically activated from all designed paths of egress.

      EXCEPTION: Metal halide luminaires meeting 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:

      - Have a metal halide lamp plus ballast mean system efficacy of greater than 75 lumens per watt, (the lamp/ballast mean system efficacy is the rated mean lamp lumens at 40% of lamp life[1] divided by the ballast rated input watts) and
      - Are used for general lighting in parking garages, parking areas and loading and unloading areas.

      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. These controls provisions in §130.1(c)7B do not apply to open rooftop parking.

H. Requirements for Hotel and Motel Guest Rooms

§130.1(c)8

[1] Illuminating Engineering Society. Section 13.3 “Life and Lumen Maintenance” in The Lighting Handbook: 10th Edition Reference and Application. 2011. New York..

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 such that, no longer than 30 minutes after the guest room has been vacated, lighting power is switched off.

EXCEPTION: A luminaire in a hotel or motel guest room meeting all of the following criteria is not required to have captive card key controls, occupancy sensing controls, or automatic controls.

- Applies to one high efficacy luminaire (where high efficacy is defined in §130.0(c), §150.0(k) and TABLE 150.0-A or 150.0-B), and
- That is switched separately from the other lighting in the room, and
- The switch for that luminaire is located within 6 feet of the entry door.

This one high efficacy light by the doorway is exempted so one can turn on a light switch to find the captive card control.

5.4.4 Mandatory 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) address mandatory requirements for daylighting.

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

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

A. Description of Terms

The following terms are used to describe the daylighting requirements in §130.1(d).

1. *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, exclusive of daylighting, and also known as ambient light. Thus general lighting does <u>not</u> include display lighting (which is typically directional lighting such as seen in MR, and PAR, spot or flood lamps) or "wall washers" (luminaires with an asymmetric distribution for illuminating vertical surfaces). General lighting is also not ornamental lighting as seen in drum fixtures, chandeliers or projection lighting. General lighting typically makes use of troffers (prismatic and parabolic and indirect diffusers), pendant lighting (direct, indirect or direct/indirect), high bay fixtures, low bay fixtures and "aisle-lighter" fixtures.

2. Window Head Height

   The vertical distance from the finished floor level to the top of a window

3. Daylit Zones

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

B. 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:

1. *SKYLIT DAYLIT ZONE is the rough area in building 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 the following:*

   a. *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, for a rectangular skylight the skylit daylit zone plan area shall be rectangular, and for a circular skylight the skylit daylit zone plan area shall be circular.

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

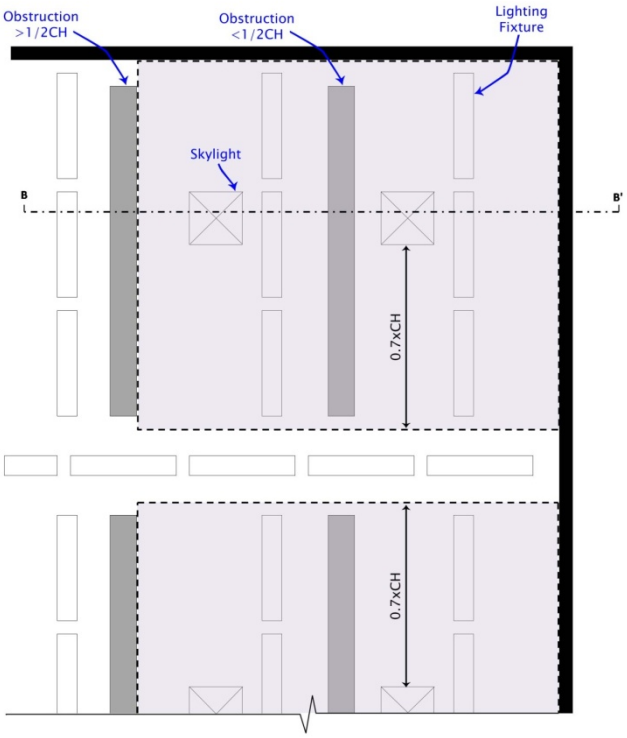

Figure 5-5 – Skylit Daylit Zone Diagram 1

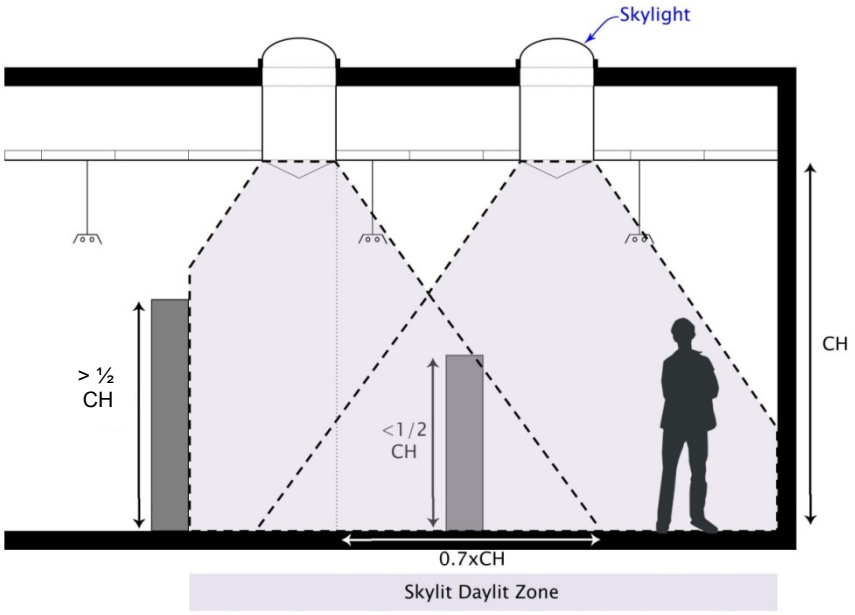

Figure 5-6 – Skylit Daylit Zone Diagram 2

2. *PRIMARY SIDELIT DAYLIT ZONE is the area on a building plan 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 shall not be considered a permanent obstruction.

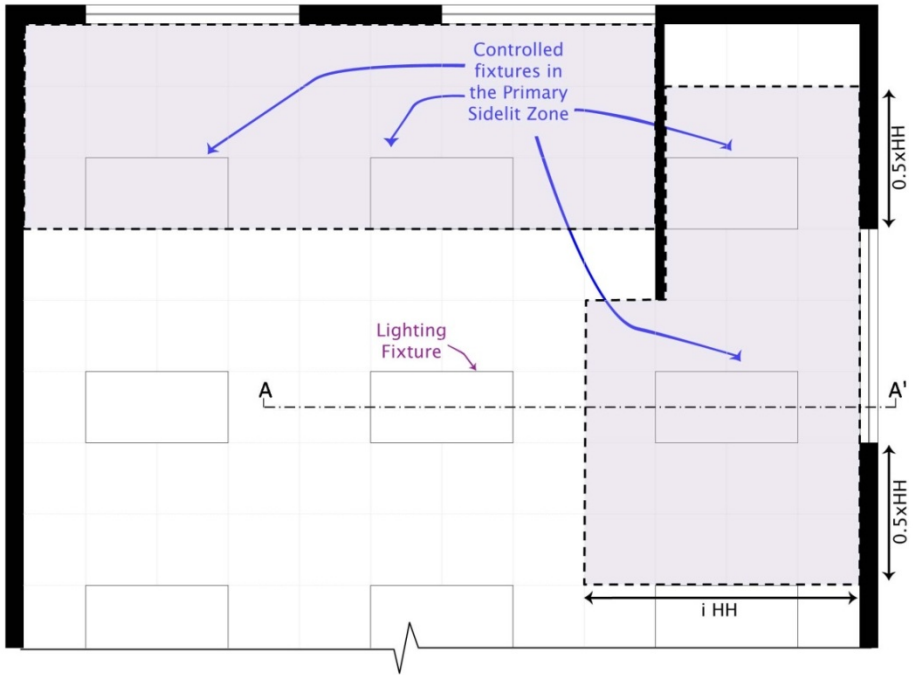

Figure 5-7 – Primary Sidelit Daylit Zone Diagram 1

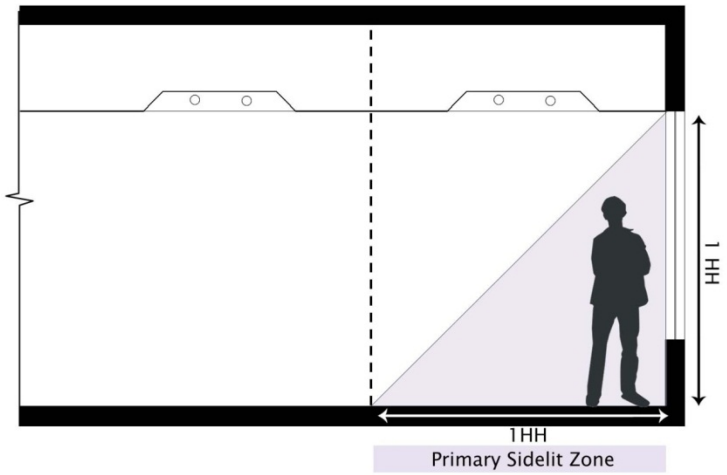

Figure 5-8 – Primary Sidelit Daylit Zone Diagram 2

3. *SECONDARY SIDELIT DAYLIT ZONE is the area on a plan 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 shall not be considered a permanent obstruction.

   The daylighting controls in the skylit zone and the primary sidelit zone are mandatory; they cannot be traded away for other efficiency measures when using the performance (whole building energy simulation) approach. The daylighting controls requirements in the secondary sidelit zone are prescriptive and thus 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 zones and these two zones must be controlled separately from each other.

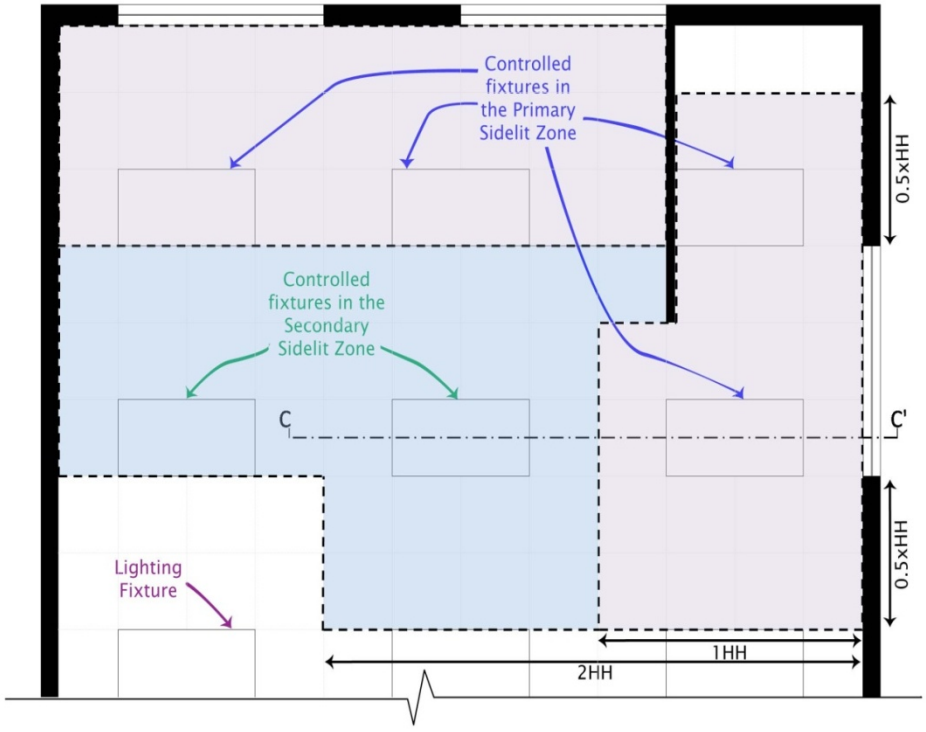

Figure 5-9 – Secondary Sidelit Daylit Zone Diagram 1

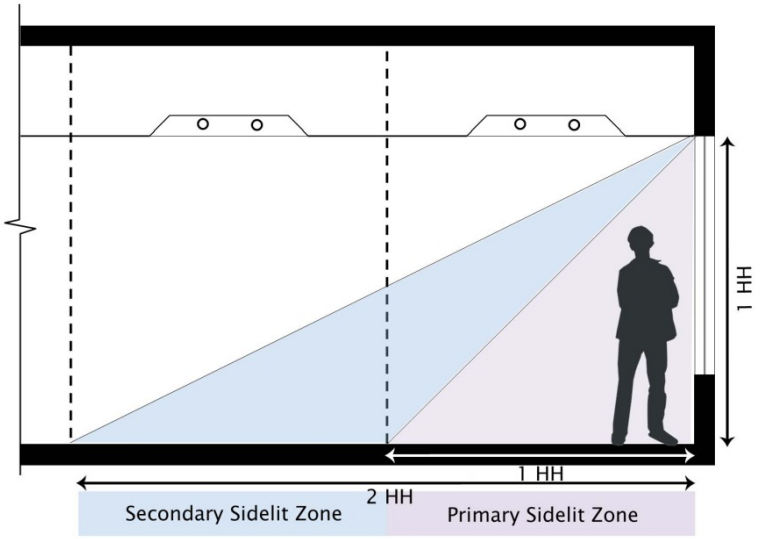

Figure 5-10 – Secondary Sidelit Daylit Zone Diagram 2

C. Controlling Lighting in Daylit Zones

1. There are mandatory controls required for lighting in Skylit Daylit Zones and Primary Sidelit Daylit Zones. The mandatory daylighting controls are covered in this section.

   There are also prescriptive controls required for lighting in Secondary Sidelit Daylit Zones. The prescriptive daylighting controls are covered in section 5.5 of this chapter.

2. Mandatory daylighting controls are required in the following daylit zones:

   Luminaires providing general lighting that are in, or at least 50% in, the Skylit Daylit Zones or the Primary Sidelit Daylit Zones shall be controlled independently by fully functional automatic daylighting controls that meet the applicable device requirements in §110.9, and meet the applicable requirements below:

   a. All Skylit Daylit Zones and Primary Sidelit Daylit Zones shall be shown on the building plans.

   b. Luminaires in the Skylit Daylit Zone shall be controlled separately from those in the Primary Sidelit Daylit Zones.

   c. Luminaires that fall in both a Skylit and Primary Sidelit Daylit Zone shall be controlled as part of the Skylit Daylit Zone.

There are also prescriptive daylighting control requirements, which are covered in section 5.5 of this chapter.

3. Automatic Daylighting Control Installation and Operation

For luminaires in Skylit Daylit Zones and Primary Sidelit Daylit Zones, automatic daylighting controls shall be installed and configured to operate according to all of the following requirements:

a. Photosensors shall be located so that they are not readily accessible to unauthorized personnel, and the location where calibration adjustments are made to automatic daylighting controls shall not be readily accessible to unauthorized personnel. 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 retro-commissioning 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 is convenient as one person can be located at the edge of the daylit zone with a light meter and the wireless calibration tool and make the calibration adjustments without having to run back and forth between taking the measurement and making the adjustment.

b. Automatic daylighting controls shall provide functional multi-level lighting levels having at least the number of control steps specified in TABLE 5-2.

   EXCEPTIONS: Multi-level lighting daylight controls are not required as follows:

   i. Controlled lighting having a lighting power density less than 0.3 W/ft^2

   ii. When skylights are replaced or added to an existing building where there is an existing general lighting system that is not being altered. This exception allows an on/off control if one is entirely skylighting the space. Thus lights do not have to be recircuited or ballasts changed. The addition of a simple daylighting ON/OFF control is not considered a wiring alteration and does not trigger all of the requirements of a lighting wiring retrofit.

c. 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 section of the daylighted area should not get darker as daylight levels increase, due to incorrect calibration of the controls.

d. In areas served by lighting that is daylight controlled, when the illuminance received from the daylight 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% of design illuminance, but the 150% / 65% requirement allows some tolerance for error while obtaining most of the energy savings. In addition, some designers consciously account for daylight adaptation where the light levels in the space at night time is less coming in from a parking lot with light levels around 1 to 3 fc than during the daytime when the light levels in the parking lot are frequently greater than 1,000 fc.

EXCEPTIONS:

i. 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.

ii. Rooms which have a total glazing area of less than 24 square feet.

iii. Parking garages complying with §130.1(d)3.

Example 5- and **Error! Reference source not found.**plot the performance of switching and dimming automatic daylighting controls (photocontrols). The performance is indicated in terms of lighting at the darkest point of the zone served by the controlled lighting (indicated as the Reference Location in Figure 5-11). The total lighting as plotted on the y-axis made up of both daylit and electric lighting contribution to total footcandles at this darkest location in the zone served by the controlled lighting. Daylight plotted on the x-axis is just the daylight available at this darkest location.

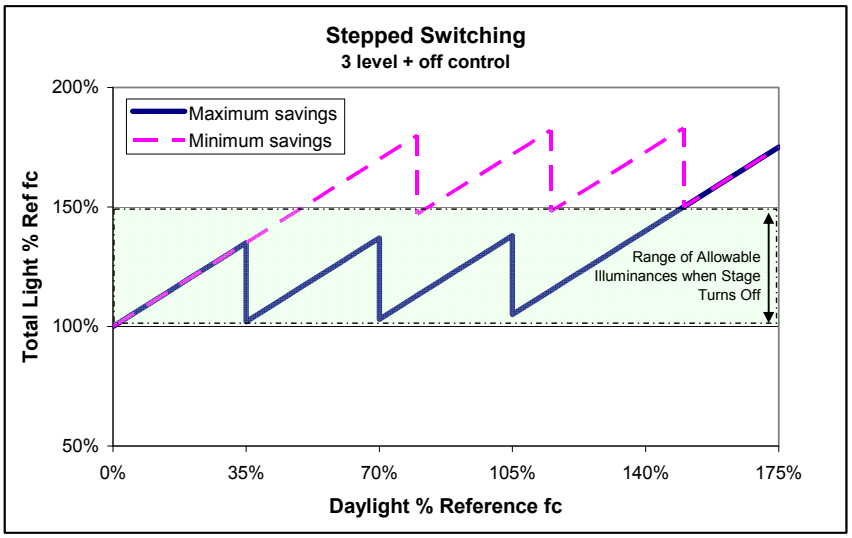

Figure 5-11 Stepped Switching

In **Error! Reference source not found.**3, the light levels are given as a fraction of the reference or design footcandles (fc). The bottom points of both controls indicate the total illuminance just after a stage of lighting has switched off. Both controls are compliant because the total illuminance at the darkest location in the zone served by controlled lighting just after switching off a stage of lighting is between 100 and 150 percent of the reference illuminance. The reference illuminance is the illuminance at this same location when there is no daylight (night time).

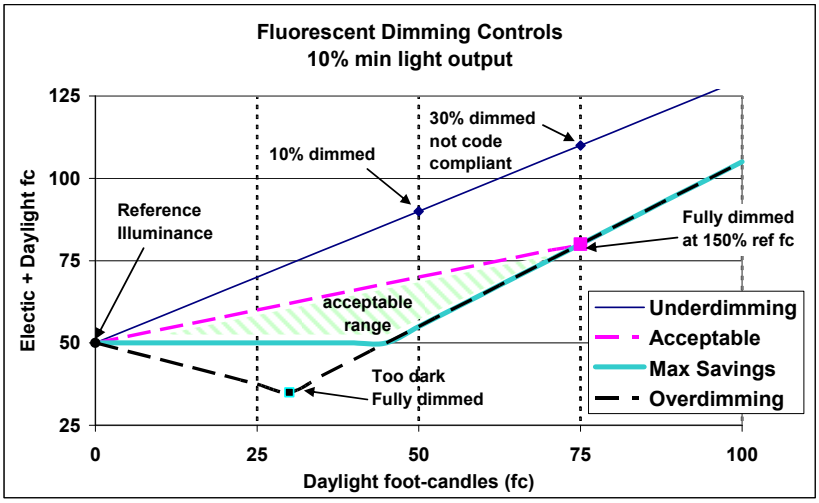

Figure 5-12 Dimming Controls

Figure 5-12 plots the performance of complying ("Acceptable" and "Max Savings") and non-complying ("Under-dimming" and "Over-dimming") controls. By fully dimming when daylight is 150 percent of the reference illuminance and also assuring that the total illuminance never falls below the reference illuminance (50 fc), the "Acceptable" control is minimally complaint with the requirements of §130.1(d)2D. Even greater savings are possible with the "Max Savings" control that maintains the 50 fc reference under all partially daylit conditions and is fully dimmed at 150 percent of the reference illuminance.

The "Under-dimming" control is only 30 percent dimmed when the daylight in the darkest portion of the zone served by the controlled lighting is at 150 percent of the reference illuminance (75 fc). The "Under-dimming" control does not save enough energy and thus is not code compliant. The "Over-dimming" condition reduces the electric lighting by more than the amount of daylight that enters the space. As a result, it actually is darker in portions of the space under partial daylight conditions than it is at night. In the short term, the "Over-dimming" control may save the most energy.

However, over the long term it is likely that the occupants may disable the control and the control would save no energy. As a result the "Over-dimming" control is not code compliant.

These performance metrics of complying and non-complying control systems are the basis of the functional performance tests for the Automatic Daylighting Controls acceptance test. This test is described in detail in Chapter 10 – Acceptance Testing.

4. 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 that are in the combined primary and secondary sidelit daylit zones shall be controlled independently from the rest of the lighting by automatic daylighting controls, and shall meet the following requirements as applicable:

a. All primary and secondary sidelit daylit zones shall 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:

i. Automatic daylighting controls shall have photosensors that are located so that they are not readily accessible to unauthorized personnel, and the location where calibration adjustments are made to the automatic daylighting controls shall not be readily accessible to unauthorized personnel.

ii. Automatic daylighting controls shall be multi-level, continuous dimming or ON/OFF.

iii. The combined illuminance from the controlled lighting and daylight shall not be less than the illuminance from controlled lighting when no daylight is available.

iv. When the sidelit zones receive illuminance levels 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:

- Luminaires located in the daylight transition zone and luminaires for only dedicated ramps. Daylight transition zone and dedicated ramps are defined in §100.1.
- When the total combined general lighting power in the primary sidelit daylight zones is less than 60 watts.

The primary differences between the sidelighting 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
- Daylighting controls in parking garages can be ON/OFF whereas for all other new interior spaces the control must be step switching or dimming
- When fully daylit, lighting in parking garages has to be turned all the way off whereas in other interior spaces the lights can consume up to 35% of full power.

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 Controls.

1. Lighting power in buildings larger than 10,000 square feet shall be capable of being automatically reduced in response to a Demand Responsive Signal; so that the building's total lighting power can be lowered by a minimum of 15 percent below the total installed lighting power. Lighting shall be reduced in a manner consistent with uniform level of illumination requirements in TABLE 5-2 of this manual (Table 130.1-A in the Standards).

2. Spaces that are non-habitable shall not be used to comply with this requirement, and spaces with a sum total lighting power density of less than 0.5 watts per square foot shall not be counted toward the building's total lighting power. Non-habitable spaces are those that are rarely used such as storage closets, unconditioned sheds, etc, Spaces with very low lighting power densities are less likely to have spare lighting capacity to shed during peak demand times.

3. Demand Response Definitions:

a. DEMAND RESPONSE is defined as short-term changes in electricity usage by end-use customers, from their normal consumption patterns.

Demand response may be in response to:

i. Changes in the price of electricity; or

ii. Participation in programs or services designed to modify electricity use in response to wholesale market prices or when system reliability is jeopardized.

b. DEMAND RESPONSE PERIOD is defined as a period of time during which electricity loads are modified in response to a demand response signal.

c. DEMAND RESPONSE SIGNAL is defined as a signal sent by the local utility, Independent System Operator (ISO), or designated curtailment service provider or aggregator, to a customer, indicating a price or a request to modify electricity consumption, for a limited time period.

d. DEMAND RESPONSIVE CONTROL is defined as a kind of control that is capable of receiving and automatically responding to a demand response signal.

4. Demand responsive controls and equipment

Demand responsive controls and equipment shall be capable of receiving and automatically responding to at least one standard messaging protocol which enables demand response after receiving a demand response signal.

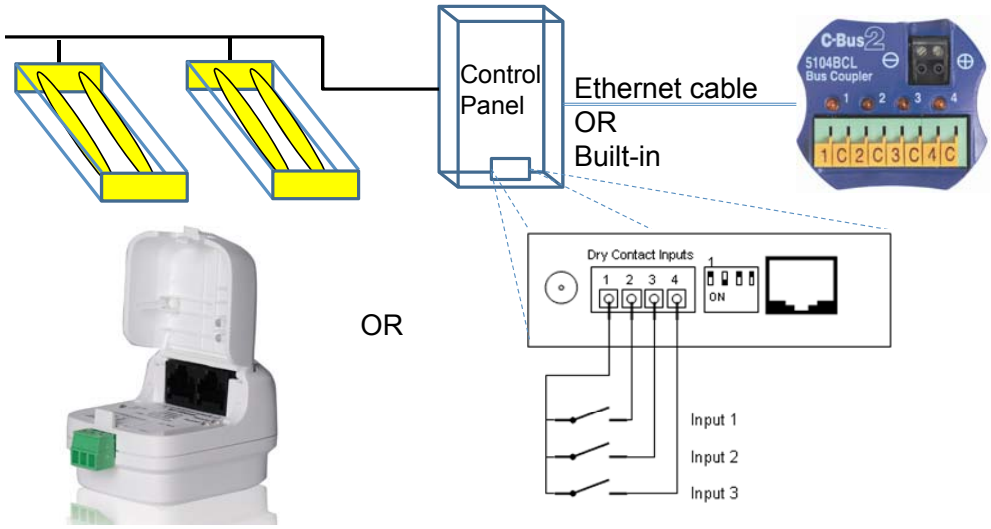

Figure 5-13 - Potential inputs to receive Demand Response signal

Figure 5- this figure illustrates example inputs that could be used to receive demand response signals. The inclusion of one of these types of control inputs, along with the proper design of the lighting system, will result in a lighting system that complies with the requirements of §130.1(e).There are several ways in which the lighting can be designed to meet the demand responsive requirements; outlined below are three specific compliance scenarios.

Example 5-1 Centralized Powerline Dimming Control

This scenario uses a system that has centralized control of dimmable ballasts using a type of powerline carrier signal. This requires no additional wiring as the control signal travels over the existing power line. This can be a very effective means of enabling demand response in small scenarios, such as a small office. This requires the use of a lighting control panel downstream of the breaker panel. The lighting circuit relays are replaced by circuit controllers, which can send the dimming signal via line voltage wires. The panel could have several dry contact inputs that provide dedicated levels of load shed depending upon the demand response signal received. Different channels can be assigned to have different levels of dimming as part of the demand response. Local controls can be provided by either line voltage or low voltage controls.

Example 5-2 Addressable Lighting System

The addressable lighting system is similar in design to that of a centralized control panel, but with additional granularity of control. With an addressable system, each fixture can be addressed individually, whereas a centralized control panel is limited to an entire channel, or circuit, being controlled in unison. The cost of enabling demand response on a system with a centralized control panel is less dependent on building size or number of rooms than a zone based system.

Enabling demand response for the addressable lighting system entails making a dry contact input available to receive an electronic signal. This is a feature that is included in the base model of most lighting control panels. Some smaller scale addressable lighting systems may have a limited number of inputs dedicated for alternative uses, such as a timeclock. If this is the case, an I/O input device can be added to the network to provide an additional closed contact input.

Example 5-3 Demand response for select zones

Enabling demand response for a zoned system would entail adding a network adapter to each room to be controlled for purposes of demand response. The network adapter allows for each room to be monitored and controlled by an energy management control system (EMCS). These types of systems are commonly used for HVAC systems, and to respond to demand response signals. The assumption is that if the building is installing an EMCS, the preference would be to add the lighting network to that existing demand response system. There is additional functionality that results from adding the lighting system to an EMCS. In addition to being able to control the lighting for demand response, the status of the lighting system can then be monitored by the EMCS. For example, occupancy sensors would be able to be used as triggers for the HVAC system, turning A/C on and off when people entered and left the room. Therefore the potential for savings from this type of system is higher than the value of the lighting load shed for demand response.

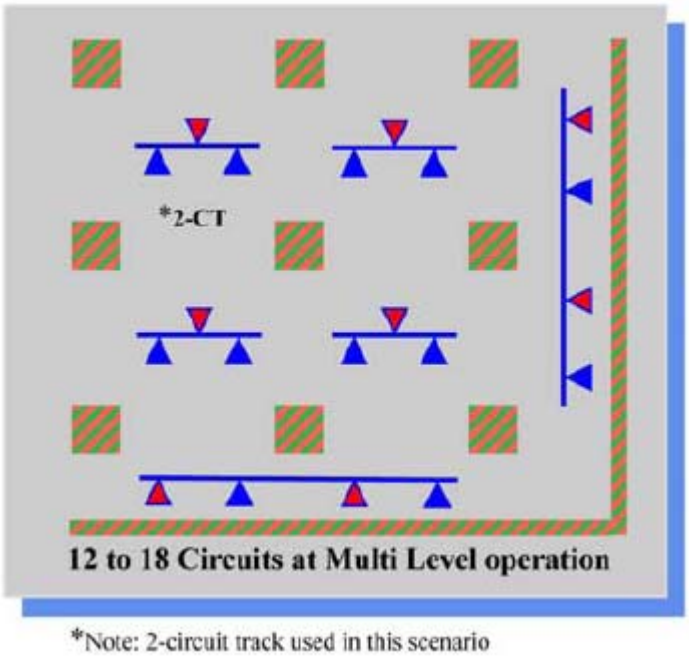

Figure 5-14 – Sample retail DR (demand response) control strategy

Figure 5- illustrates a sample demand response design that maintains uniformity and with a 25 percent power reduction exceeds the 15 percent minimum power reduction requirement. The triangles in this plan are halogen display lighting – the triangles with colored centers are turned off during the DR period. The striped squares are fluorescent troffers and the stripped lines are fluorescent wall washers. These fluorescent fixtures are wired for bi-level control so that half of the lamps are turned off during the DR period.