
IECC 2021

Section C405 – Electrical Power & Lighting Systems

Current 

Presentation Structure

Format Overview

- Actual wording directly from each code section is included for reference and context
- Common topics and frequently discussed code points are highlighted in BLUE and include summary comments
- Items new to the IECC-2021 code are highlighted in RED and include summary comments. For those familiar with past code versions, the RED text helps to skim for updates only
- Options or comments are in GREEN

Highlights and Overview

Slide deck includes entire Section C405

- Presentation focuses on lighting controls
- Sub-sections without lighting controls, or minimal lighting control changes are hidden from presentation view

New Code Highlights:

- Occupancy Sensor Changes
- Daylight Controls Changes
- Parking Garage Controls Requirements
- Automatic Receptacle Controls Requirement

C405.2 Lighting Controls

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C405.2 Lighting controls

Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.7.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:

1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
3. For each control strategy, configuration, and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

C405.2 Lighting Controls

Lighting controls are required in most interior spaces and can be accomplished using

- Sensors, relays and time-switches, or
- Luminaire Level Lighting Controls (LLLC)

When using LLLC, motion, daylight, timeouts and zoning configuration are required

Exceptions are made for security, emergency and egress purposes

C405.2.1 Occupant Sensor Controls

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C405.2.1 Occupant sensor controls

Occupant sensor controls shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms.
3. Copy/print rooms.
4. Lounges/breakrooms.
5. Enclosed offices.
6. Open plan office areas.
7. Restrooms.
8. Storage rooms.
9. Locker rooms.
10. Corridors.
11. Warehouse storage areas.
12. Other spaces 300 ft² or less that are enclosed by floor-to-ceiling height partitions.

Exception: Luminaires that are required to have specific application controls in accordance with Section C405.2.5.

C405.2.1 Occupant Sensor Controls

Motion sensors (C405.2.1) are required in most interior spaces

Corridors are added in 2021

Many *Exception* spaces require either a motion sensor or a time-switch as defined in section C405.2.5

C405.2.1.1 Occupancy Sensor Control Function

C405.2.1.1 Occupant sensor control function

Occupant sensor controls in warehouses shall comply with Section C405.2.1.2. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in corridors shall comply with Section C405.2.1.4. Occupant sensor controls for all other spaces specified in Section C405.2.1 shall comply with the following:

1. They shall automatically turn off lights within 20 minutes after all occupants have left the space.
2. They shall be manual on or controlled to automatically turn on the lighting to not more than 50-percent power.
3. They shall incorporate a manual control to allow occupants to turn off lights.

Exception: Fully automatic-on controls with no manual control shall be permitted in corridors, interior parking areas, stairways, restrooms, locker rooms, lobbies, library stacks and areas where manual operation would endanger occupant safety or security.

C405.2.1.2 Occupant sensor control function in warehouse storage areas

Lighting in warehouse storage areas shall be controlled as follows:

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an occupied setpoint of not more than 50 percent within 20 minutes after all occupants have left the controlled area.
3. Lights that are not turned off by occupant sensors shall be turned off by time-switch control complying with Section C405.2.2.1.
4. A manual control shall be provided to allow occupants to turn off lights in the space.

C405.2.1.1 Occupant Sensor Control Function

Occupant sensor controlled spaces must perform 3 functions:

1. Automatically shut OFF within 20 minutes
2. Either be manually turned ON or automatically turned to no higher than 50%
3. Include manual OFF capabilities

Fully automatic-ON sensors are permitted in select spaces like corridors, restrooms, parking garages and any space where safety is a concern

C405.2.1.2 Occupant Sensor Control Function - Warehouse

In warehouses:

1. Each aisleway requires independent control
2. Occ sensors must reduce lighting <50% within 20 min
3. A sensor or time-switch must further reduce lighting power to OFF
4. Include manual OFF capabilities

C405.2.1.3 Occupancy Sensor Function – Open Office

C405.2.1.3 Occupant sensor control function in open plan office areas

Occupant sensor controls in open plan office spaces less than 300 ft² in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall comply with all of the following:

1. The controls shall be configured so that general lighting can be controlled separately in control zones with floor areas not greater than 600 ft² within the open plan office space.
2. General lighting in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. General lighting in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.
3. The controls shall automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.

Exception: Where general lighting is turned off by time-switch control complying with Section 405.2.2.1.

4. General lighting in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.

C405.2.1.4 Occupant sensor control function in corridors

Occupant sensor controls in corridors shall uniformly reduce lighting power to not more than 50 percent of full power within 20 minutes after all occupants have left the space.

Exception: Corridors provided with less than two footcandles of illumination on the floor at the darkest point with all lights on.

C405.2.1.3 Occupant Sensor Control Function – Open Office

Open offices <300ft²: OFF ≤20min, auto-ON ≤50%, + manual OFF

Otherwise

1. Control zones cannot exceed 600 ft²
2. Motion within a control zone can trigger auto-ON to 100%
 - Adjacent spaces within the open office can auto-ON ≤20% or can remain unaffected
3. Auto-OFF is required within 20 min
 - **Exception added allowing auto-OFF via time switch; but this does not eliminate other sensor requirements**

C405.2.1.4 Occupant Sensor Control Function - Corridor

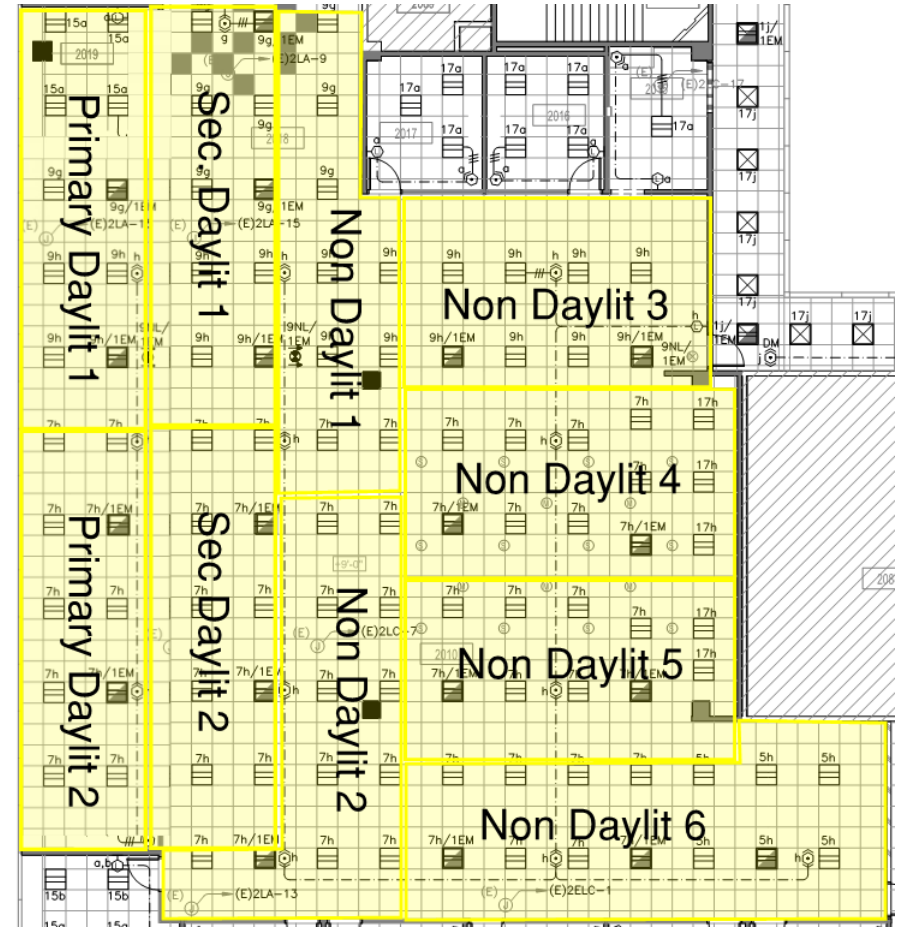
Sensors in corridors should uniformly reduce lighting to ≤50% within 20 min of being un-occupied

C405.2.1.3 – Impact (Open Offices)

Common Solution: 3 Control Zones



WSEC 2021 Updates: 10 Control Zones



C405.2.2 Time-Switch

Controls

C405.2 Time-Switch Controls

C405.2.2 Time-switch controls.

Each area of the building that is not provided with occupant sensor controls complying with Section C405.2.1.1 shall be provided with time-switch controls complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.4.
2. Spaces where patient care is directly provided.
3. Spaces where an automatic shutoff would endanger occupant safety or security.
4. Lighting intended for continuous operation.
5. Shop and laboratory classrooms.

C405.2.2.1 Time-switch control function

Time-switch controls shall comply with all the following:

1. Automatically turn off lights when the space is scheduled to be unoccupied.
2. Have a minimum 7-day clock.
3. Be capable of being set for seven different day types per week.
4. Incorporate an automatic holiday "shutoff" feature, which turns off all controlled lighting loads for not fewer than 24 hours and then resumes normally scheduled operations.
5. Have program backup capabilities, which prevent the loss of program and time settings for not fewer than 10 hours if power is interrupted.
6. Include an override switch that complies with the following:
 1. The override switch shall be a manual control.
 2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.
 3. Any individual override switch shall control the lighting for an area not larger than 5,000 ft².

Exception: Within mall concourses, auditoriums, sales areas, manufacturing facilities and sports arenas:

1. The time limit shall be permitted to be greater than 2 hours, provided that the switch is a captive key device.
2. The area controlled by the override switch shall not be limited to 5,000 ft² provided that such area is less than 20,000 ft².

C405.2.2 Time-Switch Controls

Spaces not defined to require occupant sensors must use time-switches for auto-OFF controls

Exceptions granted for patient care, safety and other specific applications.

C405.2.2 Time-Switch Control Function

Auto-OFF based on scheduled occupancy

Unique scheduling for each day of the week plus holidays

Must retain all programs & time settings for at least 10 hours

Include manual override that cannot exceed 2 hours and cannot control a space larger than 5000 ft²

Exceptions for control zone size and override duration in spaces like Malls, Auditoriums and Sports venues

C405.2.3 Light-Reduction

Controls

C405.2.3 Light-Reduction Controls

C405.2.3 Light-reduction controls

Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.
2. Luminaires controlled by special application controls complying with Section C405.2.5.
3. Where provided with manual control, the following areas are not required to have light-reduction control:
 1. Spaces that have only one luminaire with a rated power of less than 60 watts.
 2. Spaces that use less than 0.45 watts per square foot (4.9 W/m²).
 3. Corridors, lobbies, electrical rooms and/or mechanical rooms.

C405.2.3.1 Light-reduction control function

Spaces required to have light-reduction controls shall have a manual control that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonably uniform illumination pattern with an inter-mediate step in addition to full on or off, or with continuous dimming control, using one of the following or another approved method:

1. Continuous dimming of all luminaires from full output to less than 20 percent of full power.
2. Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.
3. Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.

C405.2.3 Light-Reduction Controls

When occ sensor are not used, manual light reduction controls are required to reduce the lighting without switching completely OFF

Except when automatic light reduction controls are implemented, or

In spaces with one light $\leq 60W$, spaces using $\leq 0.45W/ft^2$, Corridors, Lobbies Elec/Mech rooms

C405.2.3 Light-Reduction Control Function

Manual controls should reduce lighting in a “reasonably uniform illumination pattern” including:

1. Continuous dimming
2. High/low switching
3. Alternate luminaire switching
4. Another approve method

C405.2.4 Daylight Responsive Controls

C405.2.4 Daylight-Responsive Controls

C405.2.4 Daylight-responsive controls

Daylight-responsive controls complying with Section C405.2.4.1 shall be provided to control the general lighting within daylight zones in the following spaces:

1. Spaces with a total of more than 150 watts of general lighting within primary sidelit daylight zones complying with Section C405.2.4.2.
2. Spaces with a total of more than 300 watts of general lighting within sidelit daylight zones complying with Section C405.2.4.2.
3. Spaces with a total of more than 150 watts of general lighting within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.
2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.
3. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPAadj) calculated in accordance with Equation 4-9:

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)] \quad \text{where:}$$

LPAadj = Adjusted building interior lighting power allowance in watts.

LPAnorm = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.

UDZFA = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.

TBFA = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

C405.2.4 Daylight-Responsive Controls

Daylighting controls are required to control general lighting in spaces where:

- $\geq 150W$ of general lighting in Primary sidelit zones
- $\geq 300W$ of general lgtg in Primary & Secondary sidelit zones. *Sidelit daylighting zones now require primary and secondary control zones*
- $\geq 150W$ of general lighting within toplit zones
- Exceptions for health care, first floor of certain buildings and new buildings where the total connected lighting power is not greater adjusted lighting power based on equation 4-9

C405.2.4.1 Daylight-Responsive Control Function

C405.2.4.1 Daylight-responsive control function

Where required, daylight-responsive controls shall be provided within each space for control of lights in that space and shall comply with all the following:

1. Lights in toplit daylight zones in accordance with Section C405.2.4.3 shall be controlled independently of lights in sidelit daylight zones in accordance with Section C405.2.4.2.
 2. Lights in the primary sidelit daylight zone shall be controlled independently of lights in the secondary sidelit daylight zone.
 3. Daylight responsive controls within each space shall be configured so that they can be calibrated from within that space by authorized personnel.
 4. Calibration mechanisms shall be in a location with ready access.
 5. Daylight responsive controls shall dim lights continuously from full light output to 15 percent of full light output or lower.
 6. Daylight responsive controls shall be configured to completely shut off all controlled lights.
 7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through C405.2.1.4, daylight responsive controls shall continue to adjust electric light levels in response to available daylight but shall be configured to not increase the lighting power above the specified unoccupied setpoint.
 8. Lights in sidelit daylight zones in accordance with Section C405.2.4.2 facing different cardinal orientations [within 45 degrees (0.79 rad) of due north, east, south, west] shall be controlled independently of each other.
- Exceptions:**
1. Within each space, up to 150 watts of lighting within the primary sidelit daylight zone is permitted to be controlled together with lighting in a primary sidelit daylight zone facing a different cardinal orientation.
 2. Within each space, up to 150 watts of lighting within the secondary sidelit daylight zone is permitted to be controlled together with lighting in a secondary sidelit daylight zone facing a different cardinal orientation.

C405.2.4.1 Daylight-Responsive Controls Function

Toplit/sidelit and primary/secondary must be controlled independently

Daylight sensors must be capable of being calibrated within the controlled space and the controls must have “ready access”

Daylight sensor must provide continuous dimming from 100-15% and switch lighting loads completely OFF. *Previously, continuous dimming only applied to classrooms, offices, libraries and labs.*

When a space is unoccupied, a daylight sensor cannot control lights brighter than the unoccupied setpoint

Daylit zones facing different directions must be controlled independently. Except when there is $\leq 150W$ in the control zone

C405.2.4.2 Sidelit Daylight Zone

C405.2.4.2 Sidelit daylight zone

The sidelit daylight zone is the floor area adjacent to vertical fenestration that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).
2. Where the fenestration is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).
3. The secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 2 feet, whichever is less, as indicated in Figure C405.2.4.2(1). The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.
4. The area of the fenestration is not less than 24 ft².
5. The distance from the fenestration to any building or geological formation that would block access to daylight is greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
6. The visible transmittance of the fenestration is not less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

C405.2.4.2 Sidelit Daylight Zone

The following slides include diagrams and explanations for calculating primary and secondary daylight zones.

Note that if the fenestration (window) is $\leq 24 \text{ ft}^2$ then daylighting is not required

C405.2.4.2 Sidelit Daylight Zone - Figures

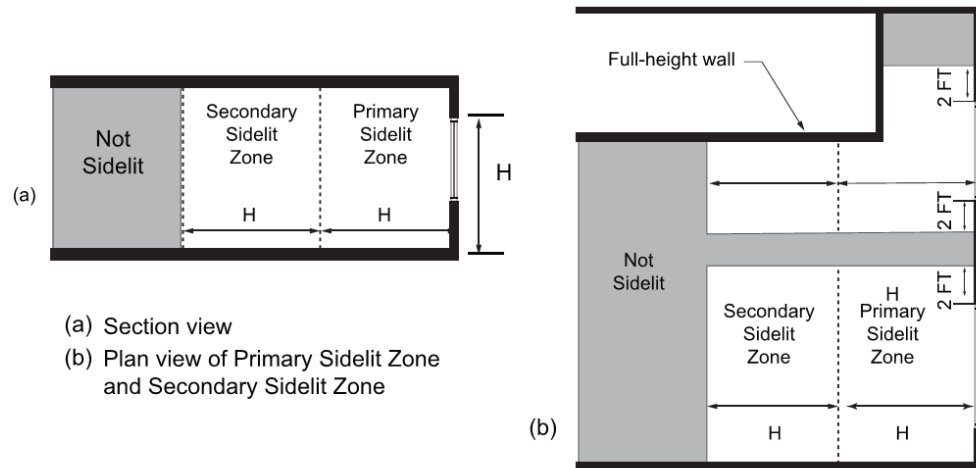


FIGURE C405.2.4.2(1)
PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

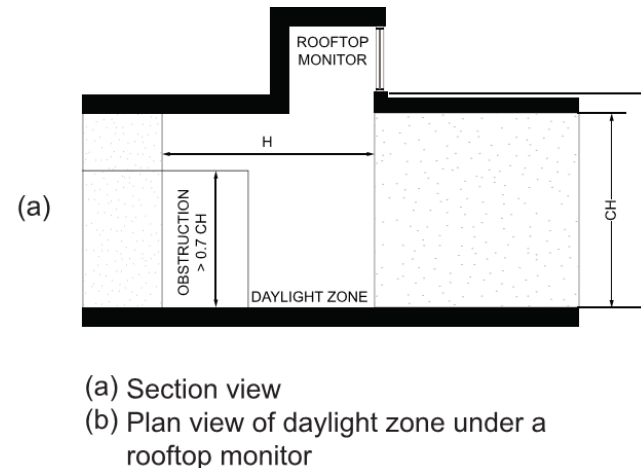


FIGURE C405.2.4.2(2)
DAYLIGHT ZONE UNDER A ROOFTOP MONITOR

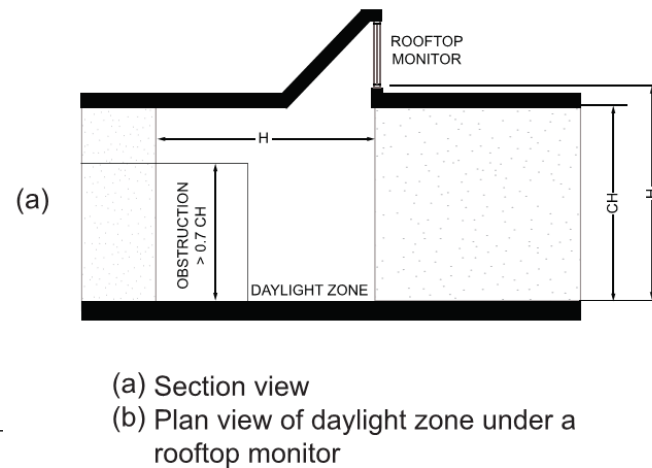


FIGURE C405.2.4.2(3)
DAYLIGHT ZONE UNDER A SLOPED ROOFTOP MONITOR

C405.2.4.3 Toplit Daylight Zone

C405.2.4.3 Toplit daylight zone

The toplit daylight zone is the floor area underneath a roof fenestration assembly that complies with all the following:

1. The toplit daylight zone shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.7 times the ceiling height, whichever is less, as indicated in Figure C405.2.4.3.
2. Direct sunlight is not blocked from hitting the roof fenestration assembly at the peak solar angle on the summer solstice by buildings or geological formations.
3. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly divided by the area of the toplit zone is not less than 0.008.

C405.2.4.4 Atriums

Daylight zones at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.4.4.

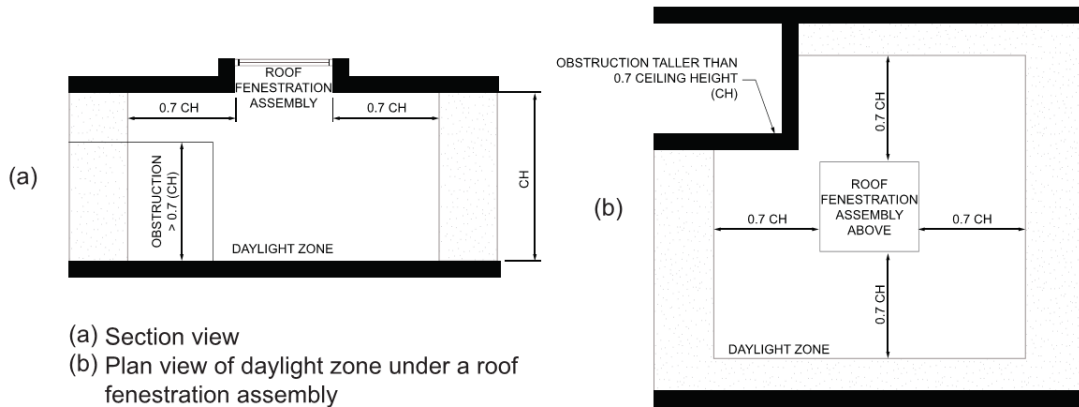
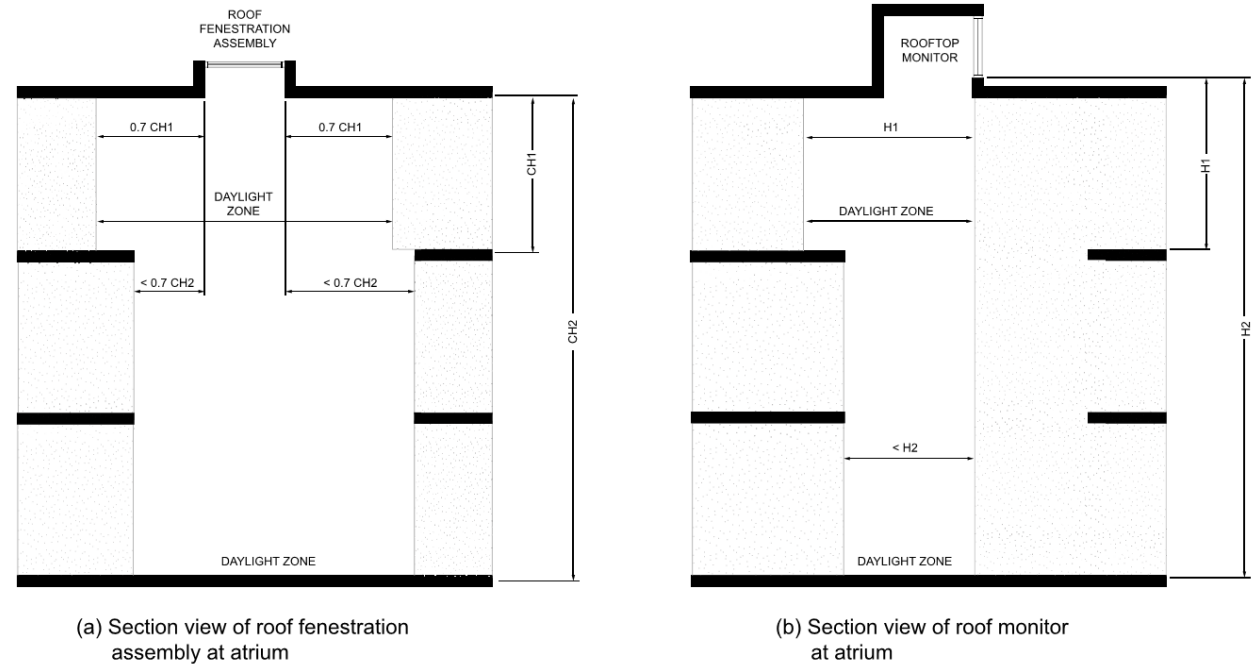


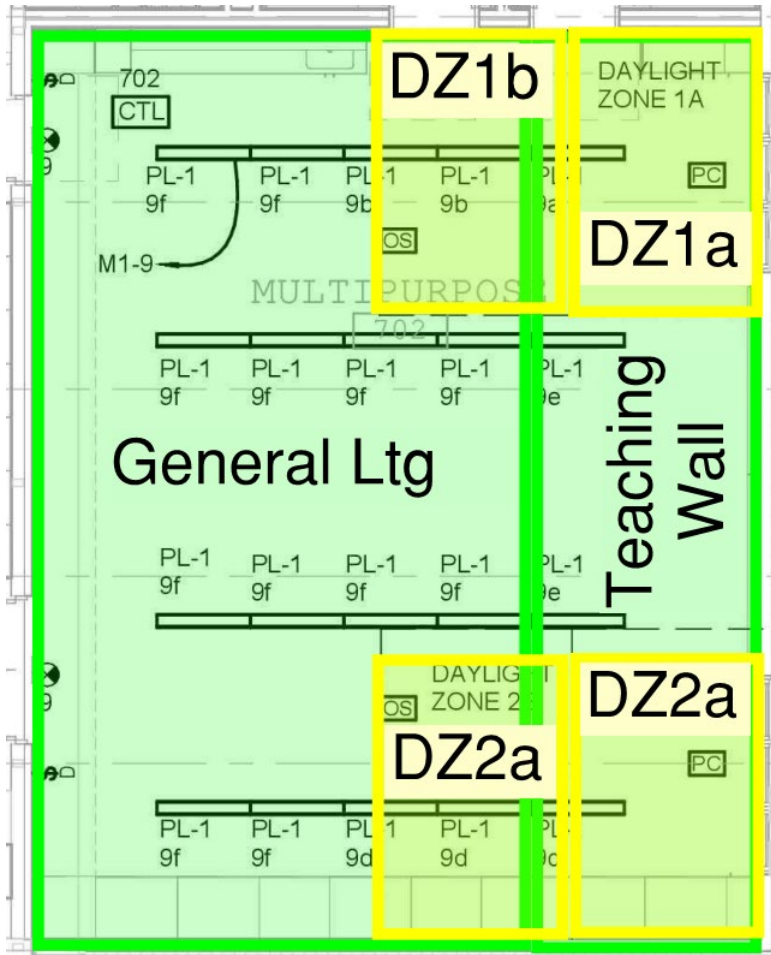
FIGURE C405.2.4.3
TOPLIT DAYLIGHT ZONE



C405.2.4.4
DAYLIGHT ZONES AT A MULTISTORY ATRIUM

C405.2.4 Daylight-Responsive Controls - Solutions

Typical Space



Wired Solution

Materials

- Room Controllers
- Occupancy Sensors
- Switch Stations
- Daylight Sensors

With a wired solution, wiring within linear runs needs to be broken per control zone

Hybrid Solution



Integral controls per 8' segment plus loose sensors (wired or wireless) provide a cost-effective alternate

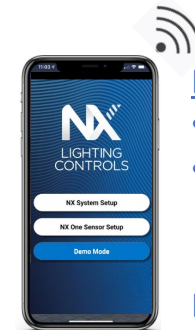


In-fixture control module

T24 daylighting requirements plus end-user control requirements can create many zones within a simple space.

130.1(d)2: Linear lighting that spans daylit zones must be uniquely controllable in ≤ 4 ft increments.

Wireless Solution



Materials

- Pendant fixture w/ integrated sensors
- Dimmer Switch

Each 8' foot length would include a sensor and controller. Zones could be defined as needed

C405.2.4 Daylight-Responsive Controls – Sensor Options

Five body styles, each includes

- Motion Sensing
- Daylight Sensing
- Bluetooth radio
- 2.4GHZ Wireless Mesh radio



-HMO



High Bay, Warehouse & Area Light



-LMO



Low Bay, Gymnasiums, Warehouse, Site & Area



-OMNI



Office, Education, Healthcare



-LMI



Architectural, Healthcare, Hospitality, Office



-SMI



Troffers, Office, Classrooms

| | | | | | |
|---------------------|---|-------------|------------|------------|------------|
| Max Mounting Height | Indoor 16ft – 45ft Outdoor 16ft – 45ft | 12ft – 16ft | 8ft – 14ft | 8ft – 12ft | 8ft – 12ft |
| Coverage | 1 : 1.4 | 1 : 3 | 1 : 2.75 | 1 : 1 | 1 : 1 |

C405.2.5 Specific Application Controls

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Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:
 1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.
 2. Display and accent.
 3. Lighting in display cases.
 4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
 5. Lighting equipment that is for sale or demonstration in lighting education.
 6. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
2. Sleeping units shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

Exceptions:

1. Lighting and switched receptacles controlled by card key controls.
2. Spaces where patient care is directly provided.
3. Permanently installed luminaires within dwelling units shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.
4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.
5. Task lighting for medical and dental purposes that is in addition to general lighting shall be provided with a manual control.

C405.2.5 Specific Application Controls

Section *C405.2.1 Occupant Sensor Controls* refers here for exceptions to occ sensor requirements. However, this section defines:

- Specific applications like displays, accent lights, task lighting, sales lighting, museum exhibits, monuments.
- And says these “specific applications” shall be controlled by an occ sensor or a time-switch and requires a manual switch so these lights can be controlled independent of the general lighting

C405.2.6 Manual Controls

C405.2.6 Manual Controls

C405.2.6 Manual controls

Where required by this code, manual controls for lights shall comply with the following:

1. They shall be in a location with ready access to occupants.
2. They shall be located where the controlled lights are visible or shall identify the area served by the lights and indicate their status.

Key Points

Manual controls must be readily accessible to occupants

If lights are not visible from the switch location then indicator lights are required on the control station

C405.2.7 Exterior Lighting

Controls

C405.2.7 Exterior Lighting Controls

C405.2.7 Exterior lighting controls

Exterior lighting systems shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.2.7.1 Daylight shutoff

Lights shall be automatically turned off when daylight is present and satisfies the lighting needs.

C405.2.7.2 Building facade and landscape lighting

Building facade and landscape lighting shall automatically shut off from not later than 1 hour after business closing to not earlier than 1 hour before business opening.

C405.2.7.3 Lighting setback

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:
 1. From not later than midnight to not earlier than 6 a.m.
 2. From not later than one hour after business closing to not earlier than one hour before business opening.
 3. During any time where activity has not been detected for 15 minutes or more.
2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

C405.2.7 Exterior Lighting Controls

With the exception of vehicle entrances/exits and lighting controlled within dwellings, exterior lights must be automatically turned off when daylight is present

Façade and landscaping must be off from 1 hour after business closes until 1 hour prior to opening

All other outdoor lights must reduce by $\geq 50\%$ using one method:

1. Defined time: Midnight – 6am
2. Business hours: Closing +1hr – Opening -1hr
3. Motion sensors: 15 min max

Parking area lights that are $>78W$ and are mounted $\leq 24ft$ require occ sensors to reduce lights by at least 50%. Sensors can be zoned to control a max of 1500W

C405.2.7.4 Exterior Time-Switch Controls

C405.2.7.4 Exterior time-switch control function

Time-switch controls for exterior lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.
2. They shall be capable of being set for seven different day types per week.
3. They shall incorporate an automatic holiday setback feature.
4. They shall have program backup capabilities that prevent the loss of program and time settings for a period of not less than 10 hours in the event that power is interrupted.

C405.2.7.4 Exterior Time-Switch Control Function

Unique scheduling for each day of the week plus holidays

Must retain all programs & time settings for at least 10 hours

C405.2.8 Parking Garage Lighting Control

C405.2.8 Parking garage lighting control.

Parking garage lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 ft².

Exception: Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.

2. Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.

3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

Exceptions:

1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.
2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.
3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interior space.

C405.2.8 Parking Garage Lighting Control

Parking garage lights must be controlled by either an occ sensor or timer.

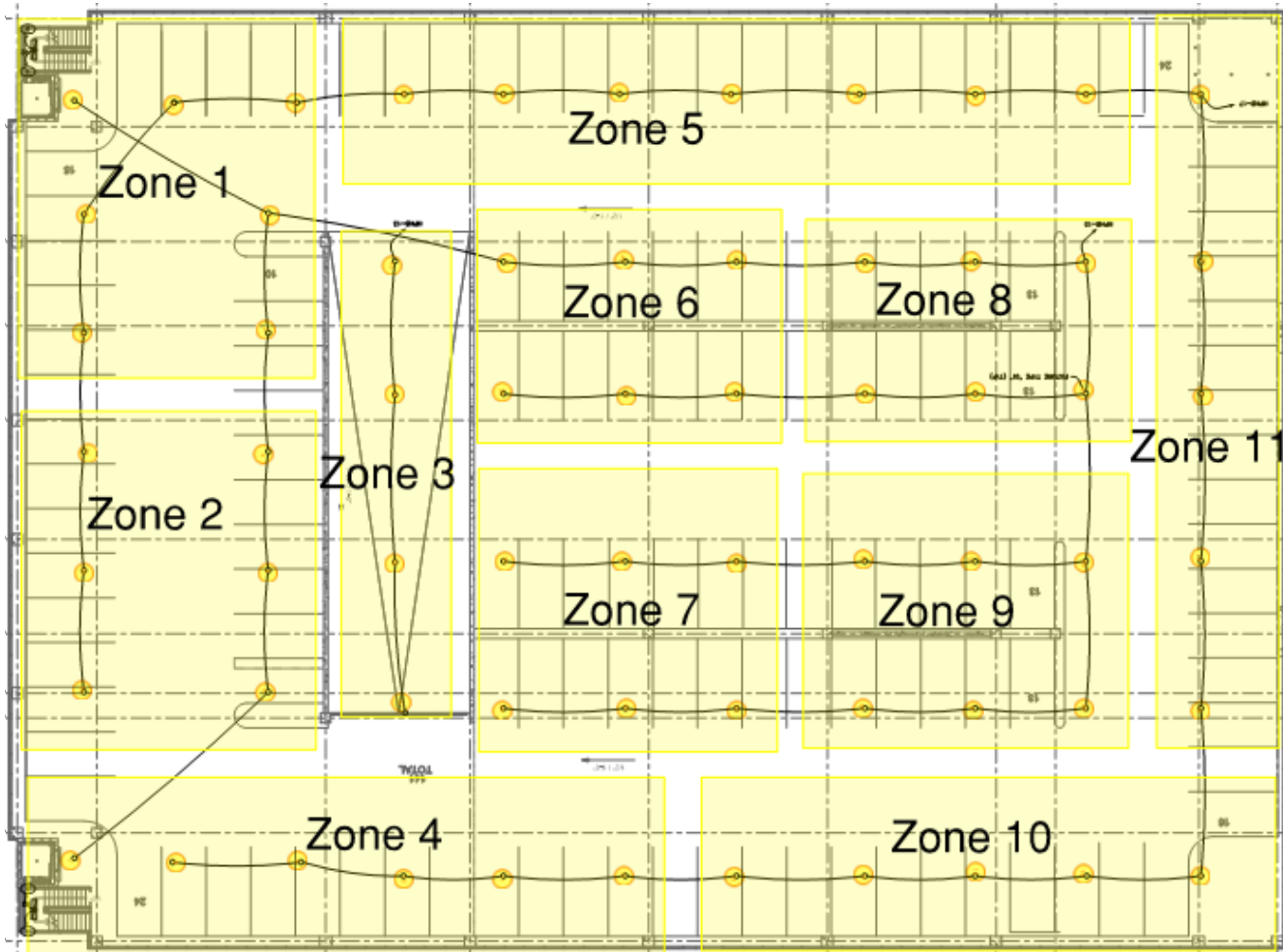
Each luminaire must reduce to $\leq 70\%$ after 20 min of in-activity unless floor-illumination is ≤ 1.5 fc. Lights can be controlled in zones of up to 3600 ft².

In transition areas (entrances/exits) lighting must reduce at to $\leq 70\%$ from sunrise to sunset

In daylight areas, lights must *automatically reduce in response to daylight* by at least 50% with defined exceptions

Time-based controls are allowed but are impractical because each luminaire must reduce lighting. This means either using high/low drivers with dual circuits to each fixture, or completely shutting the lights OFF at scheduled times.

C405.2.8 Parking Garage Lighting Control - Solutions



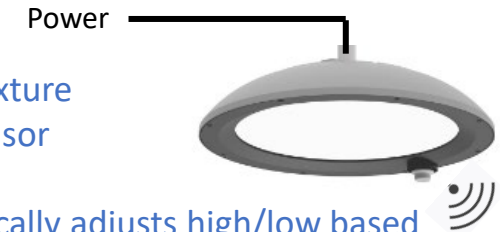
Wireless Solutions

Option 1: Garage Lights w/ Standalone Integrated Sensors

Materials

- Garage Lighting fixture w/ integrated sensor

Each fixture automatically adjusts high/low based on local occupancy/vacancy



Option 2: Garage Lights w/ Networkable Integrated Sensors

Materials

- Garage Lighting fixture w/ integrated sensor
- Wireless Gateway

Each fixture shares occupancy status with gateway. Gateway shares status with lights in each zone. Code permits ≤ 3600 ft² per control zone.



Wire Types

- Line Voltage Power
- 0-10v Dimming
- Cat 5/6

C405.3 Interior Lighting Power Requirements

C405.4 Lighting for plant growth and maintenance

C405.5 Exterior Lighting Power Requirements

C405.6 Dwelling electrical meter

C405.7 Electrical transformers

C405.8 Electric motors

C405.9 Vertical & horizontal transportation systems

C405.10 Voltage drop

C405.11 Automatic Receptacle Control

C405.11 Automatic Receptacle Control

C405.11 Automatic receptacle control

The following shall have automatic receptacle control complying with Section C405.11.1:

1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems.
2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

C405.11 Automatic Receptacle Control

Automatic controls are required for $\geq 50\%$ of all 120V 15 or 20A receptacles in:

- Private offices
- Conference rooms
- Print/Copy rooms
- Breakrooms
- Classrooms
- Including those in modular partitions and module workstations

Modular furniture not shown on construction doc must include controls for 25%

C405.11.1 Automatic Receptacle Control Function

C405.11.1 Automatic receptacle control function.

Automatic receptacle controls shall comply with the following:

1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches of each uncontrolled receptacle.
 2. One of the following methods shall be used to provide control:
 1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 ft² and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 ft²
 2. An occupant sensor control that shall turn off receptacles within 20 min of occupants leaving a space.
 3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the area is unoccupied.
 3. All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.
 4. Plug-in devices shall not comply.
- Exceptions:** Automatic receptacle controls are not required for the following:
1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
 2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.
 3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches, but not more than 72 inches from the controlled receptacles serving that Workstation.

C405.11.1 Automatic Receptacle Control Function

If not using split receptacles, then a controlled plug must be located within 12" of each uncontrolled plug

Control method can be:

- Time based: Can control ≤ 5000 ft², & overrides can't exceed 2 hrs
- Occupancy based: Auto-OFF if space is vacant for 20 min
- Security system based: Auto-OFF when security system is armed

Must be permanently installed, permanently marked, and uniformly distributed

Exceptions limited to occupant safety, and to plug dedicated to 24/7 loads (clocks, refrigerators, network equipment)

C405.12 Energy Monitoring

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C405.12 Energy monitoring

New buildings with a gross conditioned floor area of 25,000 ft² or larger shall be equipped to measure, monitor, record, and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exception: R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 ft² of conditioned floor area.

C405.12.1 Electrical energy metering

For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities, and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

C405.12.2 End-use metering categories

Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 ft² where a dedicated source meter complying with Section C405.12.3 is provided.

C405.12 Energy Monitoring

New buildings with conditioned space $\geq 25,000$ ft² must be equipped to measure, monitor, record and report energy consumption

Applies to a variety of categories including Interior Lighting, Exterior Lighting and Plug Loads

TABLE C405.12.2
ENERGY USE CATEGORIES

| LOAD CATEGORY | DESCRIPTION OF ENERGY USE |
|---|---|
| Total HVAC system | Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use. |
| Interior lighting | Lighting systems located within the building. |
| Exterior lighting | Lighting systems located on the building site but not within the building. |
| Plug loads | Devices, appliances and equipment connected to convenience receptacle outlets. |
| Process load | Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens. |
| Building operations and other miscellaneous loads | The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems. |

C405.12.3 Meters

C405.12.3 Meters

Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter.

Lighting, HVAC, or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ± 2 percent.

Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

C405.12.4 Data acquisition system.

A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly, and yearly logged data for each end-use category required by Section C405.12.2.

C405.12.5 Graphical energy report

A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month, and year for the previous 36 months.

C405.12.3 Meters

Meters are required to automatically communicate energy consumption.

Current sensors are permitted instead of meters provided they are accurate $\pm 2\%$

Data must be stored for ≥ 36 months, and acquisition system must be able to recall consumption hourly, daily, monthly, and yearly within this period

Graphical energy reports must be readily access for all consumption periods noted above