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IMPROVEMENTS TO LIGHTING ACCEPTANCE TESTING FOR LUMINAIRE LEVEL LIGHTING CONTROLS

July 17, 2026

California Energy Commission

Docket No. 25-BSTD-03

The California Statewide Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (CEC's) efforts to update California's Energy Code (Title 24, Part 6), including revisions to simplify and clarify existing code requirements. Three California Investor-Owned Utilities (IOUs) — Pacific Gas & Electric Company (PG&E), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE) sponsored this effort as a group.

This letter recommends adjustments to the language in Nonresidential Appendix 7.6, Indoor Lighting Controls Acceptance Tests, to provide clarity on luminaires that have individual sensors for daylight, occupancy, or both. These luminaires, often referred to as Luminaire Level Lighting Controls (LLLC), are becoming more prevalent in non-residential spaces. They can be programmed to either operate in groups similar to non-LLLCs or independent of one another, which can pose an issue during acceptance testing when trying to determine what should be adequate for sampling.

The intent of the proposed changes is to address fellow stakeholder concerns, ensure consistent interpretation and application of the requirements, and to support strong compliance. This letter does not recommend changes that will increase the stringency of existing requirements or recommend that existing requirements be applied more broadly. As such, a cost-effective analysis or use of the full Energy Commission codes and standards enhancement report template is not required. The outreach for this letter and the separate letter on updates to the partial daylighting test was conducted partly in coordination but docketed independently. If either or both proposals move forward, the proposed language should be revised accordingly.

1.1 Measure Description and Justification

Proposal Description

Once considered a premium feature, Luminaire-Level Lighting Controls (LLLCs) are now becoming standard installations in offices, retail spaces, warehouses, as well as other building types. By enabling precise control at the individual fixture level, they offer flexibility in meeting or exceeding Energy Code requirements, managing energy consumption, and enhancing occupant comfort.

There is no agreed-upon definition for LLLC, and in the context of acceptance testing and this comment letter, the term “LLLC” is used to broadly refer to luminaires with integrated sensors and controls. Each luminaire can perform occupant sensing and daylight responsive controls independently. Certain LLLCs additionally have networking capability, providing options for grouping luminaires and sensors together for combined control. For the purpose of contrasting LLLC systems, “non-LLLC” is used throughout the comment letter and in the code language markup to refer to control systems where sensors are mounted separately on the ceiling or wall, each controlling multiple luminaires.

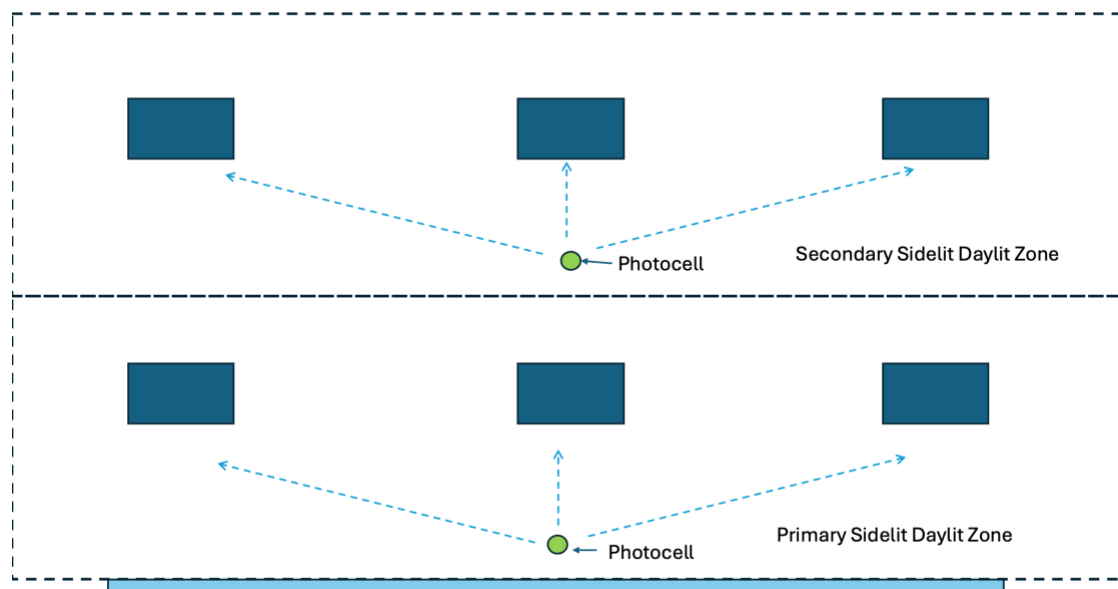


Figure 1: Example of a non-LLLC system, one sensor controls multiple luminaires

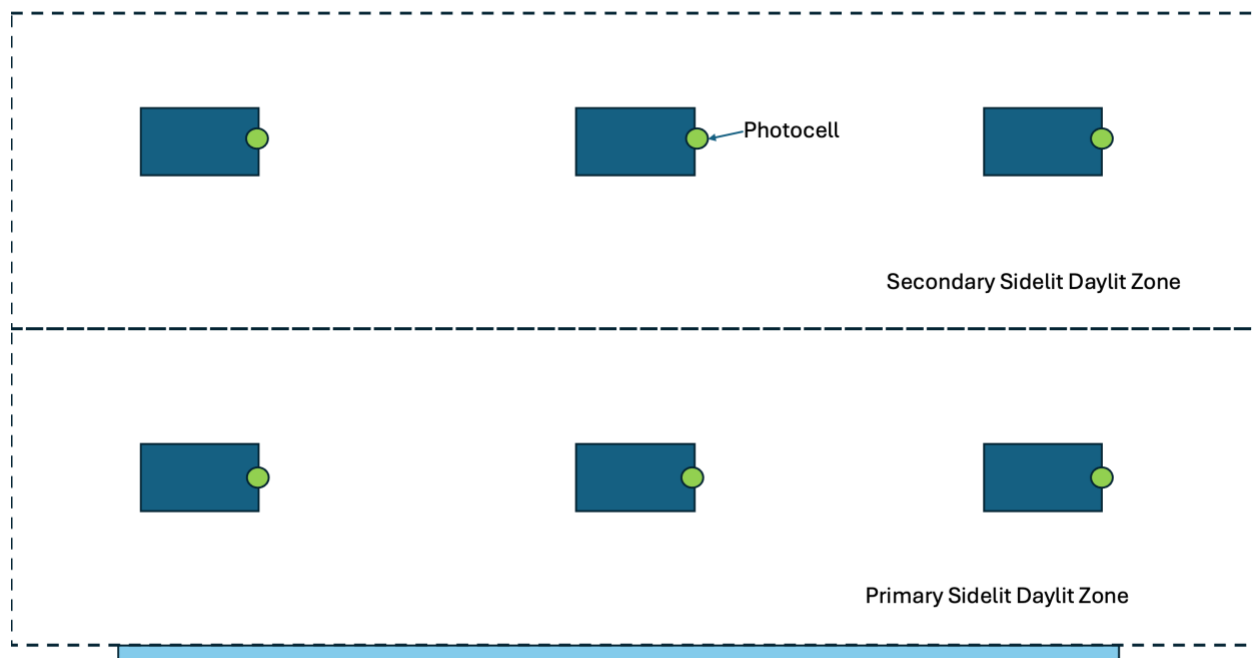


Figure 2: Example of an LLLC system, each luminaire has its own sensor

The current acceptance testing sampling procedure does not account for the flexibility of these systems, causing confusion about how to determine a representative number of luminaires for testing and potentially leading to inconsistent compliance enforcement.

The Statewide CASE Team proposes adding a distinction between two types of LLLC system configurations: “connected LLLCs” and “individually controlled LLLCs”. Connected LLLCs are configured to function similarly to non-LLLC systems, with a primary LLLC luminaire controlling other secondary LLLC luminaires; namely, the control responses of a group of LLLC luminaires are identical and are determined based on the sensor of the primary LLLC luminaire. Individually controlled LLLCs are configured such that each LLLC luminaire behaves independently based on its own sensors. For individually controlled LLLCs, a different sampling approach for occupancy and daylight sensors, as well as a method for determining daylight testing reference locations, is proposed to verify overall system functionality without placing an undue burden on Acceptance Testing Technicians (ATTs).

Recommendations:

- Add a description to distinguish between connected and individually controlled configurations of LLLCs that necessitate different sampling and testing approaches. Connected LLLC systems refer to a group of LLLCs that have a designated primary luminaire and secondary luminaires that respond to control

triggers following the primary luminaire's daylight or occupant sensor. Conversely, individually controlled LLLCs respond to control triggers individually.

- Clarify that in the case of non-LLLC systems or connected LLLC systems, the procedure remains unchanged.
- For individually controlled LLLCs, a minimum of three luminaires in similar areas must be tested.
- Recommend that the ATTs have access to the LLLC system's programming or control application user interface where applicable. The reasoning behind this is informed by conversations with ATTs who stated that access to and familiarity with the control application user interface were key determinants of how much time acceptance testing took for LLLC systems. Additionally, it can reduce time investment when readjustment and subsequent retesting are necessary, possibly allowing for a quicker turnaround.

1.2 Benefits of Proposed Change

The market share of LLLCs has been increasing and is on track to follow projections set by the Northwest Energy Efficiency Alliance (NEEA) in 2014. In NEEA's [Luminaire Level Lighting Controls Market Baseline](#), prepared by Navigant Consulting, LLLCs were projected to have a market penetration of 34 percent by 2033. Ameren Illinois also projected a 0.90 percent market share in 2025, rising to 8.87 percent in 2033 and then 39.34 percent in 2050 in its 2023 Illinois Energy Efficiency Stakeholder Advisory Group presentation titled "[Luminaire Level Lighting Controls Market Transformation Initiative Business Plan Summary](#)." California typically leads the nation in technology adoption, so its market share is expected to be at least on par with these markets. Yet the current acceptance testing procedures have not kept pace and do not align well with the flexibility of LLLCs.

By differentiating between connected LLLCs and individually controlled LLLCs, an updated acceptance testing procedure will:

- Improve the process based on ATT feedback to support the overall compliance community.
- Provide clear test instructions for testing LLLC systems for consistent sampling.
- Ensure the intent of the building code and compliance standards are followed.

The Statewide CASE Team considered the costs and time ATTs dedicate to each acceptance testing project, leading to the recommendation of separate sampling approaches for connected LLLCs and individually controlled LLLCs.

1.3 Stakeholder Engagement to Inform Proposal

When developing this comment letter, the Statewide CASE Team worked with many industry stakeholders, including ATTs. An online survey was sent out in coordination with the California Lighting Technology Center (CLTC), which distributed the survey to the California Advanced Lighting Controls Training Program (CALCTP) and the National Lighting Contractors Association of America (NLCAA). The survey was conducted in conjunction with the partial daylighting test comment effort and received a total of 92 responses, 48 of which had experience performing acceptance testing on LLLCs. In addition, the Statewide CASE Team conducted follow-up phone interviews with five ATTs. Findings include:

- Over 50 percent of ATTs test LLLCs by space and room. Follow-up interviews suggest that this is due to LLLCs usually being programmed with a connected control configuration. A smaller but notable portion of respondents reported using a hybrid testing approach, where some functions are tested individually while others are grouped. Fewer respondents grouped luminaires by identical control profiles or by network/control zone. Approximately nine percent of ATTs test each luminaire independently. This indicates that there is still variability in how LLLC systems are organized and tested in the field, highlighting the need for greater clarity in the test procedure.
- Survey responses indicated that, for most ATTs, acceptance testing time for LLLC systems is comparable to non-LLLC systems. Nearly half of respondents reported that testing takes about the same amount of time, while 31 percent said LLLC systems take slightly more time or much more time.
- The interviewed ATTs noted that software familiarity is a huge factor in the timeliness of the acceptance testing, and in some cases, if there is no access to the control application user interface, failures may mean repeat visits.
- Years of experience inform the need for clarity in testing LLLCs, with more experienced ATTs having developed approaches to testing connected LLLCs and individually controlled LLLCs, which could lead to uneven compliance. There was general agreement that a different sampling approach would be beneficial if it does not increase the time or overall burden to ATTs.

1.4 Proposed Code Language

The proposed code language affects the acceptance test procedures in the Reference Appendices NA7.6 Indoor Lighting Controls Acceptance Test and its subsections.

- **NA7.6 Indoor Lighting Controls Acceptance Tests**

- If there are no LLLCs present, then this is a non-LLLC system, and there are no proposed changes
- If LLLCs are grouped with a primary luminaire that dictates the control behavior of other luminaires in the group, the system configuration is considered a connected LLLC system. ATTs would need to confirm the grouping of LLLCs.

- **NA7.6.1.2 Functional Testing – Sampling**

- If each LLLC luminaire's sensor responds independently of other luminaires, the system configuration is considered an individually controlled LLLC system.
- If the system is configured as individually controlled LLLCs for daylight responsive controls, and if there are more than three luminaires with similar sensors and cardinal orientations of glazing, those luminaire-integrated photocontrols can be included in the same sample group. At least three luminaire-integrated photocontrols shall be tested. If any photocontrol fails, examine it, correct the failure, and retest. When retesting, an additional two luminaire-integrated photocontrols in the sample group shall be tested, and all must pass. If any tested photocontrol fails, the system is considered to have failed the acceptance test.
- If the system is configured as connected LLLCs for daylight responsive controls, the original sampling method shall be used.

- **NA7.6.1.4**

- **Reference Location**

For individually controlled LLLCs, the ATT should choose a reference location relative to the daylit area of the individually controlled LLLC being tested. This will allow the ATT to use either the illuminance method or the distance method without modifying the existing procedure for determining the reference location.

Currently, the reference location is relative to the entire daylit area, which is designed for luminaires that are controlled in groups by non-LLLC systems or connected LLLC systems. The procedure of determining the reference location would not change whether there is a sensor on each luminaire or a separately mounted sensor controlling multiple luminaires. See the example provided in Figure 3. Note that the reference location in Figure 3 is provided for illustration purposes, and an ATT's choice of reference location may vary due to onsite factors.

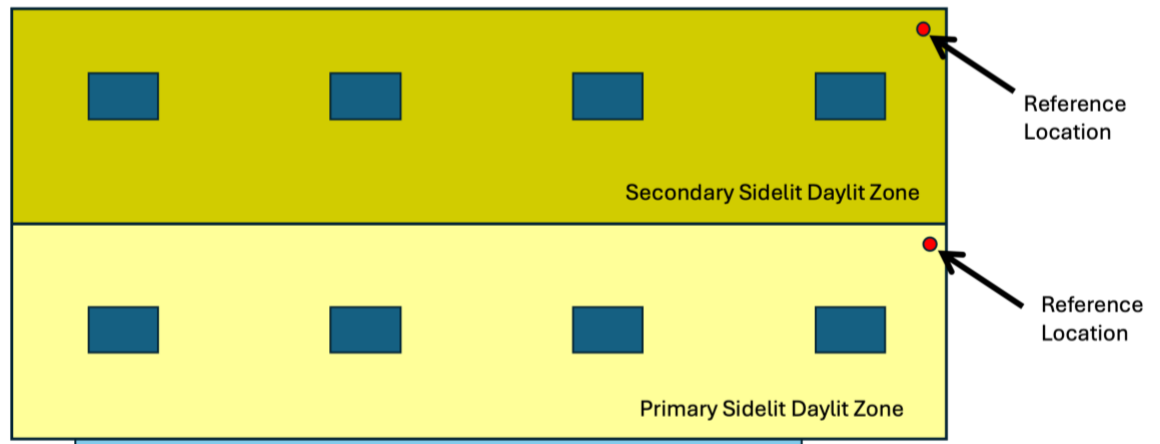


Figure 3: Example of Reference Location as written in current Standards

By subdividing the daylit zone as shown in Figure 4, it allows for the reference location methodology to remain unchanged while allowing for testing of individually controlled LLLCs. Note that the reference location with respect to every individually controlled LLLC is shown in Figure 4 for illustration purposes. For functional testing using the allowed sampling approach in NA7.6.1.2, only selected luminaires within a sample group need to be tested; therefore, the ATT only needs to determine the reference locations relative to those tested luminaires.

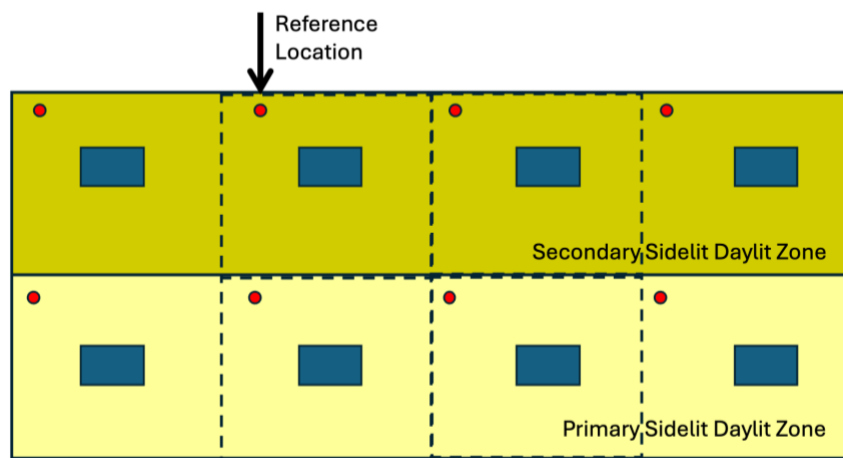


Figure 4: Example of proposed reference location for individually controlled LLLCs

- (c) **Full Daylight Test.**

- If the system is configured as individually controlled LLLCs for daylight responsive controls, use the individually controlled LLLC reference location method.
- If the system is configured as connected LLLCs for daylight responsive controls, the original sampling method and procedure shall be used, as there are no proposed changes to the existing code.
- **NA7.6.2.2 Occupant Sensing Lighting Controls Functional Testing – Sampling**
 - If there are seven (7) or fewer occupant sensors in the building, all occupant sensors shall be tested.
 - If the system is configured as individually controlled LLLCs for occupant sensing controls, and if there are more than seven (7) occupant sensors in the building, all occupant sensors in areas with similar geometry can be included in a sample group. If three occupant sensors in the sample group pass the functional test, the remaining occupant sensors in the sample group also pass. If it fails, it must be repaired or readjusted until it passes.
 - If the system is configured as connected LLLCs for occupant sensing controls, the original sampling method shall be used.

1.5 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents are marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

APPENDIX JA1 – Definitions

LUMINAIRE LEVEL LIGHTING CONTROL (LLLC) SYSTEM is a lighting system consisting of one or more luminaires, each with embedded lighting control logic, and occupant and ambient light sensors. The system may also have networking capabilities and local override switching capability, where required.

CONNECTED LLLC SYSTEM is an LLLC system configured with a primary luminaire dictating the responses of other luminaires in the group to the control triggers based on its sensor inputs.

INDIVIDUALLY CONTROLLED LLLC SYSTEM is an LLLC system in which each luminaire responds to control triggers based on its sensor inputs, independently of the other luminaires.

NA7.6 Indoor Lighting Controls Acceptance Tests

For lighting control systems with luminaires equipped with integrated photosensors and occupant sensors, commonly known as Luminaire Level Lighting Controls (LLLCs), the following shall apply. Otherwise, if the control system has no LLLCs and utilizes sensors and controls mounted separately from the luminaires, it is referred to as a non-LLLC system in the test procedure.

If LLLCs are grouped with a primary luminaire that dictates the control behaviors of other luminaires in the group based on its sensor inputs, the system configuration is considered a connected LLLC system. The control behavior of LLLC systems with connected LLLC controls is similar to that of non-LLLC systems, wherein the primary luminaire and its sensor shall be tested.

If each LLLC luminaire's sensor responds independently of other luminaires, the system configuration is considered an individually controlled LLLC, and the sampling procedure for the Individually controlled LLLC Systems shall be used.

Whether the LLLC system is a connected LLLC or an individually controlled LLLC shall be evaluated separately for the Daylight Responsive Controls Acceptance Tests in NA7.6.1 and the Shut-off Controls Acceptance Tests in NA7.6.2.

NA7.6.1 Daylight Responsive Controls Acceptance Tests

NA7.6.1.1 Construction Inspection

Prior to Functional testing, verify and document the following:

- a) The daylit zones are shown on plans documents.
- b) The general lighting in skylit daylit zones, primary sidelit daylit zones and secondary sidelit daylit zones is controlled by daylighting responsive controls. In parking garages, the general lighting in the combined primary and secondary sidelit daylit zones is controlled by daylighting responsive controls.
- c) The daylighting responsive controls provide separate control for luminaires in each type of daylit zone. General lighting in overlapping skylit daylit zone and a

sidelit daylight zone are controlled as part of the skylit zone. General lighting in both a primary sidelit daylight zone and secondary sidelit daylight zone are controlled as part of the primary sidelit daylight zone.

- d) All photosensors are not readily accessible to unauthorized personnel.
- e) [If an LLLC system is present, obtain relevant documentation or control system access to determine whether the system in the area being tested is configured as a connected LLLC system or an individually controlled LLLC system for daylight responsive controls.](#)

NA7.6.1.2 Functional Testing - Sampling

[Non-LLLC and Connected LLLC Systems:](#)

All photocontrols serving more than 5,000 ft² of daylight area shall undergo functional testing. Photocontrols that are serving smaller spaces may be sampled as follows:

For buildings with up to five (5) photocontrols, all photocontrols shall be tested. For buildings with more than five (5) photocontrols, sampling may be done on spaces with similar sensors and cardinal orientations of glazing; sampling shall include a minimum of one (1) photocontrol for each group of up to five (5) additional photocontrols. If the first photocontrol in the sample group passes the functional test, the remaining photocontrols in the sample group also pass. If the first photocontrol in the sample group fails the functional test, the rest of the photocontrols in the group shall be tested. If any tested photocontrol fails the functional test, it shall be repaired, replaced, or adjusted until it passes the test.

For each photocontrol to be tested, test each group of lights controlled separately by the photocontrol according to the protocol in NA7.6.1.4 and NA7.6.1.5. In all interior spaces other than parking garages, separate tests are conducted for daylighting control of the primary sidelit daylight zone and for daylight control of the secondary sidelit daylight zone. In parking garages, the tests are conducted on daylighting controls that control the combined area of the primary and secondary sidelit daylight zone.

[Individually Controlled LLLC Systems:](#)

[For buildings with up to three \(3\) LLLC luminaires, all luminaire-integrated photocontrols shall be tested. For buildings with more than three \(3\) LLLC luminaires, luminaire-integrated photocontrols in spaces with similar photosensors and cardinal orientations of glazing may be included in the same sample group. A minimum of three \(3\) photocontrols in the sample group shall be independently tested. If the tested](#)

photocontrols pass, all photocontrols in the sample group pass. If any of the photocontrols fail the test, they shall be repaired, adjusted, and then retested with an additional two photocontrols in the sample group until they pass.

NA7.6.1.3 RESERVED

NA7.6.1.4 Continuous Dimming Control Systems Functional Testing

- a) **Reference Location.** Identify the minimum daylight location in the controlled zone (Reference Location) for each daylight zone type (skylit, primary sidelit, and secondary sidelit) in the space. This can be identified using either the illuminance method or the distance method and will be used for illuminance measurements in subsequent tests. For parking garages, the reference location should always be the farthest edge of the secondary sidelit daylight zone away from the opening or glazing. For individually controlled LLLCs, the controlled zone is determined by subdividing the daylight zone per LLC luminaire. The controlled zone is the area within the daylight zone that is primarily illuminated by the luminaire being tested.

Illuminance Method

The Reference Location is the task location with lowest daylight illuminance in the zone illuminated by controlled luminaires. Turn off controlled lighting and measure daylight illuminance within zones illuminated by controlled luminaires. (Note: turn the controlled lighting back on before proceeding to the No Daylight Test)

Distance Method

The Reference Location is the task location within the zone illuminated by controlled luminaires that is farthest away from daylight sources.

- b) **No Daylight Test.** Simulate or provide conditions without daylight. Verify and document the following:
1. Document the reference illuminance at the Reference Location, which is the electric lighting illuminance level at the Reference Location.
 2. Daylight responsive control system turns on all controlled lighting to full light output (full design output, or full programmed output) unless it has

been documented, such as in design documents, that continuous dimming luminaires have been intentionally tuned to less than full light output.

3. Light output is stable with no visible flicker.

c) **Full Daylight Test.** [For all systems](#), simulate or provide bright conditions where the daylight illuminance is greater than 150 percent of the reference illuminance (measured during the No Daylight Test). Alternatively, provide simulated bright conditions by shining a bright light into the daylight sensor. Verify and document the following:

1. The controlled lighting power reduction is at least 90 percent under fully dimmed conditions for non-parking garage locations. For parking garages, the controlled lighting power reduction is 100 percent under fully dimmed conditions.
2. Only luminaires in daylit zones are affected by daylight control. If the daylighting control system controls luminaires outside of the daylight zones including those behind obstructions, the control system is not compliant.
3. If a Power Adjustment Factor (PAF) is claimed for daylight continuous dimming plus off controls in accordance with Section [140.6\(a\)2H](#); a compliant system shall automatically turn off the luminaires in order to pass the Full Daylight Test for daylight continuous dimming plus off controls. This portion of the Full Daylight Test does not apply to lighting systems that are not claiming a PAF for daylight continuous dimming plus off controls.

NA7.6.2 Shut-off Controls Acceptance Tests

NA7.6.2.1 Occupant Sensing Lighting Controls Construction Inspection

Prior to Functional testing, verify and document the following:

- a) The occupant sensing lighting controls are shown on plan documents and are installed.
- b) Occupant sensing lighting control is installed per manufacturer's instructions to minimize false triggering - such as to install an occupancy sensor away from HVAC diffusers to avoid probable false triggering.
- c) [If an LLLC system is present, obtain relevant documentation or control system access to determine whether the system in the area being tested is configured as a](#)

[connected LLLC system or an individually controlled LLLC system for occupant sensing controls.](#)

NA7.6.2.2 Occupant Sensing Lighting Controls Functional Testing – Sampling

[Non-LLLC or Connected LLLC Systems:](#)

For buildings with up to seven (7) occupant sensors, all occupant sensors shall be tested. For buildings with more than seven (7) occupant sensors, sampling may be done on spaces with similar sensors and space geometries; sampling shall include a minimum of 1 occupant sensor for each group of up to 7 additional occupant sensors. If the first occupant sensor in the sample group passes the acceptance test, the remaining building spaces in the sample group also pass. If the first occupant sensor in the sample group fails the acceptance test, the rest of the occupant sensors in that group must be tested. If any tested occupant sensor fails it shall be repaired, replaced, or adjusted until it passes the test.

For buildings with up to seven multi-zone occupant sensors, all occupant sensors shall be tested. For buildings with more than seven multi-zone occupant sensors, sampling may be done on space to choose up seven multi-zone occupant sensors from the space, and all seven multi-zone occupant sensors shall be tested.

[Individually Controlled LLLC Systems:](#)

[For buildings with up to seven \(7\) individually controlled LLLC luminaires, all individually controlled LLLC occupant sensors shall be tested. For buildings with more than seven \(7\) individually controlled LLLC luminaires, all luminaires in spaces with similar integral sensors and space geometries may be included in the same sample group for testing.](#)

[If a sample group contains fewer than three \(3\) individually controlled LLLC occupant sensors, all occupant sensors in the sample group must be tested. Otherwise, a minimum of three \(3\) individually controlled LLLC occupant sensors per sample group shall be tested independently. If the tested occupant sensors pass, all occupant sensors in the sample group pass. If any of the occupant sensors fail the test, they shall be repaired, adjusted, and then retested with an additional two occupant sensors in the sample group until they pass.](#)