C-12: Daylighting Controls Tradeoff (C405.2.3)

Summary: Allows for a reduction in lighting power density to avoid daylight-responsive controls. In a number of cases, faced with the cost of daylighting controls and the challenges associated with commissioning them, lighting designers have found it more cost-effective to use more efficient lamps and luminaires, reduce LPD and achieve similar savings. This proposal allows that option for buildings at or below 30% window-to-wall ratio. This change is expected to be savings neutral to slight savings, but result in more efficient base lighting systems that do not require correct control operation to provide energy savings.

DOE proposal C-12 was revised on December 18, 2015.

Stakeholder Feedback: There were eleven public comments received for proposal C-12. Comments are summarized below, followed by a DOE review:

- Two comments suggested this proposal would make IECC more complex and harder to enforce.
  Review: The elimination of mandatory daylighting controls has been requested by multiple state and regional energy representatives. The proposed tradeoff is merely an alternative option to the current requirements, and would not be allowed in buildings with exceeding a 30% window-to-wall ratio. The tradeoff is fairly straightforward and does not require performance simulation, so does not over-complicate the IECC.
- Two comments suggested the tradeoff was not needed as the 150 watt minimum (per daylit space before daylight-responsive controls are required) could be used to avoid these controls by just lowering LPDs.
  Review: Breaking below the 150 Watt space lighting threshold would be difficult in open office spaces. It is already easy in private offices. Therefore, this suggestion does not really offer a realistic trade-off option that promotes better base lighting efficiency.
- One comment suggested that daylight-responsive controls would likely save more than 30% of LPD reduction and implied that the simulation must have used secondary daylight zones where daylight-responsive controls are less cost-effective.
  Review: The simulation was for primary zones with only 17% daylit area assumed in the base case. It was also for a relatively small building that may have a higher proportion of primarily daylit area than a large floorplate building. In response to a concern that Daylight-responsive controls may have a higher savings than LPD reductions, DOE revised its proposal to require a greater reduction in LPD for the tradeoff.
- One comment requested description of the energy and economic impact of proposal C-8 being published in the 2018 IECC on this proposal.
  Review: Generally, for individual proposals DOE analyzes measures individually against the current code, as it is unknown what other proposals may be included. When an entire new edition is completed, DOE completes an analysis of the interactive effects of the new code edition in its entirety. This proposal has been established proportional to base LPD requirements so that if they change, savings will be proportional.
- One comment noted the LPD reduction was the opposite of control credits which allow an increase in LPD where certain controls are used and that lighting designers would be burdened analyzing multiple options in their design development.
  Review: It is not appropriate to add an LPD **credit** for daylight-responsive controls as it is structured in the IECC code. Daylight-responsive controls are currently a mandatory requirement, so any variance

from requiring them needs to be an exception. Once designers have basic cost comparisons for a building type, they can be reused for other projects.

- Two comments suggested that a tradeoff should not be allowed unless it was shown that daylighting was not cost-effective and questioned the cost-effectiveness of LPD reduction.
  Review: There was no claim that daylight-responsive controls are not cost-effective; just that similar savings can be achieved with lower LPDs. Since this is an option, and a choice by the building design staff, cost-effectiveness of the pursued alternatives is not appropriate. Separate analysis (C-8) has shown that LEDs are lower life cycle cost than other general lighting alternatives and provide lower LPDs, so the option being allowed by the proposal has been shown to be cost-effective.
- Two comments expressed concern that poor lighting may result from lower LPDs and indicated the cost of commissioning daylight responsive controls was not that large.
  Review: Lower quality lighting should not occur with newer high efficiency fixtures. This is not a proposal to reduce lighting levels, just LPDs. Many daylight responsive controls are still found that do not work and ease of commissioning depends on the system.

In response to these comments, DOE will revise its proposal to increase the LPD reduction from 30% to 40% required for tradeoff with daylight responsive controls, as discussed in the revised reason statement. This reduction is in response to comments that indicated there would be greater energy savings from daylight responsive controls vs. LPD reduction.

= = = IECC PROPOSAL:

Modify Sections C402.4.1.1, C405.2.3 and C405.4 as follows:

C405.2.3 Daylight-responsive controls. *Daylight-responsive controls* complying with Section C405.2.3.1 shall be provided to control the electric lights within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of *general lighting* within sidelight *daylight zones* complying with Section C405.2.3.2. *General lighting* does not include lighting that is required to have specific application control in accordance with Section C405.2.4.
2. Spaces with a total of more than 150 watts of *general lighting* within toplight *daylight zones* complying with Section C405.2.3.3.

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

1. Spaces in health care facilities where patient care is directly provided.
2. Dwelling units and sleeping units.
3. Lighting that is required to have specific application control in accordance with Section C405.2.4.
4. Sidelight *daylight zones* on the first floor above grade in Group A-2 and Group M occupancies.
5. Buildings where the total connected lighting power calculated under Section C405.4.1 is not greater than the adjusted interior lighting power allowance (*LPAadj*) calculated in accordance with Equation 4-9:

   $$LPAadj = [LPAnorm \cdot (1.0 - 0.4 \cdot UDZFA / TBFA)] \quad \textbf{(Equation 4-9)}$$

   where:

   LPAadj = Adjusted building interior Lighting Power Allowance in Watts

   LPAnorm = Normal building Lighting Power Allowance in Watts calculated in accordance with Section C402.4.2 and reduced according to C406.3 if option 2 is used to meet the requirements of Section C406.

   UDZFA = Uncontrolled *daylight zone* floor area is the sum of all sidelight and toplight *daylight zones* calculated in accordance with sections C405.2.3.2 and C405.2.3.3 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 C402.4.2.

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C405.4 Interior lighting power requirements (Prescriptive). A building complies with this section where its total connected lighting power calculated under Section C405.4.1 is not greater than the interior lighting power allowance calculated under Section C405.4.2.

C405.4.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-10~~9~~.

TCLP = [*SL* + *LV* + *LTPB* + Other] **(Equation 4-10~~9~~)**

Renumber any following equations.

Reason: The IECC currently requires daylight responsive controls in daylight areas except in specific spaces where such controls are not practical or would compromise the use of the space. This proposal allows the option for lighting power density (LPD) to be reduced by 40% in daylight areas in exchange for an exception to daylight responsive controls in daylit areas. That 40% reduction is proportional to daylight areas and can be made in any area of the building to meet the average reduced interior lighting power allowance. In a number of cases, faced with the cost of daylighting controls and the challenges associated with commissioning them, lighting designers have found it more cost-effective to use more efficient lamps and luminaires. This allows a reduction in LPD with no reduction in illumination levels in the affected spaces. However, the daylight-responsive control requirements do not currently allow this tradeoff, as daylight-responsive controls are mandatory. This proposal is **not** a mandate that the LPD be reduced and such controls not be installed – it is only an option should the lighting designer choose to apply it.

The proposal is not intended to allow the LPD reduction exception when daylight controls are used to allow the 40% window-to wall ratio, as that requirement directly references section C405.2.3.1 without referring to section C405.2.3 where the exception will be added.

Energy Savings: This change is expected to have slight savings or be savings neutral, but result in more efficient base lighting systems that do not require correct control operation to provide savings. While there is not expected to be a theoretical savings for this tradeoff, two causes may contribute a marginal savings:

- Realization rates (actual delivered savings) for base lighting power density changes are generally higher for fixed efficiency items like lighting fixture efficacy when compared with savings that rely on controls.
- The proposed exception requires a higher reduction (40% instead of 28.9%) than a theoretical analysis shows is needed, although this may be partially offset by the actual average LPDs in new buildings being below the allowed LPD.

PNNL analyzed the impact of both LPD reductions and daylighting for the small office prototype. The simulation results were reviewed for climate zone 4A which has a typical daylighting impact. It was found that the energy cost savings from 100% daylight responsive building controls could be matched with a 28.9% reduction in LPD for both a furnace and air conditioner systems and an air-source heat pump system. These values were rounded up to 40% to establish a tradeoff value of LPD reduction to daylight area controlled. The increase in savings tradeoff is included for four reasons:

- To account for the fact that many new buildings have a lower actual LPD than the allowance.
- The fact that the LPD reduction can be spread over the non-daylight areas, making it highly achievable.
- If daylight responsive controls were eligible for a performance tradeoff in Section 407, that path requires energy use to be 85% of the standard reference design building.
- There is interest in encouraging the continued implementation of daylight controls to improve field implementation and acceptance, so the tradeoff should require using the highest efficiency lighting for LPD reduction.

The U.S. Department of Energy (DOE) develops its proposals through a public process to ensure transparency, objectivity and consistency in DOE-proposed code changes. Energy savings and cost impacts are

assessed based on established methods and reported for each proposal, as applicable. More information on the process utilized to develop the DOE proposals for the 2018 IECC can be found at: https://www.energycodes.gov/development/2018IECC.

Cost Impact: There is no cost increase expected for this proposal, in fact, the higher efficiency lighting necessary to achieve the reduced LPD is expected to be less expensive than the cost of daylighting controls. A similar analysis was made for LPD reduction where it was found that LED lighting is a cost-effective way to reduce LPDs. That analysis can be reviewed in the documentation for proposal C-8 at: https://www.energycodes.gov/development/2018IECC.

Cost-effectiveness: This change is cost-effective in that it either provides some savings or neutral energy impact, combined with an increase in savings reliability, at no anticipated cost increase.