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Docket Number:	17-BSTD-01
Project Title:	2019 Building Energy Efficiency Standards PreRulemaking
TN #:	221709
Document Title:	Statewide Utility Codes and Standards Team Comments Response to Comments on Advanced Daylighting Design Proposal in 2019 Title
Description:	N/A
Filer:	System
Organization:	Statewide Utility Codes and Standards Team
Submitter Role:	Public
Submission Date:	11/10/2017 5:35:21 PM
Docketed Date:	11/13/2017

Comment Received From: Statewide Utility Codes and Standards Team
Submitted On: 11/10/2017
Docket Number: 17-BSTD-01

Response to Comments on Advanced Daylighting Design Proposal in 2019 Title 24, Part 6 Express Terms

Additional submitted attachment is included below.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Response to Comments on Advanced Daylighting Design Proposal in 2019 Title 24, Part 6 Express Terms

California Statewide Utility Codes and Standards Team

November 10, 2017

1. Introduction

The Statewide CASE Team appreciates the opportunity to participate in the rulemaking and the thoughtful feedback we have received from the California Energy Commission on the Codes and Standards Enhancement (CASE) proposals.

The CASE initiative presents recommendations to support the Energy Commission's efforts to update California's Building Energy Efficiency Standards (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and SoCalGas® – and two publicly Owned Utilities – Los Angeles Department of Water and Power, and Sacramento Municipal Utility District – sponsored this effort.

The California Statewide Utility Codes and Standards Team (Statewide CASE Team) actively supports the Energy Commission in developing revisions to Title 24, Part 6 by developing code change proposals that will result in feasible, enforceable, and cost-effective enhancements to the building energy efficiency standards. In developing these proposals, the Statewide CASE Team conducts research and market surveys, holds stakeholder meetings, and evaluates the energy savings and cost-effectiveness of considered measures. The CASE Reports, which present pertinent information that supports the code change proposals, are posted within each measure topic page on title24stakeholders.com.

The Statewide CASE Team encourages the Energy Commission to consider the feedback presented in this document regarding proposed requirements for advanced daylighting design.

On October 20, 2017 Acuity Brands submitted comments to the California Energy Commission in response to the Express Terms that the Energy Commission posted on September 20, 2017. Acuity Brand's Comment #5 pertained to advanced daylighting design and requested that the Energy Commission evaluate the proposal to develop a minimum visible transmittance (Min VT_{annual}) requirement for tubular daylighting devices (TDD) on the basis of an "equivalence study". The comment stated the following:

- "It is still not clear if the performance comparison of traditional skylights to TDDs is a direct 'apples-to-apples' comparison, especially in an open ceiling application."
- "…using [National Fenestration Rating Council] NFRC 200 or ASTM E972 as a static comparison to NFRC 203 leaves room for assumptions."

- "Traditional skylights will distribute light over a larger area than a TDD and this difference should be accounted for in the equivalence study. The equivalence study to determine Min VT_{annual} should perhaps be done on a per square foot of aperture basis to ensure that the difference in size does not result in different amount of daylight in a space from a TDD and traditional skylight."

This document presents the Statewide CASE Team's response to the above comment.

2. Statewide CASE Team Response

2.1 Why the Min VT Threshold Cannot be Developed on a per Square Foot of Aperture Basis

Visible transmittance (VT) is a unitless metric, which already incorporates area of the aperture as:

$$VT = \frac{Incident\ Daylight\ Flux \times Area\ of\ Aperture}{Transmitted\ Daylight\ Flux \times Area\ of\ Aperture}$$

A minimum VT threshold establishes the minimum throughput of light that is required for a skylight to be considered in designing a code compliant building, using prescriptive code.

Establishing a minimum VT requirement for TDDs, based on NFRC 203 (VT_{annual}), allows designers to consider TDDs for their building applications. Once a skylight (TDD or traditional) is chosen, good lighting design and illuminance criteria will then dictate the number of skylights and their placement as required to achieve the desired interior illuminance. Designers can use lighting and daylighting software tools to help them design a space that provides uniform daylighting distribution and good visual quality with any skylight they choose for their building application. Differences, such as traditional skylights that distribute light over a larger area compared to a TDD, can be studied to determine the best possible solution for a given application.

Since each building is different, and a low ceiling application produces different results from a high ceiling application, the Min VT_{annual} threshold cannot be developed using a per-square foot of aperture basis.

2.2 Title 24, Part 6 Already Has an Aperture Area Based Requirement for Skylights that Recognizes the Difference Between TDDs and Traditional Skylights

Skylight requirements in the 2016 Title 24, Part 6 standard accounts for the difference in skylight aperture of different types of skylights through the definition of a Skylit Daylit Zone:

Section 130.1 (d)1A: "the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight (…)".

Additionally, **Section 140.3(c):** "Minimum Daylighting Requirement for Large Enclosed Spaces sets a minimum skylight area of 3% (or visible transmittance times skylight area of 1.5%) of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights."

These requirements recognize the size difference between traditional skylights and TDDs. TDD systems with small aperture areas result in smaller daylit zones, while larger traditional skylights result in larger daylit zones on a per-unit-basis. Therefore, to cover the same area, more TDDs may be required than traditional skylights. The requirements also identify that if a skylight has very high VT, a smaller aperture may be sufficient to provide enough daylight.

The current proposal for Min VT_{annual} for TDDs does not alter these requirements.

2.3 Photometric Data from Traditional Skylights was Modified to be Appropriate for Comparison to TDDs

The Statewide CASE Team's approach of using the 2003 PIER Study photometric testing data performed over traditional domed skylights, was to establish how light transmittance varies with varying incident angles on domed skylights. To ensure an "apples-to-apples" comparison, all differences in the methodology between NFRC 203 and the PIER photometric testing were identified, and key differences, such as light well lengths, were addressed in the calculation of the proposed Min VT_{annual} threshold.

The differences between the two approaches were highlighted in the presentation from the second utility-sponsored stakeholder meeting (see Figure 1).[1] Observations on the key assumptions include:

- **Solar Altitude** bins were considered close enough to be equivalent.
- **Solar Azimuth** in the PIER Photometric Testing varied, and was different from NFRC 203 test procedure that has 3 bins of 0 degrees, 30 degrees, and 60 degrees. However, azimuthal changes to domed skylights such as the ones tested in the PIER Study were expected to be minimal, since all the skylights tested were quadrilaterally symmetrical.
- **Testing procedures** were different in the way the instruments were set up – the PIER study used an array of mirrors, and the NFRC 203 procedure uses an integrating sphere. However, in photometric theory, they provide the exact same information – the amount of light transmitted through a product at different incident angles. Hence, they were considered equivalent.
- **Light well length** was a key difference between the two approaches. While the NFRC 203 required having a 3ft light well, which in most cases for TDDs is highly specular, the PIER Photometric Testing has a 1ft light well. To account for this difference, the Statewide CASE Team developed a correction factor based on typical references of TDD light wells, which was applied to the final proposed value of Min VT_{annual} for TDDs. This approach is documented in the Final CASE Report (**Section 4.2.2.3: PIER Data Analysis**).

Based on these responses, the Statewide CASE Team concludes that there is not sufficient reason to modify or change the current proposal for Min VT_{annual} for TDDs, and the CASE Report analysis does account for the aperture size-based factors identified by Acuity Brands.

	NFRC 203	PIER Photometric Testing
Solar Altitude	10° inc. from 20° to 70° solar alt	10° inc. from 10° to 60° solar alt
Solar Azimuth	3 bins of 0°, 30° and 60° azimuths	various azimuth angles based on the sun's movement (for 30° Lat. location)
Light Well	3ft light well	1ft light well
Testing Procedure	Integrating sphere on a rotating track	Static setup, mirrors used to "fold" the path of light

Figure 1: Comparison of key assumptions used in NFRC 203 and PIER photometric testing.

[1] http://title24stakeholders.com/wp-content/uploads/2017/03/2019T24-Utlity-Stkldr-Mtg-2-ADD_All.pdf