

2019 Title 24, Part 6 Codes & Standards Enhancement (CASE) Proposal

Advanced Daylighting Design

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Proposed Code Change Overview

- Power Adjustment Factors (PAF)
 - If a qualifying technology installed, lighting power density (LPD) for compliance is reduced by this PAF. Example:
 - A space has 1 W/sf
 - Prescriptive maximum LPD for that space is 0.8 W/sf
 - The space also has a technology that qualifies for a PAF of 0.2
 - The space complies because $(1 - 0.2) * 1 = 0.8$
 - Determined by
 - Simulations where the technology is virtually installed show energy savings when compared to the baseline.
 - The fraction of savings becomes the PAF
- Envision all nonresidential buildings will qualify

Proposed Code Change Overview – Strategies Proposed (1 of 6)

1. Fixed slats

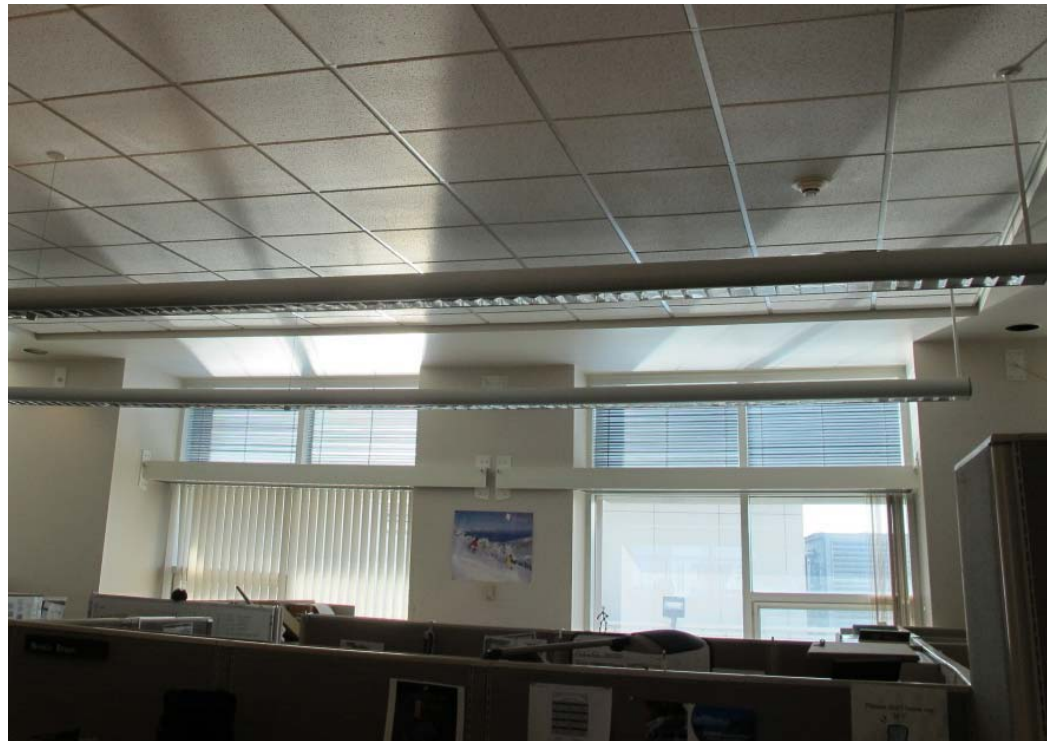
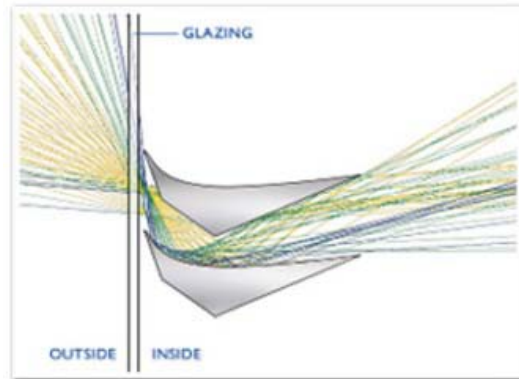
- Mitigates glare
- Distributes daylight
- Exterior
 - Solar gain (RSGHC)
- Interior
 - Wind loads
 - Vandalism



Proposed Code Change Overview – Strategies Proposed (2 of 6)

2. Daylight distribution devices

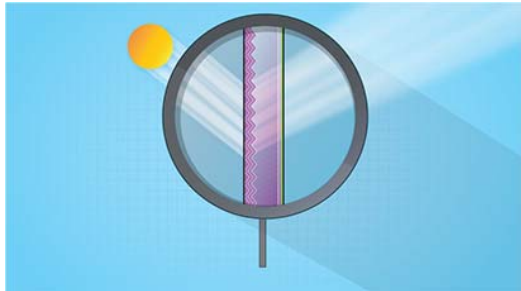
- Mitigates glare (at clerestory)
- Distributes daylight



Proposed Code Change Overview – Strategies Proposed (3 of 6)

3. Daylight redistributing films

- Mitigates glare (at clerestory)
- Distributes daylight



Proposed Code Change Overview – Strategies Proposed (4 of 6)

4. Automatic shades

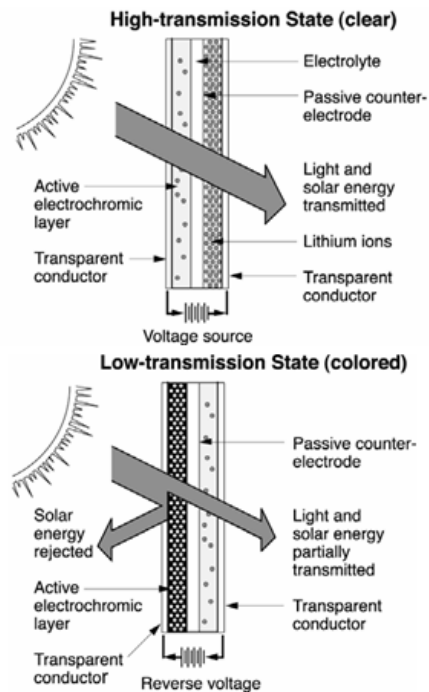
- Mitigates glare
- Maintains view



Proposed Code Change Overview – Strategies Proposed (5 of 6)

5. Dynamic glazing

- Mitigates glare
- Maintains view



Proposed Code Change Overview – Strategies Proposed (6 of 6)

6. Clerestory windows

- Daylight distribution (increases daylit area)



Proposed Code Change History

Why are we proposing these measures?

- Daylight distribution: Increase daylight level, area and/or hours
- Glare mitigation: Improve daylighting reliability

Current Code Requirements

Existing Title 24, Part 6

- PAFs given for certain types of lighting controls only.
- Solar heat gain credit for shading but no daylighting credit
- Dynamic glazing can meet prescriptive minimum but no credit
- Nothing for other proposed technologies (films, daylight distribution, automatic shading)

Existing Model Code

- No known requirements or daylighting credits for these strategies.

Typical Practices

Current practices

- Windows are bare and use conventional (i.e. non-dynamic) glazing
- Window setbacks are common

Trends

- Slats/louvers becoming more frequent (Bay Area only?)
- Other technologies are still “fancy”

Do you agree with this description?

Market Overview and Analysis

Current Market

- Well-established but not widespread
- No known utility incentives in CA (other than modeled)

Market impacts

- Expected increase in market share

Market barriers

- Cost prohibitive, but PAF = optional
- Affects aesthetic, but many choices and some like the aesthetic

Other market considerations/information we should know about?

Methodology for Savings Analysis

Criteria and constraints:

- Maximize useful daylight distribution
- Minimize glare
 - Occupied hours, not sunrise to sunset
- Account for
 - Overcast solar aureole (sunlight glare spreads out behind clouds)
 - Daylight savings time
 - Occupant behavior with blinds

Methodology for Savings Analysis

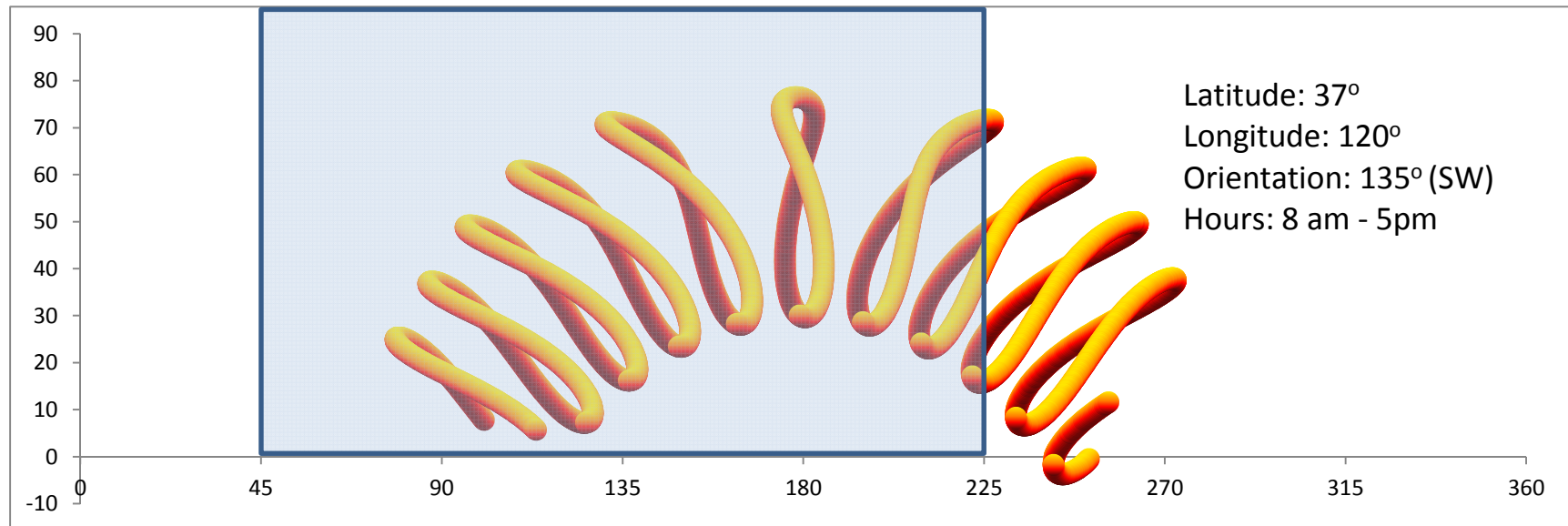
Methodology for energy and demand Impacts

- Model: genBSDF/Existing BSDFs, Window7, Radiance, EnergyPlus, OpenStudio, CBECC-Com
- Parametrics: Ruby, Python
- SOLPAS (NREL): solar position
- Spreadsheet: miscellaneous calculations
- Prototype Buildings
 - Based on DOE commercial reference buildings, CBECS 2012, CBECC-Com test buildings
 - Possibly > 1; consider building types w/highest forecasted sf
 - 2016 Title 24, part 6
 - Meet Prescriptive Requirements
 - Nonresidential ACM by building type
- Radiance data from Utility studies for some technologies

Methodology for Savings Analysis

Solar Position (SOLPAS plus some filters and math)

- Goal: Block high percentage of solar positions



Methodology for Savings Analysis

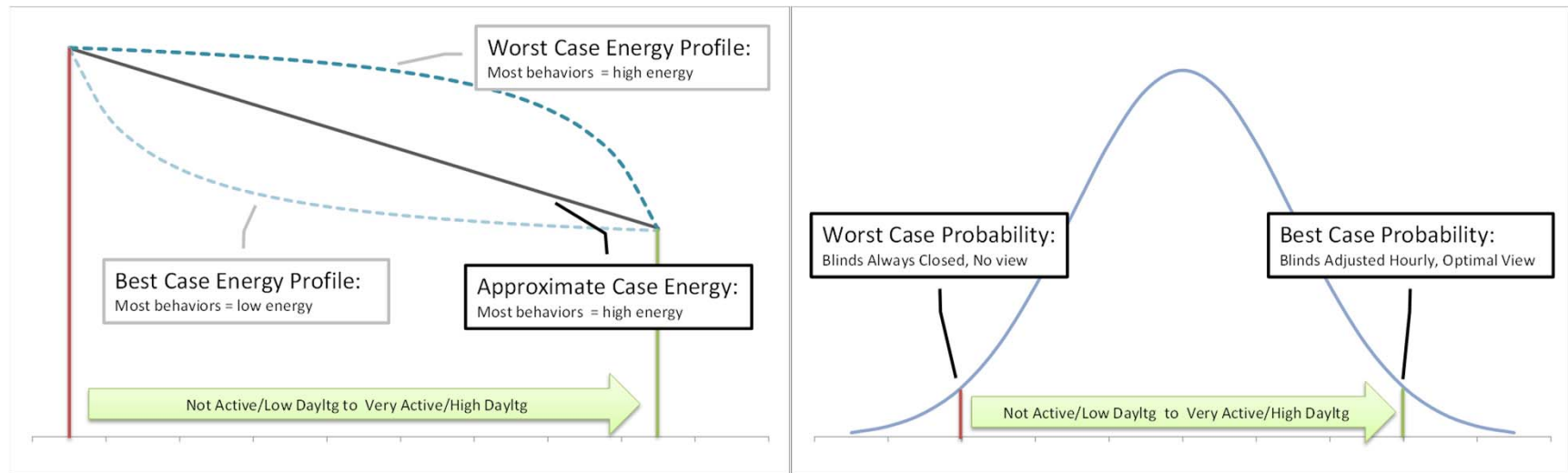
Blinds behavior

- University of Idaho meta-study
 - Study of the body of studies on occupant behavior and window coverings (hereafter blinds).
 - Span the U.S., Canada and Europe
 - Varying in orientation, type, etc.
 - How and why of blinds
 - Conclusion: No agreement among studies
- For our study we are interested in daylighting savings
 - Assume glare triggers blinds adjustment, but users prefer view
 - Still many hows and whys left

Methodology for Savings Analysis

Blinds behavior

- How can we approach? Use statistics.
- There are a variety of ways to use blinds and a variety of blind and shade types; each case has an energy impact.
- Each case also has a likelihood of occurring
- Net energy impact is a probability-weighted energy impact of all behaviors



Methodology for Savings Analysis

Glare Metric: Traditional metrics

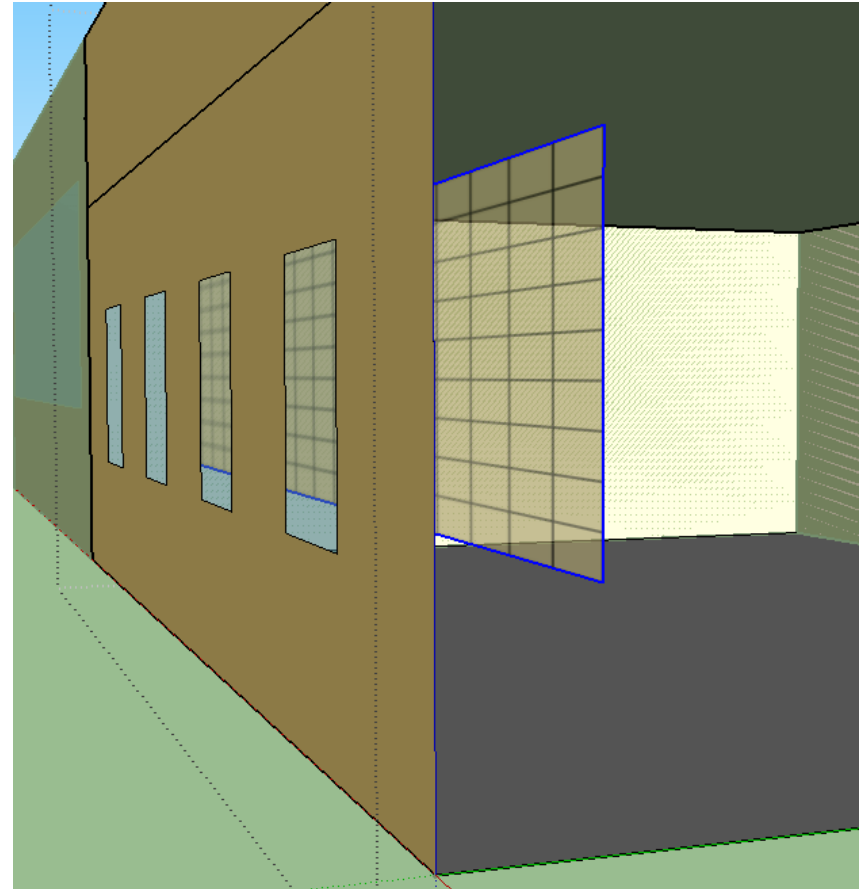
- Formula with intensity, peripheral angle and area (solid angle) of daylight
- Shortcomings
 - Always a specific position in the space
 - Very old user surveys
 - Low number of test subjects
 - Luminaires above occupants eye level, not daylight to side of occupant
 - Luminaires at 100s of lux, not daylight at possible 100,000 lux
 - High window-to-wall ratios
 - Inherent to formula, best is 80% don't see glare
 - Improvements/newer/better metrics, but no universal acceptance

Methodology for Savings Analysis

Glare Metric: Proposal

- Check illuminance at the wall with windows
 - Conservative intensity (most intense location in room)
 - Can examine any occupant location, height, orientation, peripheral vision
 - Glare thresholds
 - Contrast ratio: $> 10:1$?
 - Absolute intensity: $> 1,500$ lux?
 - Offset from wall: 2 ft.?
 - Offset above floor: 3 ft.?

Methodology thoughts? Opinions?



Assumptions for Energy Impacts Analysis

Key assumptions

- Prototype building features close to average CA future construction features as mapped into 2016 Title 24, part 6 compliant buildings
- CA future construction forecast accuracy
- Blind statistical analysis is a reasonable approximation
- Proposed glare evaluation and thresholds are valid

Data sources

- Literature: Utility studies, LBNL, etc.
- Prototype: as above
- SOLPAS: as above
- AEDG, EDR, CHPS, WBDG, Advanced Lighting Guidelines, SMEs
- Stakeholder help with optimal control strategies
 - Electrochromics
 - Automatic shades
- Utility study Radiance data

Initial Data and Findings

PAFs (Very ballpark)

Fixed shades: 0.2

- Preliminary modeling runs

Daylight distribution devices: 0.2

- Advanced Sidelighting Products (SMUD)

Daylight redistributing films: 0.3

- Advanced Sidelighting Products (SMUD)

Automatic shades: 0.3

- Advanced Daylighting Blinds and Shades Assessment (PG&E ET)

Dynamic glazing: 0.1

- Advancement of Electrochromic Windows (LBNL, 2006)

Clerestory windows: 0.2

- Preliminary modeling runs

Compliance and Enforcement- Market Actors

- Market Actor #1 – Attachments Energy Rating Council (AERC)
- Market Actor #2 – Architects / Designers
- Market Actor #3 – Compliance Software Manufacturer
- Market Actor #4 – Title 24 Consultants
- Market Actor #5 – Manufacturers
- Market Actor #6 – Distributors
- Market Actor #7 – Installers
- Market Actor #8 – Code Officials / Plan checkers / Field Inspector
- Others?

Compliance and Enforcement—Tasks

Market Actor	Task(s)	Success Criteria
AERC	<ul style="list-style-type: none"> - Test and rate products 	<ul style="list-style-type: none"> - Certify performance (e.g. labels)
Architect / Designer	<ul style="list-style-type: none"> - Design building envelope to meet Title 24, Part 6 - Specifies products 	<ul style="list-style-type: none"> - Design buildings that meet building owner's needs and comply with Title 24, Part 6
Compliance Software Manufacturer	<ul style="list-style-type: none"> - Incorporate new technologies in compliance software 	<ul style="list-style-type: none"> - Properly understand new technologies and code
Title 24 Consultants	<ul style="list-style-type: none"> - Complete applicable compliance forms - Use compliance software 	<ul style="list-style-type: none"> - Compliance documents are properly completed and system is compliant
Manufacturers	<ul style="list-style-type: none"> - Provide products that meet the minimum PAF requirements - Educate distributors of the new code update 	<ul style="list-style-type: none"> - Develop products that meet Title 24, Part 6 requirements that are cost-effective
Distributors	<ul style="list-style-type: none"> - Stocks window coverings - Inform and educate Installers 	<ul style="list-style-type: none"> - Stock code requirement compliant products
Installers	<ul style="list-style-type: none"> - Install window covering products 	<ul style="list-style-type: none"> - Install cost-effectively and according to needs of building owner
Code Officials / Plan Checkers / Field Inspector	<ul style="list-style-type: none"> - Check to ensure all components of building envelope meet code 	<ul style="list-style-type: none"> - Understand Title 24, Part 6 - Properly inspect everything

Compliance and Enforcement—Resources

Market Actor	Resource(s)
AERC	<ul style="list-style-type: none">- Test equipment
Architect/Designer	<ul style="list-style-type: none">- Resources: Compliance manual, CEC hotline, EnergyCodeAce- Tools: Simulation tools like Lumen Designer, SkyCalc, Radiance, others?
Compliance Software Manufacturer	<ul style="list-style-type: none">- Resources: Conferences (ASHRAE, IBPSA, SimBuild), CABEC
Title 24 Consultants	<ul style="list-style-type: none">- Resources: CABEC training, classes- Tools: CBECC-Com, EnergyPro/Compliance Software
Manufacturers	<ul style="list-style-type: none">- Resources: NFRC Meetings
Distributors	<ul style="list-style-type: none">- Manufacturer's literature
Installers	<ul style="list-style-type: none">- Manufacturer's literature
Code Officials / Plan Checkers / Field Inspector	<ul style="list-style-type: none">- Resources: CALBO training, classes

What resources or tools are typically used for compliance?

Strawman Code Change Language

Title 24, part 6 Standards

- PAFs for technologies meeting certain requirements
 - Only when daylighting controls installed
 - AERC rating: reflectance, transmittance, etc.
 - “Fixed” technologies: Dimensions, location
 - “Controlled” technologies: Control strategy
 - Consider exterior permanent obstructions (similar to current skylights)
 - Clerestory extend down from ceiling

Title 24, part 6 Appendices

- Perhaps locate tables here for various technologies and combinations of technologies

Strawman Code Change Language

Alternative Compliance Method (ACM) Technical Manual

- Standard Building (baseline): maximum Prescriptive LPD
- Proposed Building (design): The energy modeler using CBECC-Com will be have two choices
 - Multiplier: As with previous PAFs, can be applied as multiplier on proposed LPD
 - Energy savings assumed equal to PAF
 - Short modeling time
 - Radiance: Similar to how overhangs are currently handled, can be modeled
 - More accurate savings
 - Longer modeling time
 - Radiance/OpenStudio integration already exists but needs enhancement
 - Simplification techniques
 - Cumulative database of parameters vs. results (start with Utility study data)

Feedback Request from Stakeholders

- Please provide feedback/input:
 - Do you have feedback on the products we are investigating?
 - Are there other products we should be looking at?
 - Optimizing: geometry, controls, etc.
- Email: eric@Determinant-LL.Com

Thank you.

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