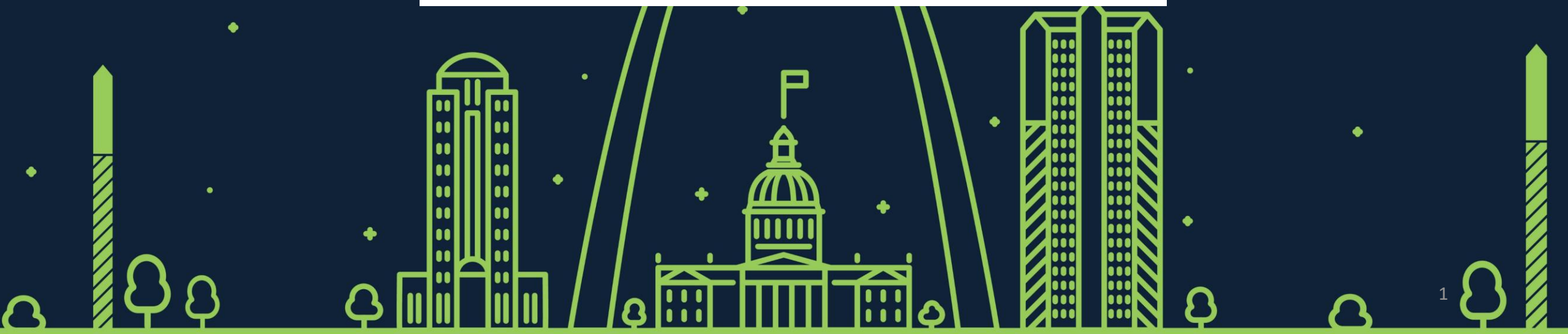
2019 DLC

April 1 - 3 • St. Louis, MO

STAKEHOLDER MEETING

As you find your seats, don't sit alone and find folks you don't know!



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STAKEHOLDER MEETING

Discussion Session:
Efficacy and Flicker

Objectives, Desired Outcomes, and Agenda

Session Objectives:

- Review draft Efficacy and Flicker rationale and requirements
- Summarize comments received into main themes
- Discuss remaining feedback and ways to address main themes

Desired Outcome:

- Actionable feedback to inform Draft 2

Agenda:

- Welcome and Introduction
- Efficacy
  - Overview
  - Comments Takeaways
- Flicker
  - Overview
  - Comments Takeaways
- Discussion

Session Structure and Ground Rules

- **Structure**
  - DLC will provide overview of each topic, summarize main themes from comments, and ask questions to the group
  - Each table **choose two questions** to discuss and **elect one person to report out** their thoughts to this group
    - Report outs will go in order of the questions
  - DLC will report out results to the larger group at the end of the day
- **Ground Rules**
  - Participate
  - Be respectful
  - Defer to the facilitator

Audience

- Whom do we have in the room?
  - Manufacturers
  - Researchers
  - Specifiers
  - Labs
  - Utilities
  - Distributors
  - Others

Efficacy

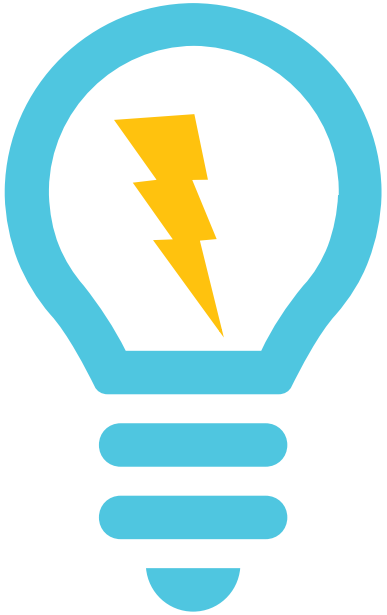
Revision History

- V5.0 proposes an **average efficacy increase of 9.6%**
- We have significantly pushed efficacy in the past, but we realize that continuing such increases may impact quality and cost
  - This round of efficacy increase is designed to go **hand-in-hand** with quality improvements

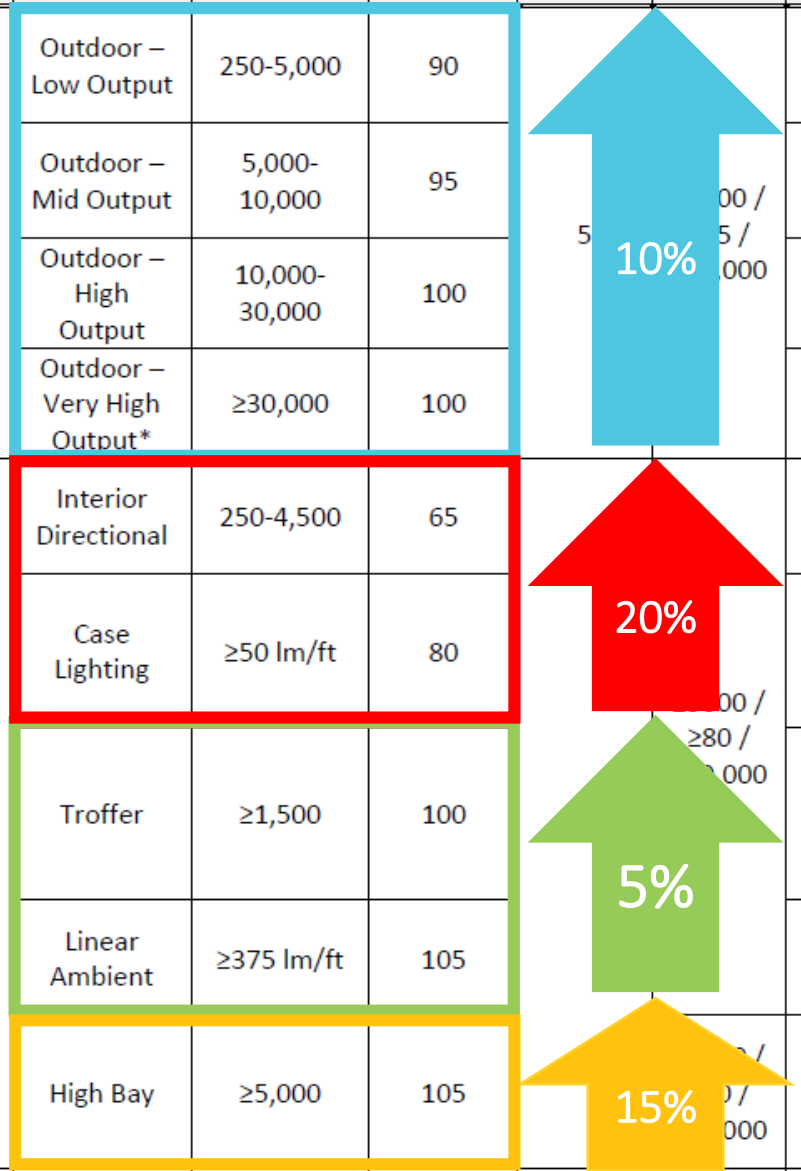
Year	SSL Version	Average Efficacy Increase
2011	1.6	25%
2013	2.0	17%
2015	3.0	n/a (category restructure)
2016	4.0	27%
2019	5.0	9.6% (proposed)

Efficacy Increase Bins

- The goal was to strike the balance between efficacy, quality of light, and product cost
- As a result, each General Application was grouped into four bins:
  - ≈ 5% increase
  - ≈ 10% increase
  - ≈ 15% increase
  - ≈ 20% increase
- Draft values represent a DLC Standard classified product-weighted **average increase of 9.6%**



#	Category	General Application	Minimum Light Output (lm)	Requirements						Primary Use***	Distribution
				DLC Standard			DLC Premium**				
				Minimum Efficacy (lm/W)	Minimum Warranty (years)	CCT / CRI / L_{70}	Minimum Efficacy (lm/W)	Minimum Warranty (years)	CCT / CRI / L_{90} / L_{70}		
1	Outdoor	Outdoor – Low Output	250-5,000	90	5	00 / 5 / ,000	110	5	≤5700 / ≥65 / ≥36,000 / ≥50,000	• Outdoor Pole/Arm-Mounted Area and Roadway Luminaires • Outdoor Pole/Arm-Mounted Decorative Luminaires • Outdoor Full-Cutoff Wall-Mounted Area Luminaires • Outdoor Non-Cutoff and Semi-Cutoff Wall-Mounted Area Luminaires • Bollards • Parking Garage Luminaires • Fuel Pump Canopy Luminaires • Landscape/Accent Flood and Spot Luminaires • Architectural Flood and Spot Luminaires • Stairwell and Passageway Luminaires • Specialty: _____	See Primary Use Zonal Lumen Density Requirements in Table 4, below
2		Outdoor – Mid Output	5,000-10,000	95			115				
3		Outdoor – High Output	10,000-30,000	100			120				
4		Outdoor – Very High Output*	≥30,000	100			120				
5	Indoor	Interior Directional	250-4,500	65			90	5	≤5000 / ≥80 / ≥36,000 / ≥50,000	• Wall Wash Luminaires • Track or Mono-Point Luminaires • Specialty: _____	
6		Case Lighting	≥50 lm/ft	80		00 / ≥80 / ,000	125			• Display Case Luminaires • Horizontal Refrigerated Case Luminaires • Vertical Refrigerated Case Luminaires • Specialty: _____	
7		Troffer	≥1,500	100			125			• 2x2 Luminaires for Ambient Lighting of Interior Commercial Spaces • 1x4 Luminaires for Ambient Lighting of Interior Commercial Spaces • 2x4 Luminaires for Ambient Lighting of Interior Commercial Spaces • Specialty: _____	
8		Linear Ambient	≥375 lm/ft	105			130			• Direct Linear Ambient Luminaires • Linear Ambient Luminaires w/ Indirect component • Specialty: _____	
9		High Bay	≥5,000	105		0 / 000	130		≤5700 / ≥70 / ≥36,000 / ≥50,000	• High Bay Luminaires for Commercial and Industrial Buildings • Low Bay Luminaires for Commercial and Industrial Buildings • High Bay Aisle Luminaires • Specialty: _____	



#	Category	General Application	Minimum Light Output (lm)	DLC Standard: Minimum Efficacy (lm/W)	DLC Standard: Minimum Warranty (years)	DLC Standard: CCT / CRI / L_{70}	Primary Use	Distribution
17	Linear Replacement Lamps	T8 Four-Foot Linear Replacement Lamps	In luminaire: 2 lamps: 3,000 3 lamps: 4,500 4 lamps: 6,000 Bare lamp: 1,600	In luminaire: 100 Bare lamp: 110	5	≤5000 / ≥80 / ≥50,000	• Replacement Lamps ("Plug and Play") (UL Type A) • Internal Driver/Line Voltage (UL Type B) Lamps • 2-lamp External Driver (UL Type C) Lamps • 3-lamp External Driver (UL Type C) Lamps • 4-lamp External Driver (UL Type C) Lamps • Dual Mode Internal Driver (UL Type A or B)	
18		T5 Four-Foot Linear Replacement Lamps	In luminaire: 2 lamps: 3,000 3 lamps: 4,500 4 lamps: 6,000 Bare lamp: 1,600	In luminaire: 100 Bare lamp: 110	5	≤5000 / ≥80 / ≥50,000	• Replace • Internal • 2-lamp E • 3-lamp E • 4-lamp E • Dual Mo	
19		T5HO Four-Foot Linear Replacement Lamps	In luminaire: 3 lamps: 7,500 4 lamps: 10,000 6 lamps: 15,000 Bare lamp: 3,200	In luminaire: 105 Bare lamp: 110	5		• Replace Internal • lamp E • 4-lamp E • 6-lamp E • Dual Mo	ts
20		T8 Two-Foot Linear Replacement Lamps	In luminaire: 2 lamps: 1,350 3 lamps: 2,000 4 lamps: 2,700 Bare lamp: 800	In luminaire: 100 Bare lamp: 110	5		• Replace • Internal • 2-lamp E • 3-lamp E • 4-lamp E • Dual Mo	
21		U-Bend Replacement Lamps	In luminaire: 2 lamps: 2,500 3 lamps: 3,750 Bare lamp: 1,400	In luminaire: 100 Bare lamp: 110	5	≤5000 / ≥80 / ≥50,000	• Replacement Lamps ("Plug and Play") (UL Type A) • Internal Driver/Line Voltage (UL Type B) Lamps • 2-lamp External Driver (UL Type C) Lamps • 3-lamp External Driver (UL Type C) Lamps • Dual Mode Internal Driver (UL Type A or B)	
22		T8 Three-Foot Linear Replacement Lamps	In luminaire: 2 lamps: 2,200 Bare lamp: 1,200	In luminaire: 100 Bare lamp: 110	5	≤5000 / ≥80 / ≥50,000	• Replacement Lamps ("Plug and Play") (UL Type A) • Internal Driver/Line Voltage (UL Type B) Lamps • 2-lamp External Driver (UL Type C) Lamps • Dual Mode Internal Driver (UL Type A or B)	

10%

Please note:

- As this is a conceptual draft, we haven't proposed specific level for DLC Premium or additional allowances. This will be proposed in the second draft.

Clarifying Questions?

We'll get to the technical issues shortly…

Takeaway 1: Balance Efficacy & Quality

- The proposed efficacy levels may be reasonable in isolation, but there also may be tradeoffs with quality of light
  - Aspects of quality may suffer, such as glare / optical control, color quality, and flicker
- V5.0 quality requirements must be determined before we decide if the proposed efficacy levels are reasonable
  - To meet rigorous quality thresholds, efficacy could be penalized

Discussion Q1: Balance Efficacy & Quality

- What are some strategies for balancing efficacy and quality in the V5.0 specification?

Takeaway 2: Cost Implications

- Meeting the efficacy requirements may have an impact on product cost
  - Difficult to avoid higher cost with both efficacy and quality requirements
  - May require manufacturers to use more low- or mid-power LEDs, which drives up cost
  - The new requirements would need higher utility rebate support

Discussion Q2: Cost Implications

- What strategies could DLC use to mitigate cost increases associated with V5.0 efficacy?

Takeaway 3: Highbay levels are too high

- 15% increase (105 lm/W → 120 lm/W) for high-bay is too steep
  - While most high-bays could achieve this level, incorporating glare control will make it very difficult to meet
  - The increase is acceptable if the quality requirements are relaxed for high-bay
  - V5.0 would be particularly challenging for low-bay fixtures

Discussion Q3: Highbay levels are too high

- What are the appropriate efficacy levels for high bay? How might we select a final level?

Clarifying Questions?

We'll review Flicker in the same way and then get to discussions…

Flicker

Rationale

- Flicker free operation is a critical component of **visual comfort**
  - Can cause annoyance, loss in productivity
- Flicker has **health impacts**
  - Can lead to eye strain, migraines, anxiety, photo epilepsy, exacerbate undesirable behaviors among persons with autism
- Flicker can cause **dangerous industrial working environments**
  - Rotating machinery can appear still
- Flicker can **interfere** with machine vision and imaging devices
  - E.g. barcode scanners, sensors, video feeds

Definitions

- DLC uses the term “Flicker” to generally describe Temporal Light Artifacts (TLA), which includes 3 categories of light modulation over time:
  - Flicker (<80 Hz)
  - Stroboscopic Effect (80 Hz – 2,000 Hz)
  - Phantom Array Effect (80 Hz – 2,500 Hz)

Draft Testing and Reporting Requirements

Metric	Current V4.4 Require-ments	V5.0 Draft Requirements			Method of Evaluation
		Threshold		Reported	
		Tier 1	Tier 2		
Short Term Flicker (P_{st})	n/a	≤1.0 at 100% and 20% light output		P_{st} at 100%, 20%, and minimum fraction of light output	ANSI/IES LM-xx-19 Approved Method: Measuring Optical Waveforms for use in Temporal Light Artifact (TLA) Calculations
Stroboscopic Visibility Measure (SVM)	n/a	≤0.4 at 100% and 20% light output	≤0.9 at 100% and 20% light output	SVM at 100%, 20%, and minimum fraction of light output	

- P_{st} ≤1.0 is the recommended limit for short term flicker in NEMA 77
- The two tier threshold for SVM reflects recent research that an SVM of 0.9 means 25% of the population will detect the flicker 63% of the time and an SVM of 0.4 means that just 10% of people will detect the stroboscopic flicker

Draft Testing and Reporting Requirements

Metric	Current V4.4 Require-ments	V5.0 Draft Requirements			Method of Evaluation
		Threshold		Reported	
		Tier 1	Tier 2		
Percent Flicker	n/a	No required threshold		Report values at 100%, 20%, and minimum fraction of light output for frequencies under 40, 90, 200, 400, and 1,000 Hertz	ANSI/IES LM-xx-19 Approved Method: Measuring Optical Waveforms for use in Temporal Light Artifact (TLA) Calculations
Flicker Index	n/a				

- Reporting Percent Flicker at these various light outputs and frequency cutoffs allow users to compare a product's flicker performance according to IEEE PAR 1789 and determine if their product meets California's Title 24 levels
- Flicker Index accounts for average peak-to-peak amplitude, wave-form shape, and duty cycle of the flicker

Clarifying Questions?

We'll get to the technical aspects shortly…

Takeaway 1: Testing Cost and Burden

- Flicker testing on every fixture variation and at dimmed states may add significant testing cost burden
- Test labs may not have proper equipment and will be required to purchase new equipment, passing that cost onto manufacturers

Discussion Q4: Testing Cost and Burden

- What strategies might DLC use to balance the tradeoff between flicker performance and testing burden?

Takeaway 2: Thresholds

- Various arguments for threshold limits, such as:
  - SVM < 0.4 seems roughly equivalent to PAR1789, good.
  - Do not deviate from NEMA 77 metrics limits
  - SVM < 0.9 is not an enormous improvement for many sources that are causing visible problems today
  - IEEE PAR 1789 limits should be used for Tier 1
  - SVM and Pst are not widely used in the lighting industry yet; DLC should apply the flicker requirement of California Title-24
  - Short term flicker (Pst) and stroboscopic visibility measure (SVM) should be enough; no need for other metrics

Discussion Q5: Thresholds

- What are the appropriate thresholds for flicker? How would DLC decide?

Takeaway 3: Application Specific Requirements

- Flicker is not as critical for most outdoor locations as indoor locations
  - Not a concern for spaces where people do not spend long periods of time
- Flicker requirements related to dimming should not be imposed on spaces that dim in result to vacancy
  - For example, outdoor and highbay areas
  - Flicker requirements for architectural or office settings are reasonable

Discussion Q6: Application Specific Requirements

- What might be the application-specific requirements for flicker?

Clarifying Questions?

If not, on to discussions…

Discussion Questions: Pick 2 and Discuss!

Please provide actionable, solution-based ideas and input

Efficacy	Flicker
1. What are some strategies for balancing efficacy and quality? 2. What strategies could DLC use to balance the tradeoff between efficacy and cost? 3. What are the appropriate efficacy levels for high bay? How might we select a final level?	4. What strategies might we use to balance the tradeoff between flicker performance, testing burden, and cost? 5. What are the appropriate thresholds for flicker? How would we decide? 6. What might be the application-specific requirements for flicker?

Other Issues Not Discussed

Is there another issue related to flicker and efficacy that you think should be addressed by this group?

Next Steps

Next Steps

- We'll summarize take-aways from this session
  - DLC will report out at the end of the day
- How to get involved
  - Send additional comments and questions to comments@designlights.org
  - Sign up for DLC newsletter and keep an eye out for Draft 2
  - Submit comments and participate in policy development process
- Enjoy the rest of the Meeting!
  - If something comes to mind later on, track us down

Thank You!

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Bernadette Boudreaux, DLC
Matt Rusteika, DLC
Dan Mellinger, Energy Futures Group
Naomi Miller, PNNL

Please send questions and comments to:
Comments@designlights.org

DesignLights Consortium®
www.designlights.org

Appendix

Other Efficacy Issues Heard in Comments

- Efficacy levels…
  - The draft efficacy levels are just right
  - The draft efficacy levels are too low
  - Efficacy levels for outdoor should be flat instead of tiered
  - The draft efficacy levels will result in too many delisted products
- Reference fixture testing for lamps needs to be removed and replaced with lamp distribution requirements
- The efficacy allowances permitted under V4.4 need to be maintained
  - Existing family grouping will make the delist impact more severe

Other Flicker Issues Heard in Comments

- Flicker thresholds in dimmed states
  - As flicker is exacerbated with dimming, it should be required, but perhaps at more lax thresholds
  - Designing around full light output should be sufficient
  - Should be a requirement to list the dimmer used to pass the qualification and any other recommended dimmers
  - Require testing with a standard dimmer.
- Phantom array frequency limit
  - Upper frequency limit for the phantom array should be higher