ENERGY STAR® Criteria Update

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US Department of Energy

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2007 DOE Solid State Lighting Workshop

EERE Network News:

January 17, 2007

DOE Launches Energy Star for Solid-State Lighting

DOE released draft Energy Star program requirements for solid-state lighting luminaries on **December 20th**. Solid-state lighting includes light-emitting diodes (LEDs) as well as organic LEDs, and DOE is establishing Energy Star requirements for solid-state lights as part of a national strategy to accelerate the market introduction of these products.

The draft document set minimum requirements for earning the Energy Star label, including the minimum light output, efficacy, and warmth of the LED lights, as well as how well the light is focused upon its task for certain applications. The draft requirements apply to recessed downlights, under-cabinet kitchen lighting, under-cabinet shelf-mounted task lighting, portable desk task lights, outdoor wall mounted porch lights, outdoor step lights, and outdoor pathway lights. The draft requirements are open to public review, with comments due by January 19th.

Proposed ENERGY STAR Format

- Two Categories:
  - Category A: Near-term Niche Applications
  - Category B: Efficacy Based Performance
- Why two Categories?
  - Transitional approach
  - Take advantage of directionality for near-term applications
  - Ensure high end-user satisfaction with the technology
  - Maintain the integrity of the ENERGY STAR label
- In the future, when there are a large number of systems meeting Category B, drop Category A.

Proposed ENERGY STAR Format

- Two Categories:
  - Category A: Near-term Niche Applications
  - Category B: Efficacy Based Performance
- Why two Categories?
  - Establish future industry performance target
  - Allow time for standard and test procedure development
  - Protect the integrity of the ENERGY STAR label
  - Provide DOE leadership
- In the future, when there a large number of systems meeting Category B, drop Category A.

Key Considerations

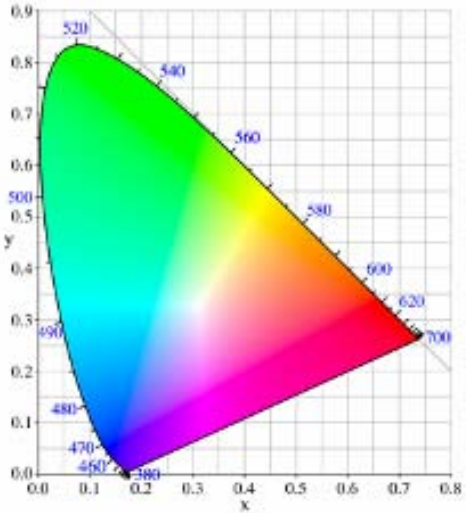
- General illumination applications only
  - Not indication or decoration
  - Not monochromatic light
- Residential and commercial applications
- Based on current and expected white LED performance
- Designed to ensure energy efficiency relative to existing light sources

Standards and Test Procedures

- **DOE hosted 2nd Standards Workshop in DC on Oct. 26, 2006**
- **Standards groups working to the ENERGY STAR schedule**
- **DOE providing on-going technical support for standards development**

Standards and Test Procedures

- **Test procedures under development**
  - **Photometric measurements (IESNA LM-79)**
  - **Lumen Depreciation (Life) (IESNA LM-80)**
  - **Chromaticity (ANSI C78.377A)**
  - **Electrical measurements (ANSI C78.XX3)**
  - **Definitions RP-16**
- **Final procedures expected in May 2007**



Terms

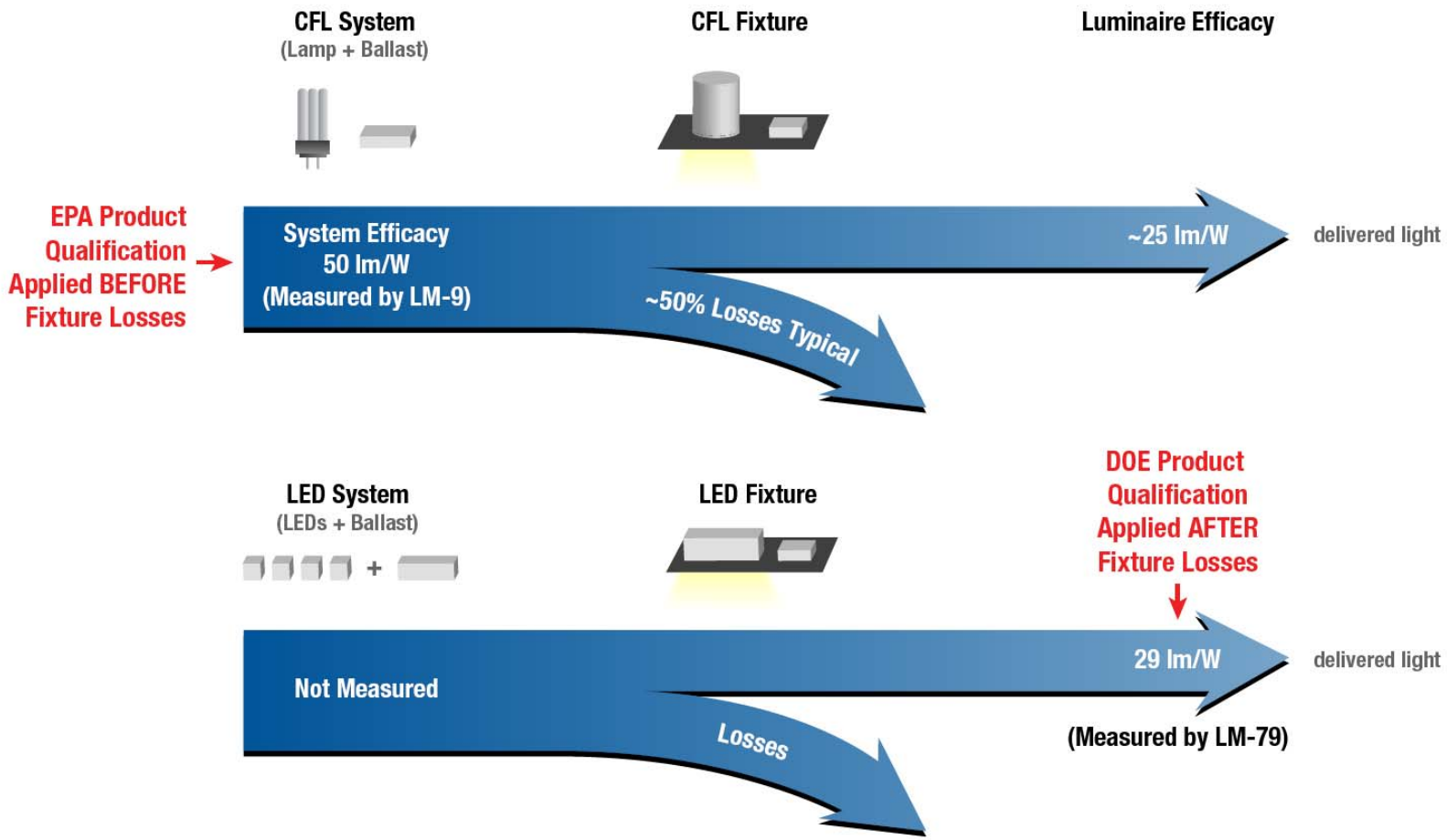
$$\text{Lamp Efficacy} = \frac{\text{Rated Lamp Lumens}}{\text{Lamp Input Power}}$$

$$\text{System Efficacy}_{\text{fluor}} = \frac{\text{Rated Lamp Lumens x BF}}{\text{Ballast/Driver Input Power}}$$

$$\text{Luminaire Efficacy} = \frac{\text{Luminaire Light Output}}{\text{Ballast/Driver Input Power}}$$

System Efficacy Vs. Luminaire Efficacy

(Recessed Downlights Example)



Luminaire Efficacy: Measurement

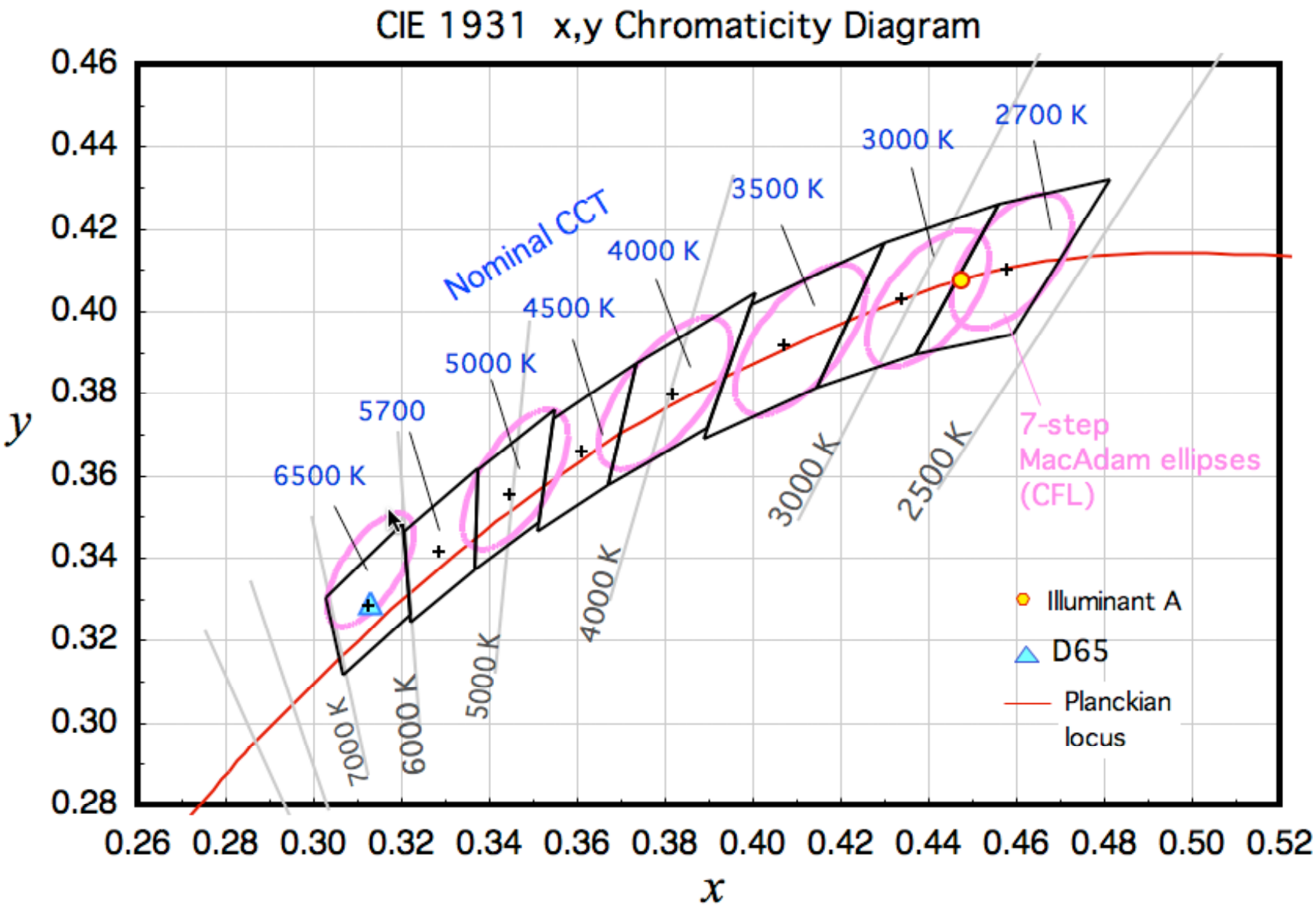
- **Photometric measurement of LED fixture**
  - **Based on new LM-79 in process**
- **Measure total luminous flux from fixture**
- **Measure system input watts to fixture**
- **Calculate luminaire efficacy as lm/W**

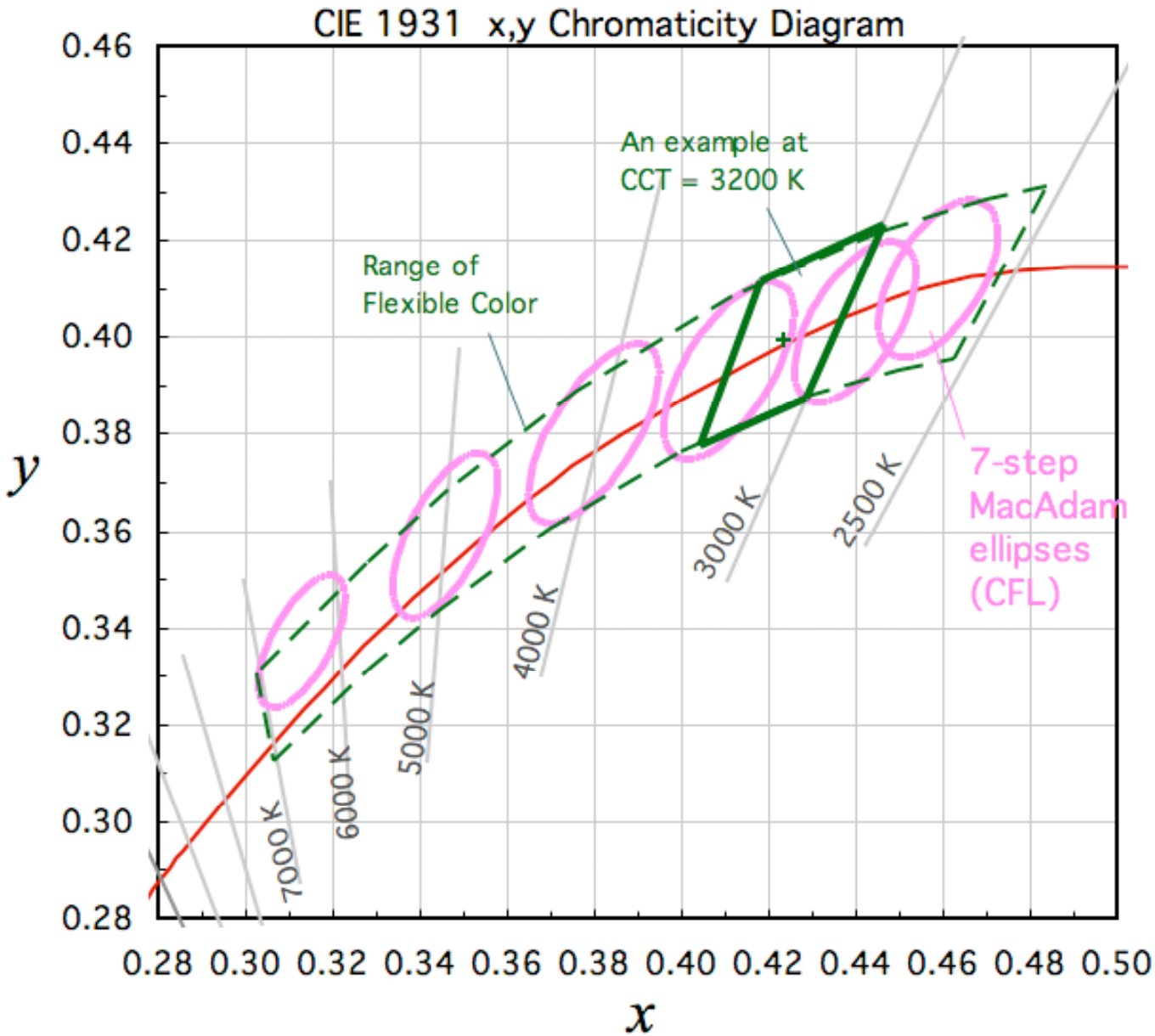
LED Useful Life

- LED useful life (L_{70}) based on lumen depreciation
- The number of continuous run hours until 70% of initial light output attained
- Joint ANSI/IESNA task group
  - Designated LM-80-XX

Correlated Color Temperature (CCT)

- Developed by joint ANSI/IESNA Task Group
- Includes the 6 CCTs ranges currently in ENERGY STAR
- Adds 4500K and 5700K
- Adds a “Flexible Color” option
- Uses 7-step quadrangles
  - quadrangles better align with die manufacturer bin structures


CIE 1931 x,y Chromaticity Diagram
Nominal CCT
6500 K
5700
5000 K
4500 K
4000 K
3500 K
3000 K
2700 K
7000 K
6000 K
5000 K
4000 K
3000 K
2500 K
7-step
MacAdam ellipses
(CFL)
Illuminant A
D65
Planckian
locus
y
x
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.28
0.30
0.32
0.34
0.36
0.38
0.40
0.42
0.44
0.46
0.48
0.50
0.52



Nominal CCT
3200 K

Min CCT	2998
Max CCT	3402
Center Duv	0.0002

4 corners (x,y)

x	y
0.4464	0.4234
0.4180	0.4116
0.4046	0.3774
0.4289	0.3871

ANSI C78.377A DRAFT 3.3 (Nov. 22, 2006)

Category A: Niche Applications

- **Directed light applications**
  - **Energy efficiency potential due to directional light source**
- **Source relatively close to illuminated surface**
- **Relatively modest illuminance requirements**
- **Typical Fixture efficiencies less than 50%**

Category A: Niche Applications

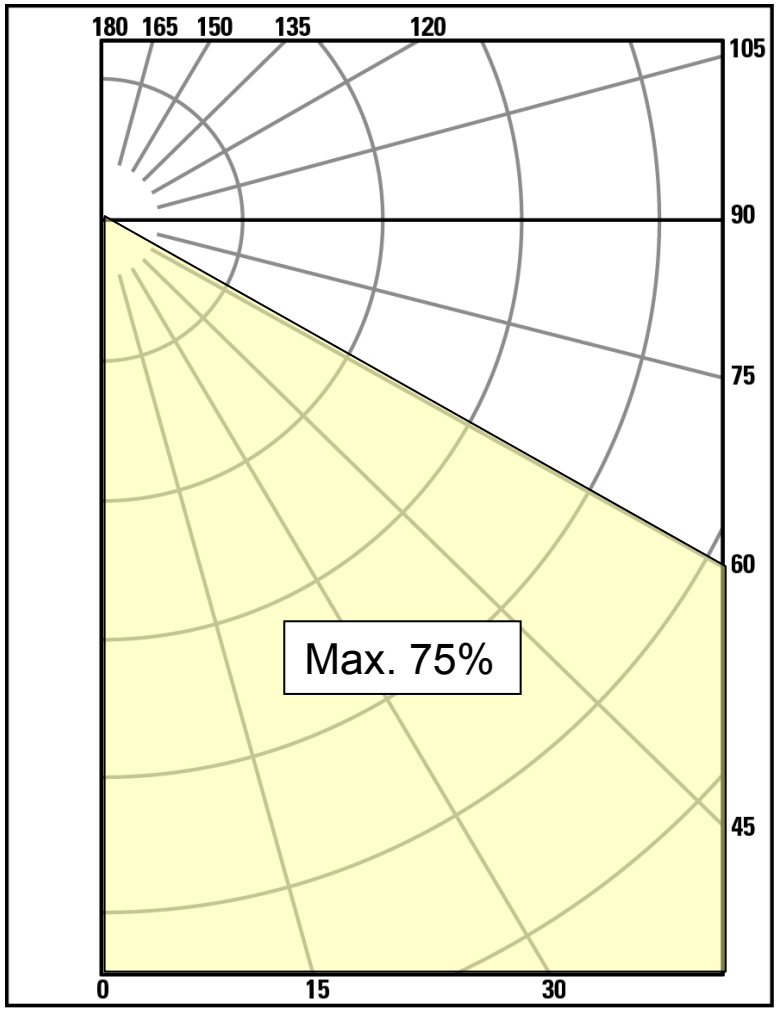
1. **Undercabinet Kitchen**
2. **Undercabinet Shelf-mounted Task**
3. **Portable Desk/Task**
4. **Outdoor Wall-mounted Porch**
5. **Outdoor Step**
6. **Outdoor Pathway**
7. **Recessed Downlights**

Category A: Overall Approach

- **Use IESNA guidelines where applicable**
- **Benchmark fixture efficiency of existing products in the market where possible**
  - **Few residential luminaires are tested photometrically**
  - **Wide ranges in efficiency for same category of luminaire**
- **Establish minimum net light output and zonal lumen density requirements**

Under-cabinet Kitchen

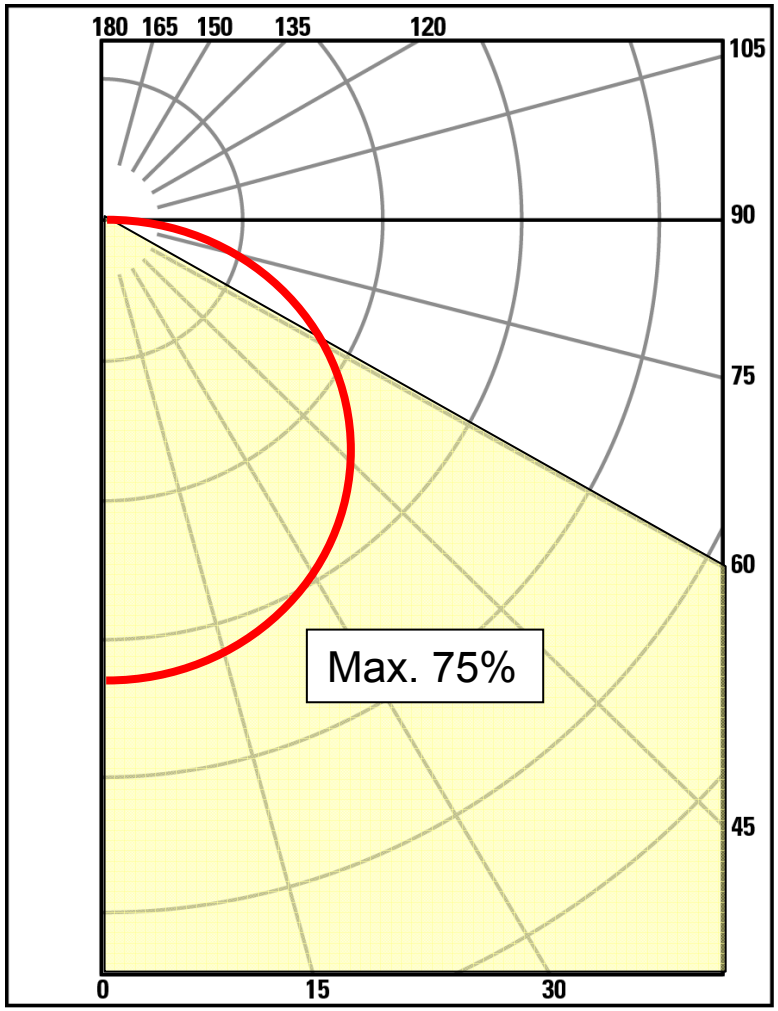
- Minimum Light Output
  - 150 lumens per lineal foot
- Zonal Lumen Density
  - Maximum 75% of total light output in the 0-60° zone
- Luminaire Efficacy
  - ≥ 23 lm/W
- CRI
  - ≥ 80



Under-cabinet Kitchen (Sample)

- Data taken from directly from photometric report
  - Net lumens
  - % Luminaire

Zonal Lumen Summary		
Zone	**Lumens**	**% Luminaire**
0 - 30	75.8	23.3
0 - 40	125.3	38.5
0 - 60	226.5	69.7
60 - 90	78.2	24.1
0 - 90	304.7	93.7
90 -180	20.3	6.3
0 - 180	325.1	100.0



Undercabinet

- **Residential kitchens**
- **Commercial offices**
- **Photometry available for commercial products**
- **Provide task lighting on countertop or desk**
- **Benchmark is linear fluorescent**

Portable Desk/Task

- **Plug-in portable fixtures**
- **Wide variety of styles and prices**
- **Provide supplemental task lighting on desk or other horizontal work surface**
- **Residential/Commercial offices**

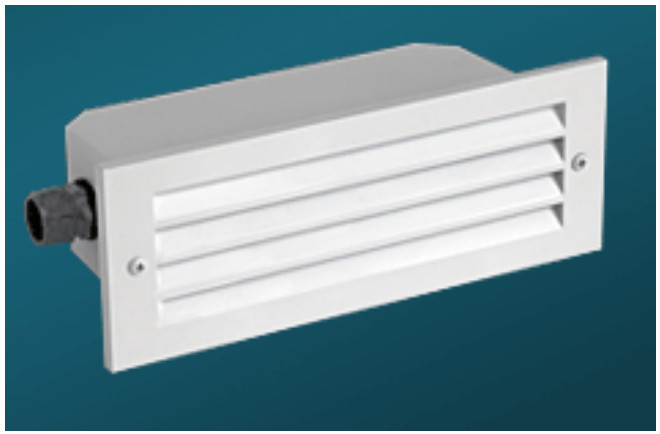
Category A: Portable Desk/Task

6 Watt LED Desk Lamp

Halley LED Desk Lamp

Category A: Outdoor Porch

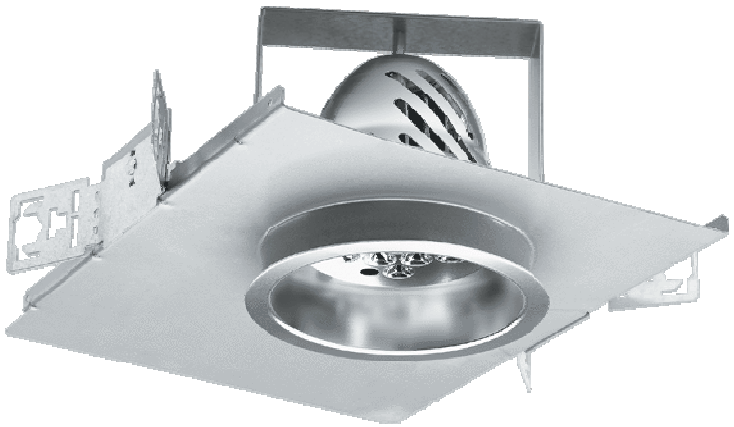
Category A: Outdoor Step



Category A: Outdoor Pathway

Category A: Recessed Downlights

Permlight



Prescolite

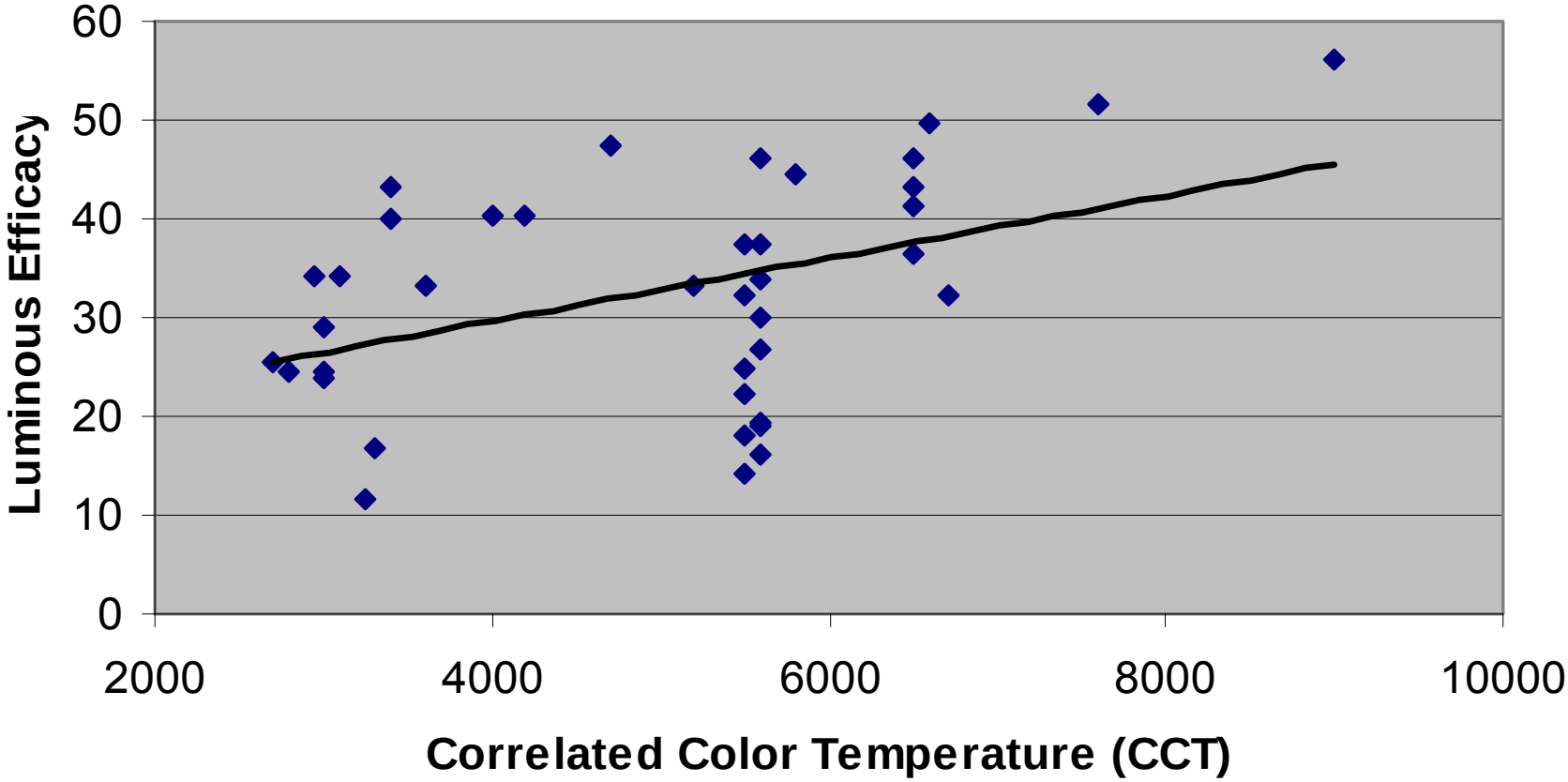
Gallium

Category B: Luminaire Efficacy Based Performance

- **Assumes performance level several years out**
- **Exceed efficacy of best CFLs**
- **No application efficiency requirement**
  - **No minimum net lumens or zonal lumens**
- **Uses luminaire efficacy**
  - **Total fixture lumens/total fixture watts**
- **Thresholds established based on CCT**

Production LEDs

as of 7/06



Keeping Pace with the Technology

- DOE will develop strategy to keep pace with the technology
- May add additional Category A niche applications as the technology improves

The Path Forward

- Stakeholder meeting: February 8, 2007
- Issue second draft: March 2007
- Complete final criteria: April 2007
- Effective date: December 2007

Questions

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