2008 ENERGY STAR®
Lighting Partner Meeting
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New Technologies

Solid-State Lighting

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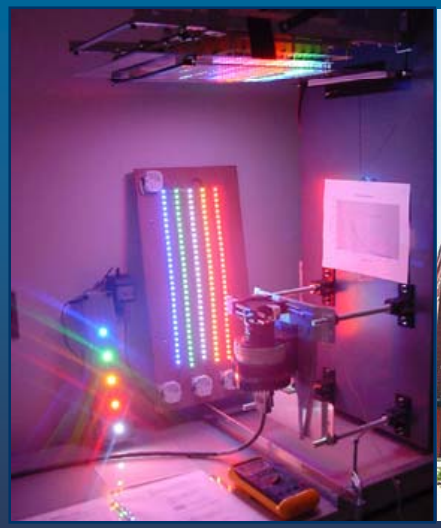
Acknowledgments

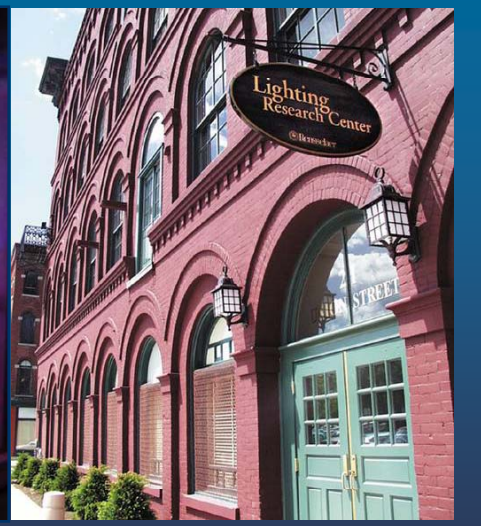
- Organizers and sponsors of 2008 ENERGY STAR® Lighting Partner Meeting
- ASSIST Program sponsors
- LRC staff

ASSIST Sponsors

ASSIST

- Program basics:
  - LRC-based project to evaluate LEDs and LED systems
  - 16 funding members, all major LED manufacturers, agencies in UK and China
  - NVLAP-accredited labs
  - Publications



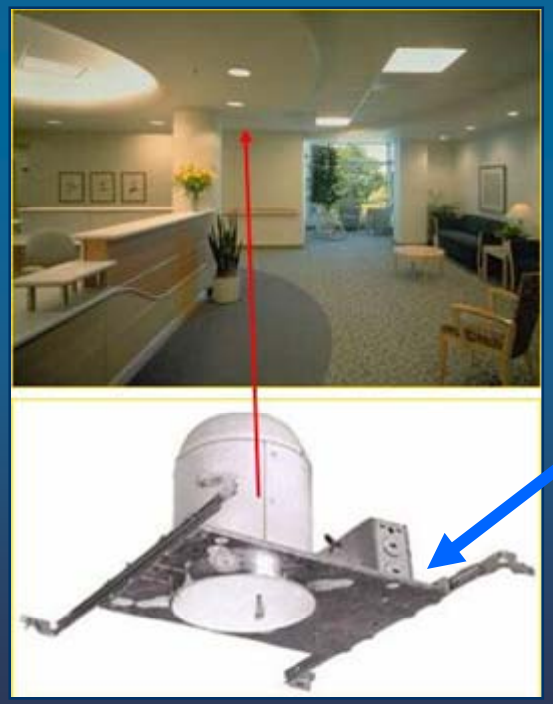


Industry trend

- Growing number of LEDs and LED fixtures

Downlighting

- Many light source technologies available today can cater to downlighting applications.
  - › Growing number of commercial LED downlights



Incandescent Halogen

CFL

LED

LED Luminaire Performance

- LED luminaire performance depends on how it is designed, built, and used.
- The LED junction temperature is a good predictor of performance
  - Tj depends on drive condition and application environment

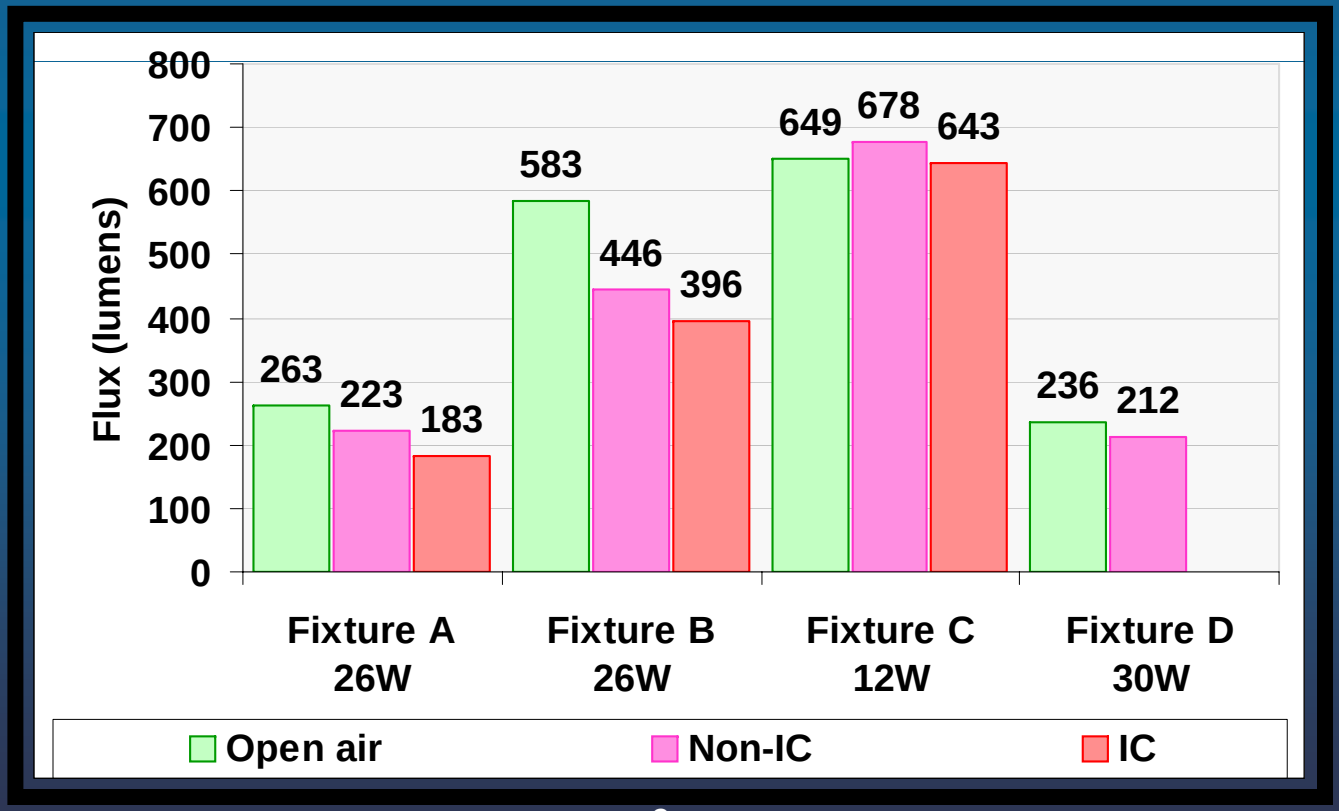
http://www.ylighting.com/linear-system.html

Luminaire Testing

- Several commercial LED fixtures are being tested in 3 environments (per ASSIST Recommends).
  - Open air
  - Non-IC
  - IC
- Short-term testing
  - Flux and color
- Long-term testing
  - Lumen depreciation and life (L70)
  - Color shift

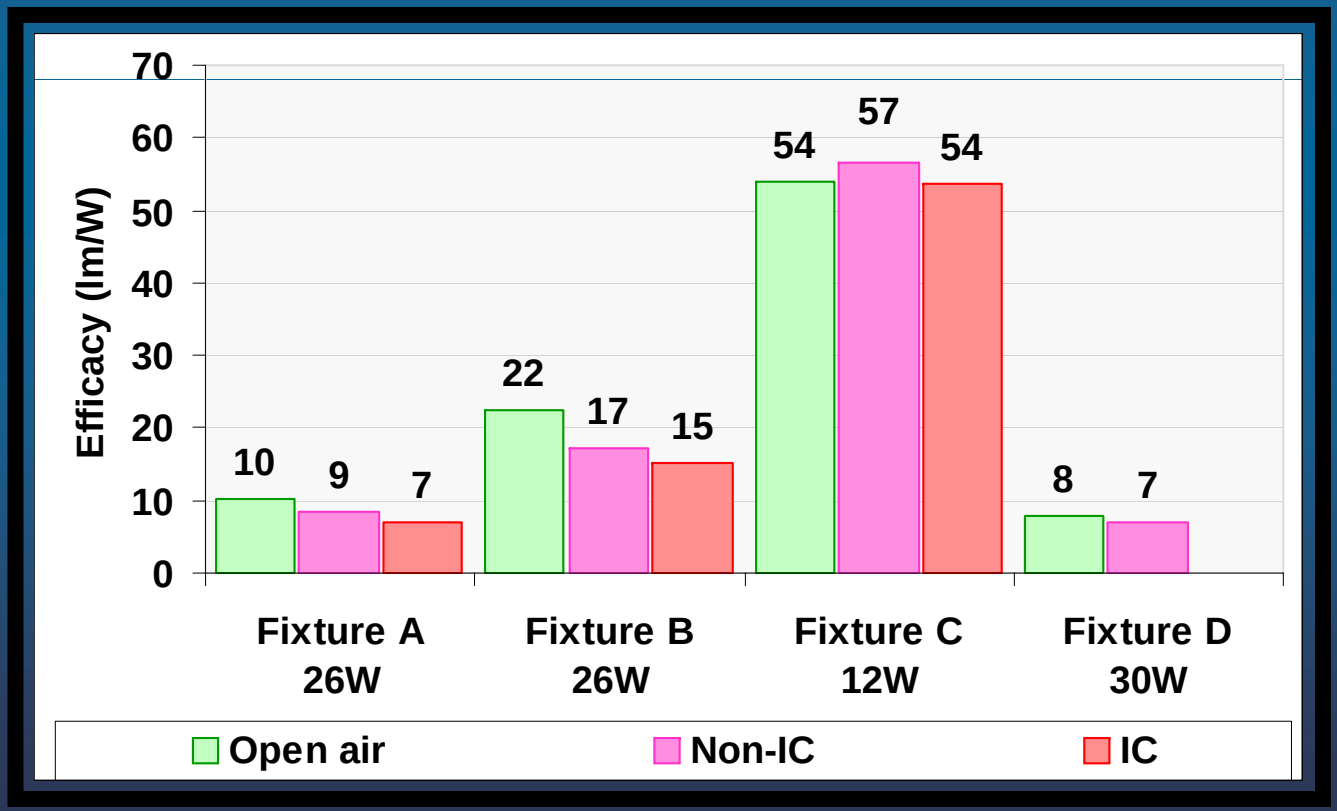
Flux (lumens)

- Well designed luminaires maintain light output even in hotter environments
- Poorly designed luminaires have more than 30% lower light output in IC-condition



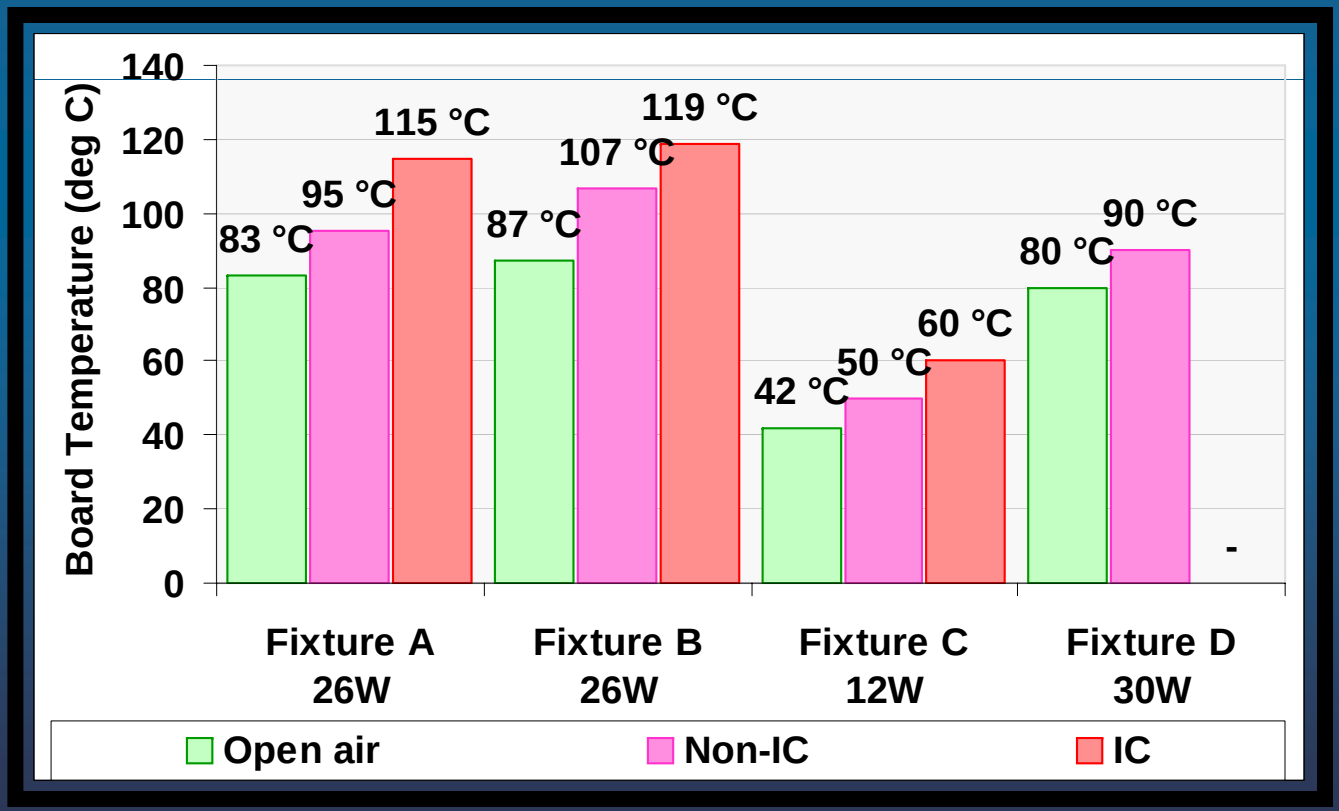
Efficacy (lm/W)

- Generally, system efficacy values are 30% to 50% lower than LED efficacy values.
- However, well designed luminaires have achieved over 50 lm/W

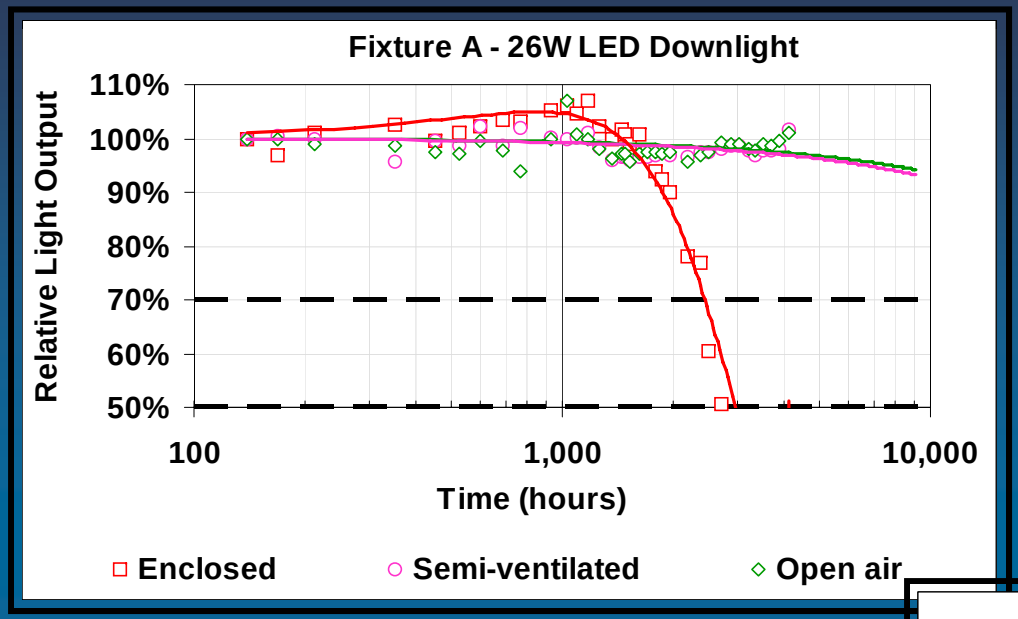


Board Temperature (deg C)

- With increasing Tj the life shortens
  - generally half the life for every 10 deg C increase.



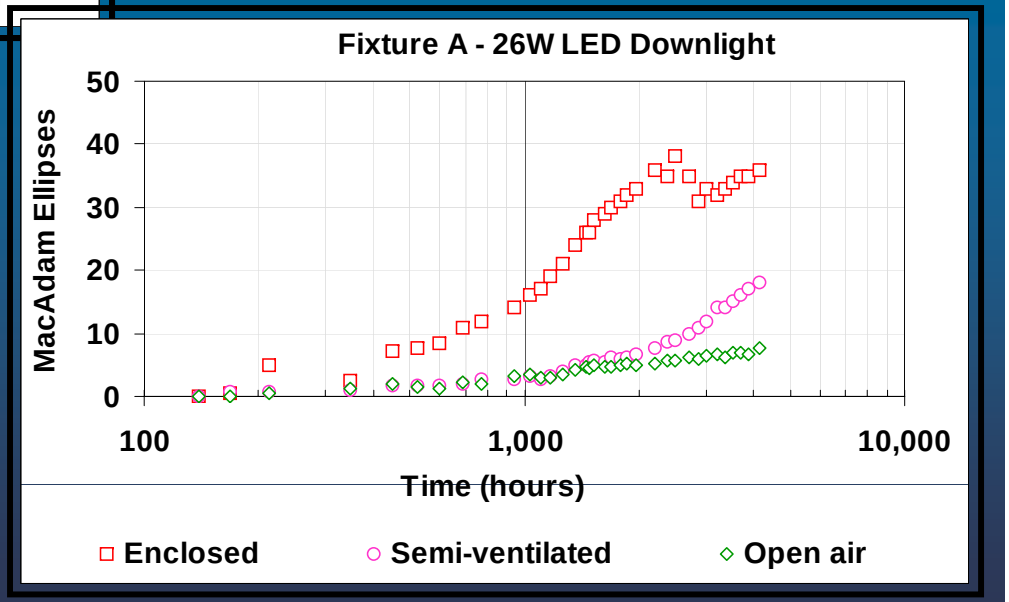
Lumen depreciation & Color shift



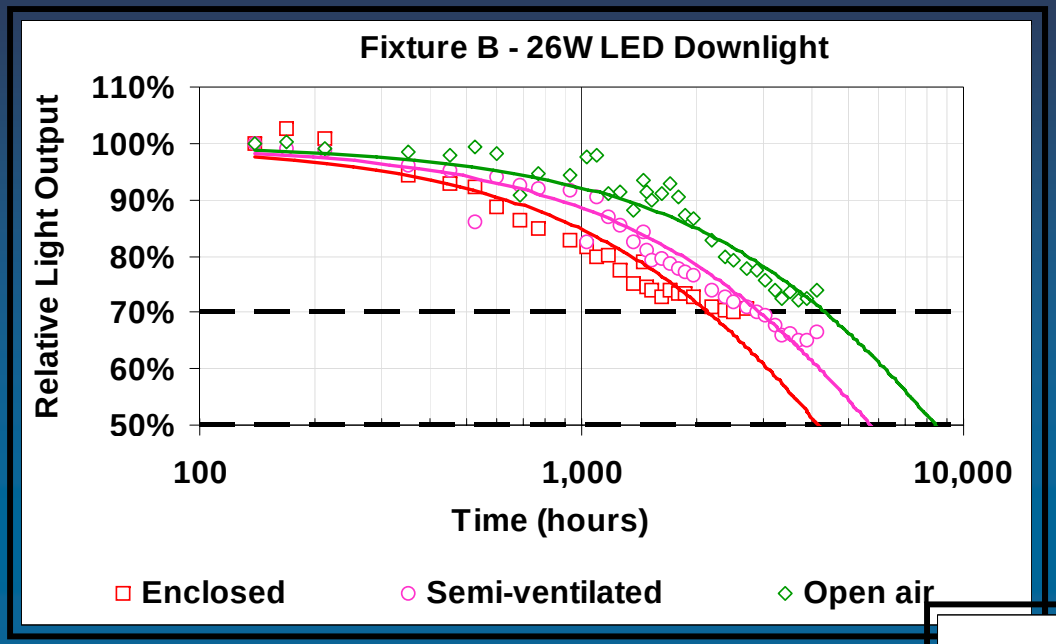
IC	Non-IC	Open air
115 °C	95 °C	83 °C

In the IC condition,

- Life (L70) is less than 3000 hrs.
- The color shift is greater than a 36-step MacAdam ellipses (reached within 3000 hours).



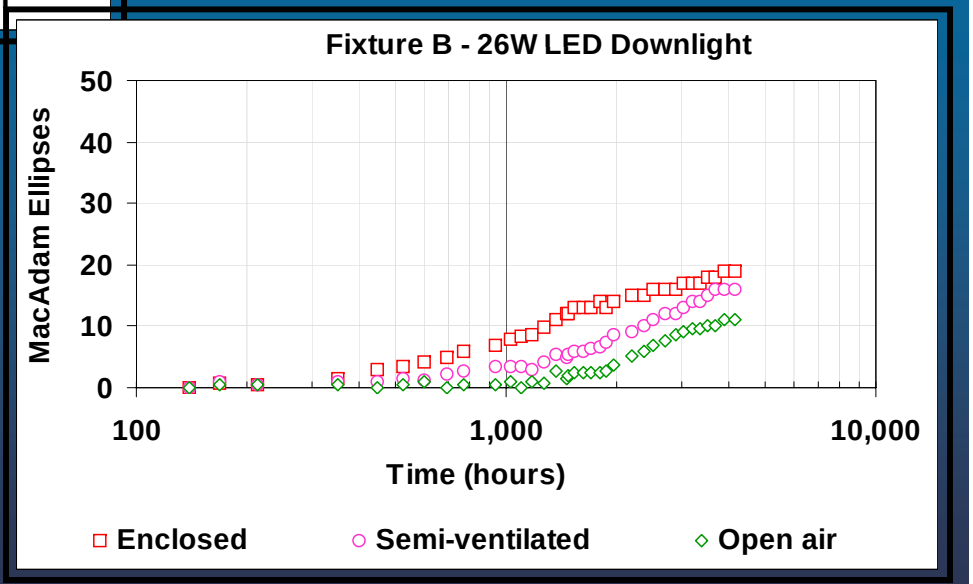
Lumen depreciation & Color shift



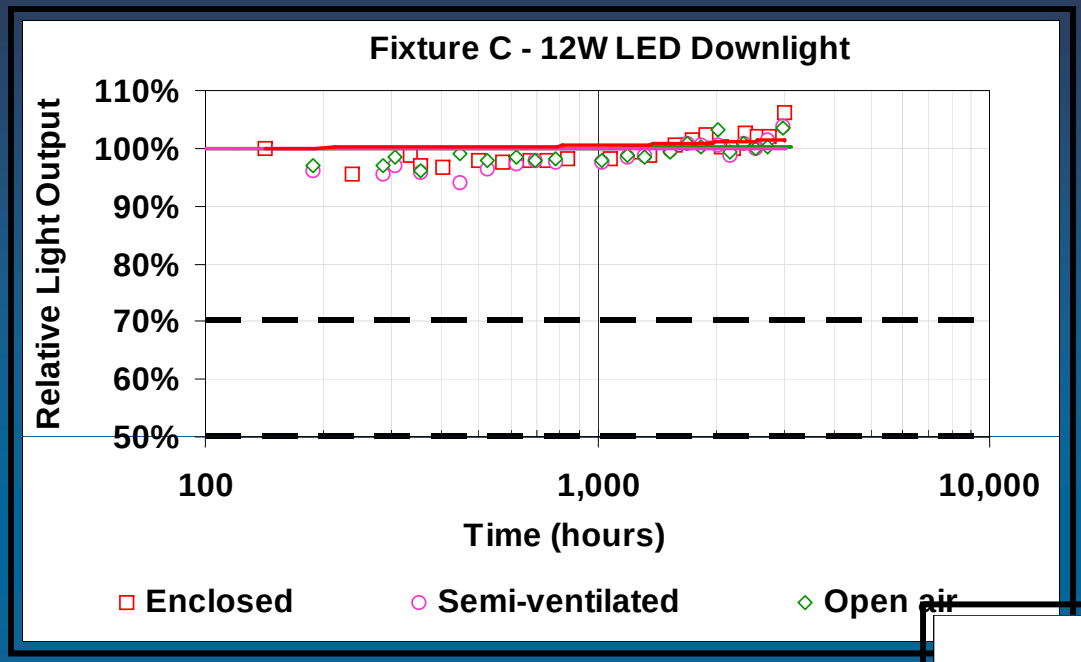
IC	Non-IC	Open air
119 °C	107 °C	87 °C

In the IC condition,

- Life (L70) is less than 3000 hrs.
- The color shift is greater than a 19-step MacAdam ellipses (reached within 4000 hours).



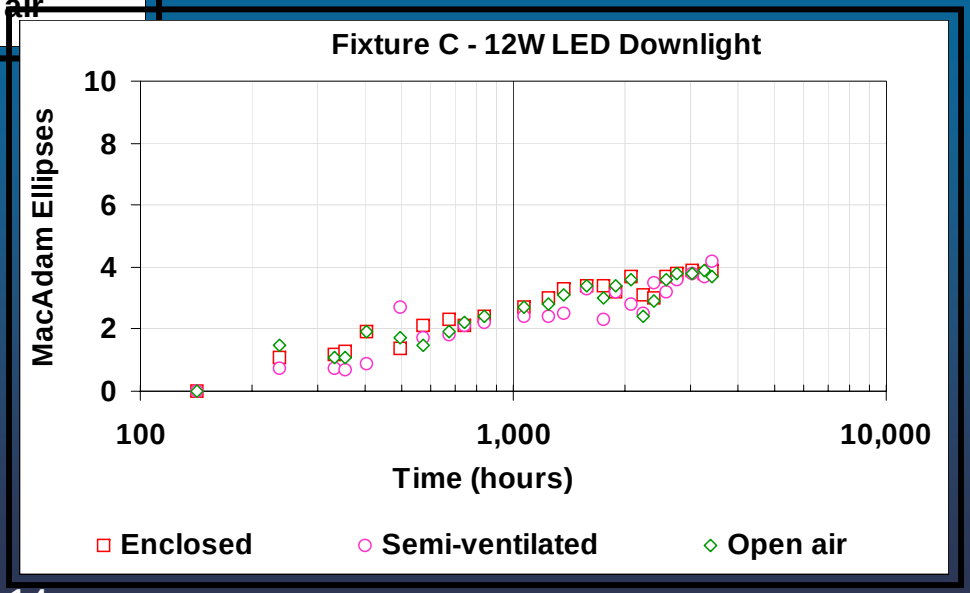
Lumen depreciation & Color shift



IC	Non-IC	Open air
60 °C	50 °C	42 °C

Even in the IC condition,

- Life (L70) seems very long.
- The color shift is within 4-step MacAdam ellipses (in the 3000 hours).



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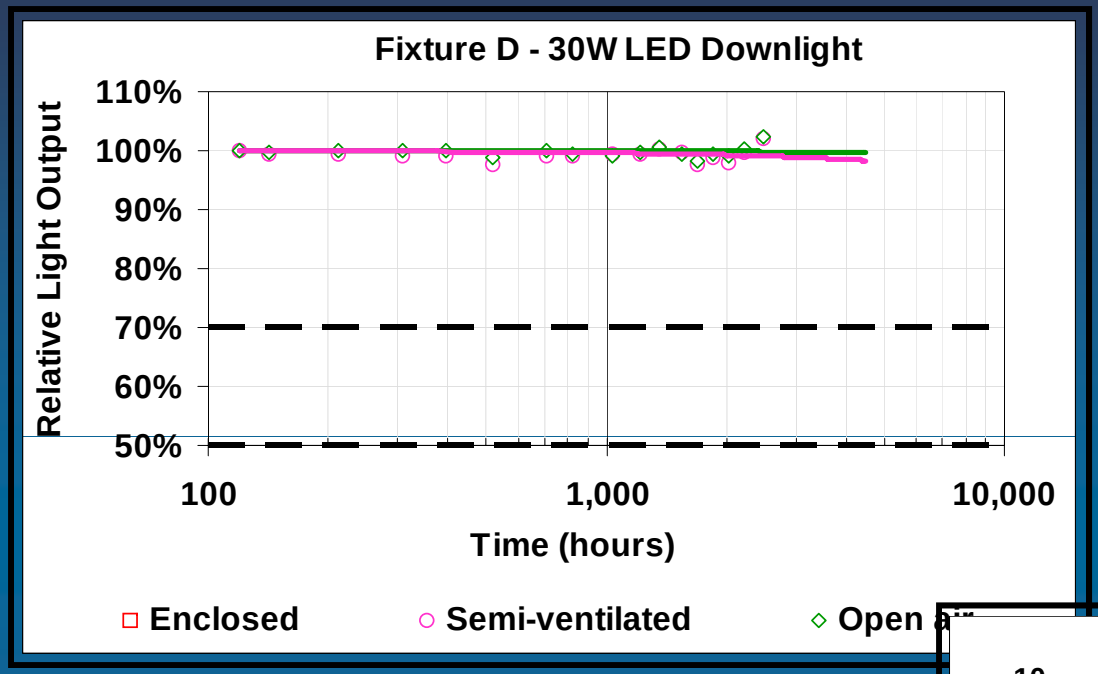
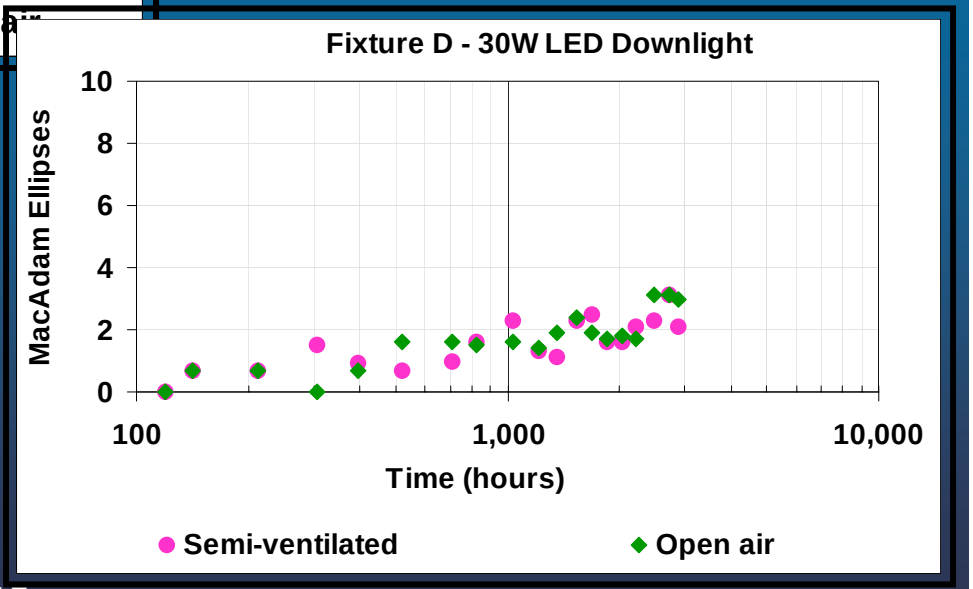
Lumen depreciation & Color shift



	Non-IC	Open air
	90 °C	80 °C

Even in the IC condition,

- Life (L70) seems very long.
- The color shift is within 3-step MacAdam ellipses (in the 3000 hours).



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Summary

- Out of the 4 fixtures presented here only one showed results acceptable for general lighting, considering:
  - Light output
  - Efficacy
  - Lumen depreciation
  - Color shift over time
- "ASSIST recommends" test methods were designed to:
  - Provide more useful information for selecting and using LED directional lighting luminaires
  - Help differentiate between good and poor performing LED luminaires in terms of light output and life

Thank you

www.lrc.rpi.edu/programs/solidstate