U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

LED Reliability and Current Standards for Measurement

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Life and Reliability for Lighting

- Historically…….

  Lighting Reliability = Lamp Life
- Lamp failure is well established as critical lighting reliability component (shortest life)
- Fixture and Ballast not typically considered – expected life relatively long
- Lamps separately measurable from other components – easy target for life

….along comes LED technology

- LED “lamp” no longer a short life item
- Lamp not (really) separately measurable
- Potential long life of LEDs forces critical look at other components and performance
  - Driver (ballast) and electrical circuitry
  - Fixture parts and operation (i.e. dimming)
  - Color?

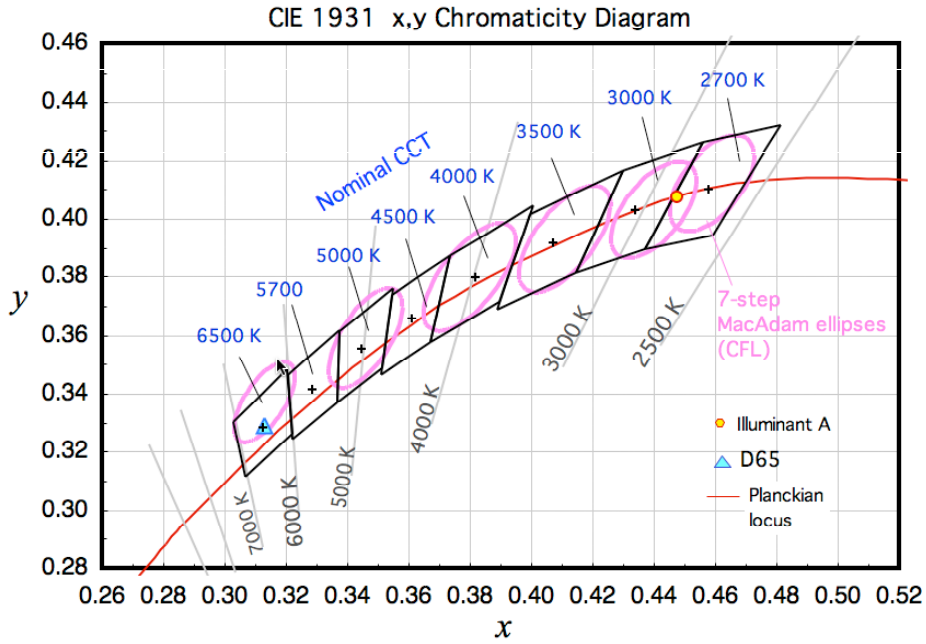
True (LED) life = Total Luminaire Reliability

Current LED Standards Status

- C78.377 Chromaticity
- RP-16 (addendum)
- LM-79 Photometric and Electrical performance
- LM-80 Lumen Degradation (and TM-21)
- UL8750 Safety
- NEMA SSL-3 Binning
- LED Application Guide (G-2)
- Others
  - White papers
  - Standards and test methods in development

C78.377 Chromaticity

- Specifies chromaticity ranges for white light LEDS
- Based on CFL color ranges – supports effective replacement

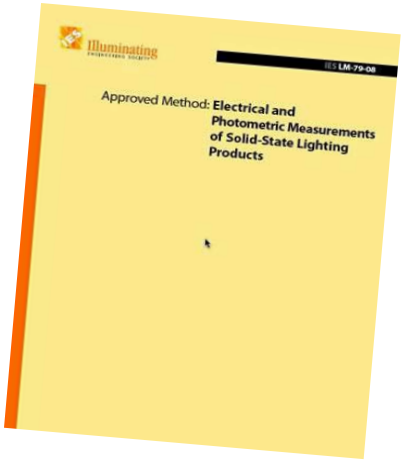


IES RP-16 Definitions

- Addendum “a” added initial LED related definitions
- Addendum “b” adds more and updates some from “a”
- Future addenda (“?”) will likely emerge as technology matures and more terms are needed.

LM-79 – LED Performance

- Defines measurement of photometric and electrical performance of LED luminaires
- Applies to complete luminaires – necessary to capture heat issues
- Provides critical performance measures
  - Total Luminous flux
  - Light distribution
  - Efficacy
  - Color



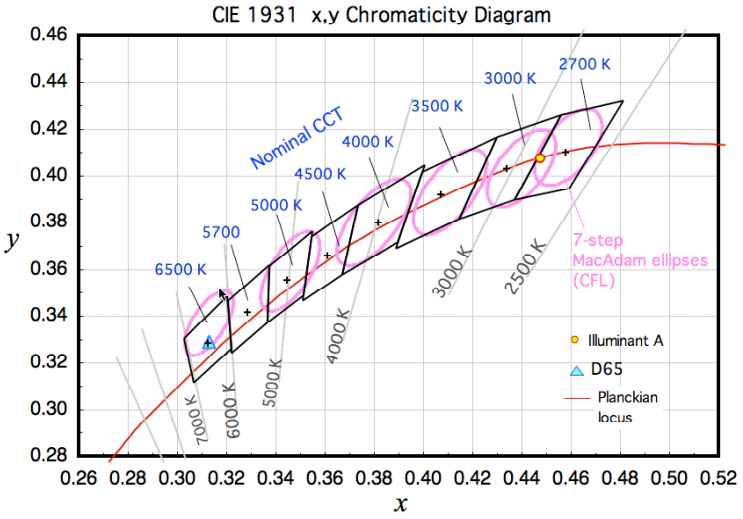
Safety - UL 8750 (CSA, ETL)

- Initially a UL “outline of Investigation” addressing LED from other standards
- Addresses standard luminaire and “lamp” issues
- UL 8750 currently in update process to address technology development and application issues.
- CSA and ETL also Nationally Recognized Test Labs (NRTL)

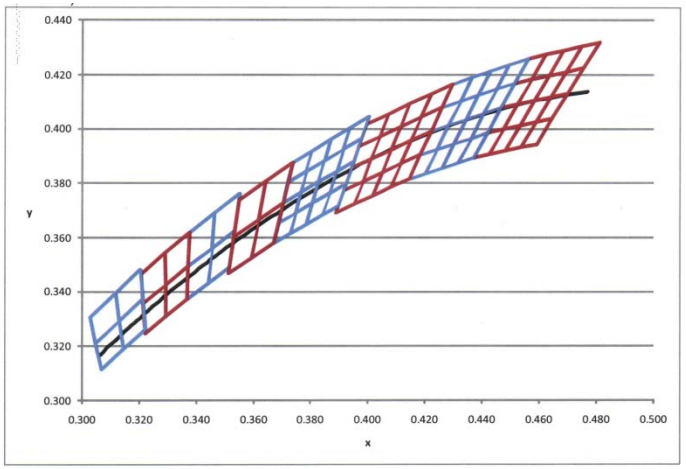
NEMA SSL-3 Binning

- Provides manufacturers and integrators useful LED chip categorization
- Promotes more effective luminaire development – better consistency

C78.377



SSL-3



IES LED Application Guide (G-2)

- IES guideline specifically addressing LED performance and application issues
- Provides specific LED technology issue background
- Includes application specific guidance
- Currently being printed!

Other LED related documents

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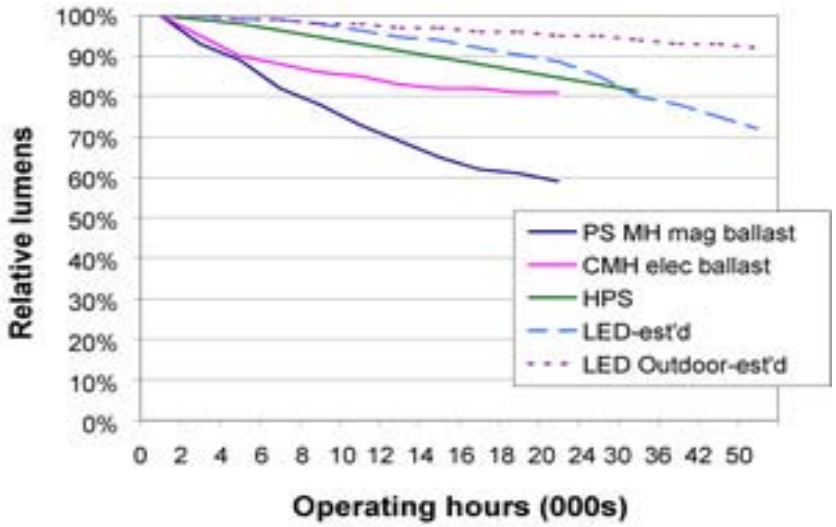
- IES – test methods in development
  - Light engine test method (~decorative)
  - High power LED component test method
  - Lumen maintenance of LED lamps *New!*
  - Lumen maintenance of LED luminaires New!
- NEMA - white papers
  - LSD 49 LED dimming
  - LSD 45 LED standardization for module integration
- NEMA standards in development
  - SSL-1 Driver standard
  - Dimming standard
- IEEE PAR 1789 white paper – Mitigating LED Flicker
- CIE TC1-69 - Color Quality Scale (new CRI type metric)

Lumen Maintenance as "Life"

- Typical Lamp "Life"
  - All lamps degrade
  - Most have failure component - filament
  - Most fail before critical light output achieved
  - LEDs can degrade well beyond useful light level



….therefore LED lumen "life" is performance based

  - Light output level is critical measure

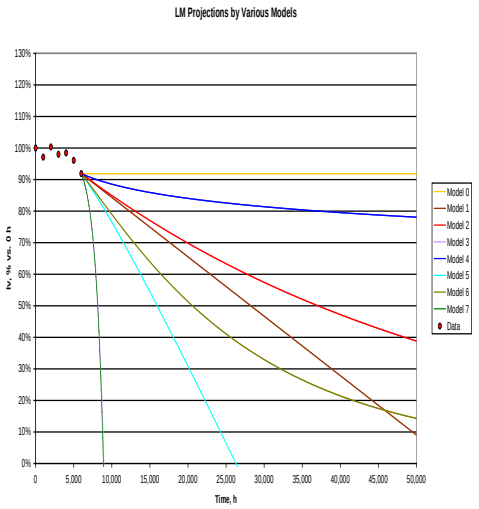
LM-80 – Lumen Maintenance

- Provides format for measurement of lumen degradation
- Recommends 6000 hours testing
- Covers LED packages, arrays and modules only
- ….but does not define methods for “life” prediction beyond 6000 hours or other reliability elements

LM-80 is not a complete lumen “life” metric!

IES TM-21 ("Life" Estimation)

- Test Method to provide a prediction of Lumen maintenance over long timeframe
- Based on LM-80 testing (6000 hours)
- Multiple methods under consideration
- Looking at reporting:
  - L_{70} metric – i.e. hours to 70% light output
  - Light output at specified time periods (i.e 35,000 hours)



Will provide only one part of the LED reliability puzzle

The process still needs your support…..

Current standards and New standards need champions, drivers, and reviewers!