

# Don't be Left in the Dark: The Changing Lighting Industry will Impact those Unprepared

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November 4<sup>th</sup>, 2011

# Overview

- Economic Analysis
- Market Pressures
  - Rare Earth Phosphor Shortage
  - EISA 2007
- Trends & Technology
  - LED
  - Controls

# Economic Analysis

- Incentives/Standards/Regulations
  - moving market towards energy efficiency
- Cost of Ownership vs. Initial Cost
  - dominates purchasing decision
- Movement away from “commodity” mindset to “asset” mindset
  - as long life product makes lighting a part of the built environment



# Economic Analysis

- Methodology
  - Full-fledge Life Cycle Cost Analysis is complicated
  - For quick calculations, use:
    - **Simple Payback**
      - Energy Savings
      - Maintenance Savings
      - Cooling Savings
    - **Future Cash Flow**
    - **Return on Investment (ROI)**



# Economic Analysis

In the Bahamas, you can't afford not to use energy efficient lighting strategies.

## Annual cost for 1W lighting

Energy Rate	12 hrs/day (4380 hrs/year)	24 hrs/day (8760 hrs/year)
\$.26/kWh	\$1.14	\$2.28
\$.38/kWh	\$1.66	\$3.33

## Annual cost for 1W lighting + associated .34W cooling savings

Energy Rate	12 hrs/day (4380 hrs/year)	24 hrs/day (8760 hrs/year)
\$.26/kWh	\$1.52	\$3.04
\$.38/kWh	\$2.21	\$4.42

# Economic Analysis

Multiply this by 10:

## Annual cost for 10W lighting

Energy Rate	12 hrs/day (4380 hrs/year)	24 hrs/day (8760 hrs/year)
\$.26/kWh	\$11.40	\$22.80
\$.38/kWh	\$16.60	\$33.30

## Annual cost for 10W lighting + associated 3.34W cooling savings

Energy Rate	12 hrs/day (4380 hrs/year)	24 hrs/day (8760 hrs/year)
\$.26/kWh	\$15.20	\$30.40
\$.38/kWh	\$22.10	\$44.20

# Economic Analysis

Multiply this by 10:

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Energy Rate	12 hrs/day (4380 hrs/year)	24 hrs/day (8760 hrs/year)
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# Economic Analysis

- What about maintenance costs?
  - Cost of Lamp
  - Cost of Labor



OR



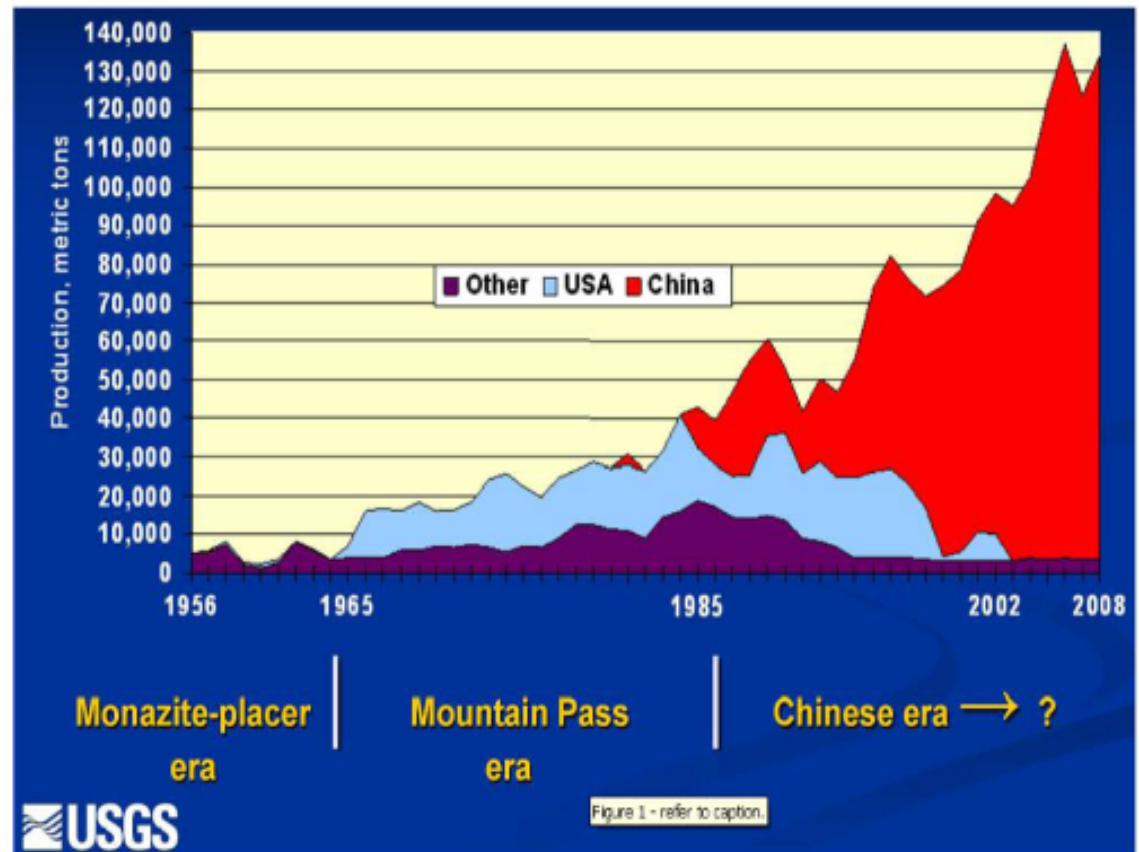
(1) LED A-lamp  
50,000 hr life

(5) CFLs  
10,000 hr life  
each



# Rare Earth Phosphor Shortage

- Rare earths comprise 85% of the phosphors used in fluorescent lamps
- **Since 2002 China controls 95% of the world's rare earth oxide production**



**Figure 1.** Global rare-earth-oxide production trends. The Mountain Pass deposit is in California, U.S.A. Graph from D.J. Cordier (U.S. Geological Survey, written commun., 2011) was updated from Haxel and others (2002, fig. 1).

# Rare Earth Phosphor Shortage

- Earlier this year, China started reducing exports
- This resulted in 25 – 75% price increases in:
  - Linear fluorescent T5, T8, and T12
  - Compact Fluorescents
- Prices will continue to rise until the price of rare earth phosphors stabilize
- WTO ruled in July that China broke international law by limiting exports. China has appealed.
- In the meantime, the U.S. and other countries are looking to increase their own production.



# Rare Earth Phosphor Shortage

- What does this mean?
  - You will continue to pay higher and higher prices on fluorescent lamps
  - Alternate technologies will begin to look more and more cost effective



# EISA 2007

- Energy Independence Security Act
- Signed into law by President Bush in 2007
- Lighting Elements
  - Fluorescent Lamps
  - General Service Incandescent Lamps
  - Halogen PAR Lamps

# EISA 2007

- General Service Incandescent Lamps
  - Phasing out of standard household A-lamp
    - 100W A-lamp obsolete as of January 1, 2012
    - 75W A-lamp obsolete as of January 1, 2013
    - 40 - 60W A-lamp obsolete as of January 1, 2014
  - Solution: Energy efficient halogen A-lamps are available. Opportunity to replace with CFL or LED.



# EISA 2007

- Fluorescent Lamps
  - T12 Linear Fluorescent Lamps
    - As of July 2012, T12 lamps will be obsolete
    - Solution: Install new fixtures or retrofit to T8 or T5
    - Effect: Energy savings on 4' T12 from 48W down to 32W or less
  - T8 Linear Fluorescent Lamps
    - As of July 2012, T8 lamps will no longer be available in 70 CRI, only 80 CRI
    - Example: 32WT8/735 will become 32WT8/835
    - Effect: Better color rendering, higher lamp price



# EISA 2007

- Halogen PAR20 / PAR30 / PAR38
  - Lamps that do not meet a minimum efficacy level will be obsolete
  - No standard halogen will be available, only halogen IR technology

Wattage	Type	Diameter	Voltage	Standard
40 – 205	Standard	PAR38/30	130 V	6.8*P <sup>0.27</sup>
40 – 205	Standard	PAR38/30	120 V	5.9*P <sup>0.27</sup>
40 – 205	Standard	PAR 20	130 V	5.7*P <sup>0.27</sup>
40 – 205	Standard	PAR 20	120 V	5.0*P <sup>0.27</sup>
40 – 205	Reveal	PAR38/30	130 V	5.8*P <sup>0.27</sup>
40 – 205	Reveal	PAR38/30	120 V	5.0*P <sup>0.27</sup>
40 – 205	Reveal	PAR 20	130 V	4.9*P <sup>0.27</sup>
40 – 205	Reveal	PAR 20	120 V	4.2*P <sup>0.27</sup>



# EISA 2007

- Example:
  - 60W PAR38 120V = new min. efficacy of 17.5 LPW
  - 60PAR/H/FL @ 800 lm = 13.3 LPW
  - 60PAR/HIR/FL @ 1050 lm = 17.5 LPW
  - 60PAR/HIR+/FL @ 1260 lm = 21 LPW
- Solution:
  - Use HIR+ of the same wattage and increase light levels
  - Or, maintain light levels and use HIR+ of lower wattage
    - 90PAR38 standard halogen = 60 PAR38 HIR+
    - 75PAR38 standard halogen = 48 PAR38 HIR+
  - Or, switch to LED technology
- Effect:
  - Halogen HIR lamps are 2-3 times more expensive
  - You will forced to save 1/3 energy
    - If PAR lamp cost you \$4 before, it will now cost you \$12
    - But, this will payback in 2 months @ 12 hrs/day & \$.26/kWh

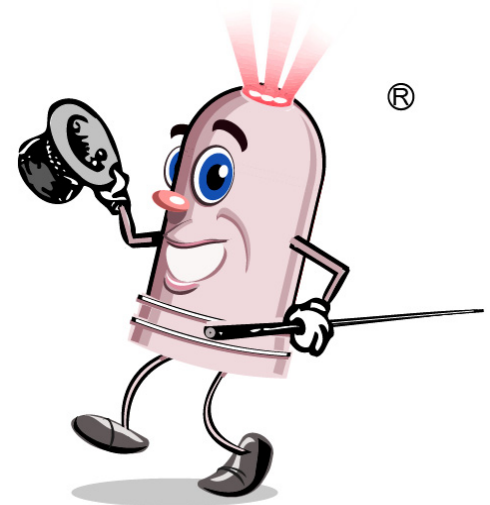




# LED Technology

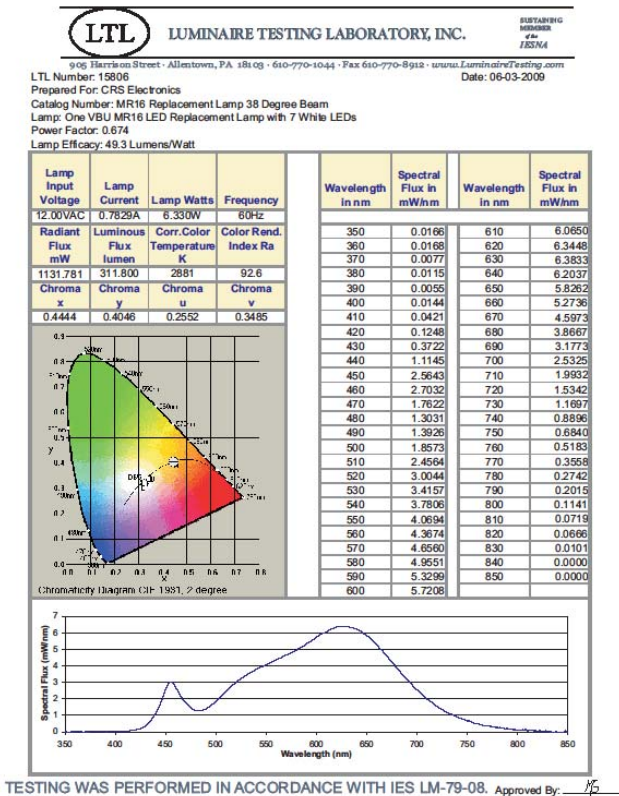
We are in the midst of, what  
some have coined, the LED  
Revolution

*"It's the Wild Wild West..."*



# LED Technology

- Emerging Market
- New companies launching monthly
  - Electronics companies = Toshiba/Samsung/Panasonic
  - Start-ups = Soraa/Solais
  - Lighting companies reincarnated = MSI
- New products introduced daily
  - Wide variations in quality
- New standards & testing procedures
  - IESNA LM-80 = Life of LED chips
  - IESNA LM-79 = Photometric/Spectral Performance of Luminaire
  - UL 8750 = LED equipment for use in Lighting Products
  - Standards for longevity of luminaires are not finalized



# LED Technology

- Forecast
  - \$2.8B LED sales in 2009, estimated to reach \$14B by 2013
  - Application Segment Market Share 2009
    - Architectural – 29.1%
    - Replacement Lamps – 7%
    - Off-Grid – 2.1%
    - Consumer Portable – 13.8%
    - Retail/Refrigerated Display – 5%
    - Outdoor – 3%
    - Commercial & Industrial – 18.8%
    - Entertainment – 4.2%
    - Safety/Security -11%
    - Residential – 2.4%
  - Replacement Lamps, followed by Outdoor, are the fastest growing segments

# LED Technology

- U.S. Government Involvement
  - DOE initiatives = [www.ssl.energy.gov](http://www.ssl.energy.gov)
    - CALiPER
    - SSL Quality Advocates Lighting Facts = [www.lightingfacts.com](http://www.lightingfacts.com)
      - Become a Partner to support truth in labeling
      - New Label with watermark
      - Now 2194 registered products (dated: 3/5/11)
  - Gateway Demonstrations
  - Fixture/Lamp Design Competitions
    - L-Prize
    - Next Generation Luminaire Design (commercial) = [www.ngldc.org](http://www.ngldc.org)
    - Lighting for Tomorrow (residential)
  - Standards Development
  - Technical Information Network

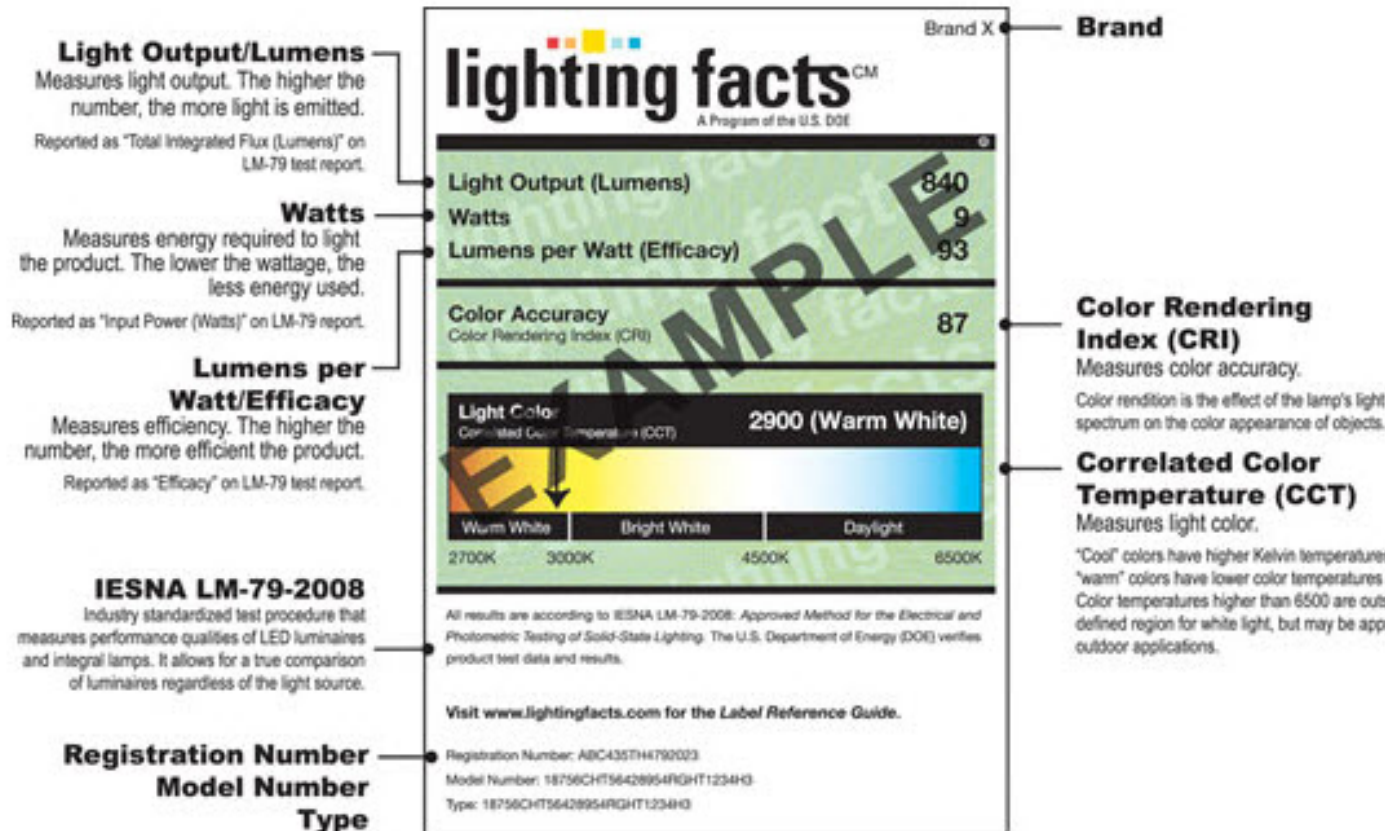


L-PRIZE<sup>SM</sup>

LIGHTING  
for  
tomorrow



# LED Technology



## Partner & Product Count

Manufacturers	215
Retailers & Distributors	170
Lighting Pro	200
Products	2194

Last updated 3/5/2011

# LED Technology

- U.S. Government Involvement
  - EPA Energy Star
    - Used to be DOE program – EPA is recent change
    - Watch out for Partner Label vs. Certification Label
    - Criteria Categories
      - Under-cabinet kitchen lighting
      - Recessed, surface-, and pendant-mounted downlights
      - Ceiling-mounted luminaires with diffuser
      - Cove Lighting
      - Surface-mounted luminaires with directional heads
      - Outdoors wall-mounted porch lights
      - Outdoor step lights
      - Outdoor pathway lights
      - Outdoor pole/arm-mounted decorative luminaires
      - Portable desk task lights
      - Wall-wash luminaires
      - Integral LED lamps



# LED Technology

Journ  e  
Lighting

products

downloads

installations

news

contact

where to buy

awards



**Next Generation  
Luminaires**



LED Technology.  
Simplified.

Explode



Partner Logo,  
not to be confused with  
Certification Logo

news

November 4, 2009

**GE Lumination Acquires Journ  e's LED Module Technology**

Leaders of GE Consumer & Industrial in the U.S. and Europe are already presenting the new module to lighting fixture manufacturers, distributors,

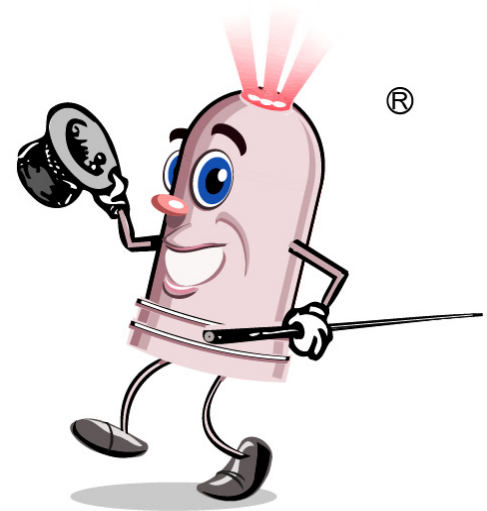
 **L.E.D. PASS.**  
LED Product Assessment & Screening System





# LED Technology

- Why is it important to vet product?
  - Standards are new & manufacturers are still catching up
  - Chip technology is changing faster than luminaires can be designed around them
  - Many of the products tested by the DOE have not performed as claimed
  - Ignorance and misunderstanding pervades LED marketing
  - Missing information is the norm
    - Cutsheets
    - LM79 Reports/IES Photometry
    - Installation Sheets
    - Warranty Terms & Conditions





# L.E.D. PASS – “*Guilty until Proven Innocent*”

- **Performance Assessment Screening System**
  - Method for qualifying product for a particular application
  - Variety of criteria, customized to client/app:
    - Product Assessment
      - Go/No-Go Criteria
      - Performance Criteria
      - Visual Performance Criteria
    - Manufacturer Assessment
      - Company Criteria
      - IP/Testing Criteria
      - Market Participation Criteria
  - Allows us to compare:
    - Existing, against
    - LED product(s) they have been considering, against
    - LED product(s) we recommend

# L.E.D. PASS

- PRODUCT ASSESSMENT
  - Go/No-Go Criteria
    1. UL
      - a. Is the product listed to UL standards?
    2. LM79
      - a. Has the product been spectrally and photometrically tested to LM-79 standards?
    3. Warranty
      - a. Is a 3+ year performance warranty offered, covering lumen maintenance and color shift?

# L.E.D. PASS – #1 - UL 8750

- Testing procedure
  - UL 8750, LED Equipment for Use in Lighting Products
  - In addition to the UL standard that corresponds to that product type
    - e.g. UL 1993 Self-ballasted Lamps
- Testing Labs
  - Product does not need to be UL listed, per se
  - Product can be listed by any NRTL lab, as long as it is tested to UL standard 8750
  - A NRTL is an independent testing lab recognized by OSHA to test products to the specs of applicable product safety codes
    - ETL (Intertek)
    - TUV
    - CSA
    - Others:  
<http://63.234.227.130/dts/otpcanrtl/index.html#nrtls>



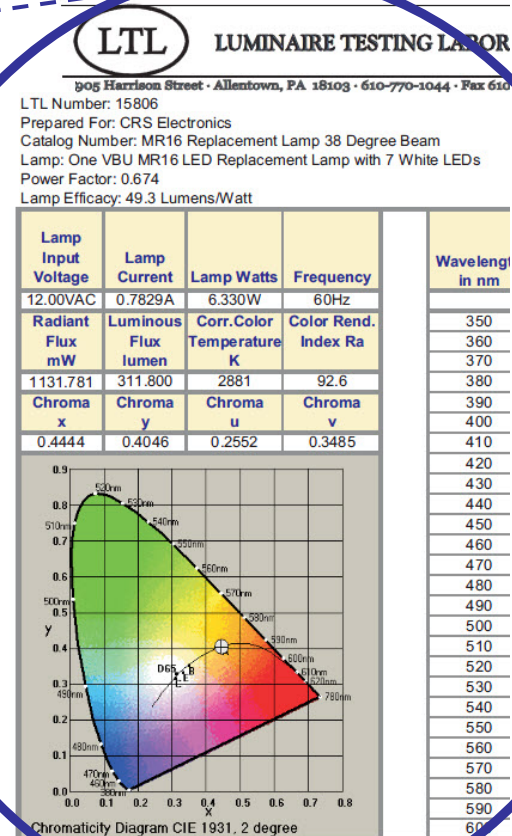
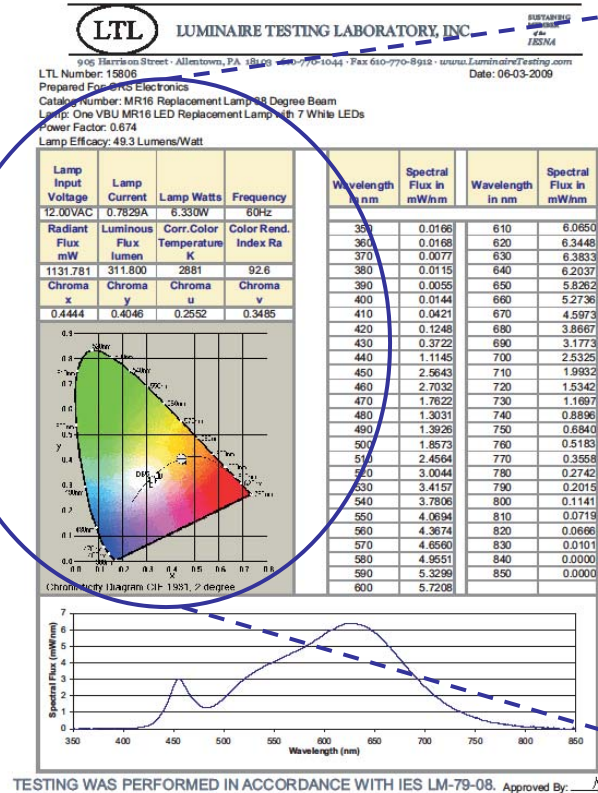
# L.E.D. PASS – #1 - UL 8750

- Do your homework
  - Testing labs have online directories
    - <http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html>
  - If manufacturer not listed, product may be private labeled under another company
- Concerns
  - Legal liability
    - Insurance will not cover fire or injury related claims due to product not listed by a NRTL lab
  - Retrofit Kits (e.g. LED fluorescent tube replacements)
    - Be wary of product that changes the electrical configuration of the product it is being installed into
  - Low Voltage Lamps (e.g. LED MR16s)
    - Confusion amongst the testing labs. Lamps are low voltage, but they still have electronic driver components on board and should be tested (according to UL). UL standards are under development to clarify.

# L.E.D. PASS - #2 - Photometric Testing

- LM-63 = Relative Photometry
  - Testing methodology for non-LED sources
    - Fixture performance measured, then lumen output of test lamp measured.
    - Fixture “Efficiency” is expressed as the percentage of lumens delivered vs. the total lumens of the lamp
    - Delivered lumens can be calculated by multiplying the “Efficiency” by lamp lumens
  - All relevant data embedded in IES File
  - Manufacturers tested only a sampling of fixtures.
    - Software allows you to “insert” different lamp values into calculations
- LM-79 = Absolute Photometry
  - Testing methodology for LED sources
    - Fixture (or lamp) performance is measured.
    - Lumen output is expressed as total delivered lumens.
    - “Efficiency” measurements are not applicable
  - Also tests spectral and other characteristics of LEDs
    - Reason to request full LM79 report in addition to IES File
    - Look for CCT, CRI, R9, CQS, Power Factor, etc.
  - Manufacturers must test all combinations - CCT/Beam Angle
  - On LED MR16s – ask whether AC or DC tested – AC preferred

# L.E.D. PASS - #2 - Photometric Testing



# L.E.D. PASS - #3 - Warranty

- Coverage Length

- 3 years

- @ 24/7 = 26,280 hrs
    - @ 12/7 = 13,140 hrs

- 3 yrs @ 24/7 or 5 yrs @ 12/7

- @ 24/7 = 26,280 hrs
    - @ 12/7 = 21,900 hrs

- 5 years or 25,000 hours, whichever comes first

- @ 24/7 = 25,000 hrs @ 2.9 yr mark
    - @ 18/7 = 25,000 hrs @ 3.8 yr mark
    - @ 12/7 = 21,900 hrs

- 5 years

- @ 24/7 = 43,800 hrs
    - @ 12/7 = 21,900 hrs

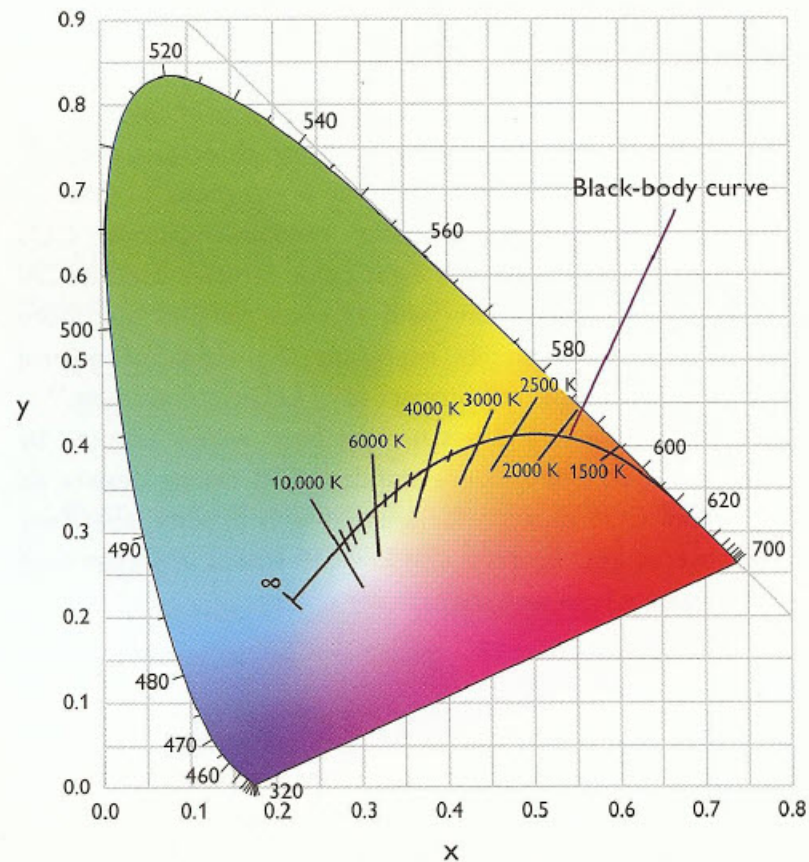
<u>Annual Hours Reference</u>
• @ 24/7 = 8760 hrs
• @ 12/7 = 4380 hrs

# L.E.D. PASS - #3 - Warranty

- Coverage Type
  - Failure
  - Performance
    - Lumen Maintenance
      - To a %, typically 70%
    - Color Shift
      - To a +/- CCT
      - Often references Energy Star/ANSI standards
- Exclusions – what voids the warranty?
  - Certain ambient temperatures?
  - Certain locations/types of fixtures?



# L.E.D. PASS - #13/14/15 – Color Temp

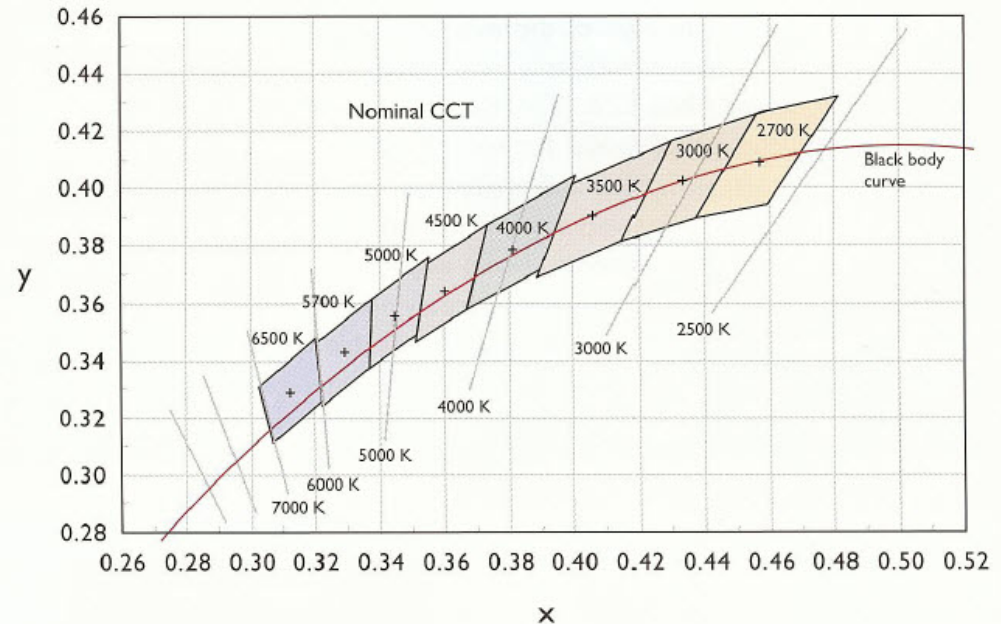


*The black-body curve defines the range of color temperatures, from warm (reddish) to cool (bluish), within the CIE 1931 color space.*

# L.E.D. PASS - #13/14/15 – Color Temp

**ANSI C78.377A CCT Standard**

Nominal CCT	CCT Range (K)
2700 K	2725 ± 145
3000 K	3045 ± 175
3500 K	3465 ± 245
4000 K	3985 ± 275
4500 K	4503 ± 243
5000 K	5028 ± 283
5700 K	5665 ± 355
6500 K	6530 ± 510



# L.E.D. PASS - #16/17/18 – Color Rendering

CRI = Color  
Rendering Index  
(8 swatches)

R9 = Strong  
Red Content  
(single swatch)

Name	Appr. Munsell	Appearance under daylight	Swatch
TCS01	7,5 R 6/4	Light greyish red	
TCS02	5 Y 6/4	Dark greyish yellow	
TCS03	5 GY 6/8	Strong yellow green	
TCS04	2,5 G 6/6	Moderate yellowish green	
TCS05	10 BG 6/4	Light bluish green	
TCS06	5 PB 6/8	Light blue	
TCS07	2,5 P 6/8	Light violet	
TCS08	10 P 6/8	Light reddish purple	
TCS09	4,5 R 4/13	Strong red	
TCS10	5 Y 8/10	Strong yellow	
TCS11	4,5 G 5/8	Strong green	
TCS12	3 PB 3/11	Strong blue	
TCS13	5 YR 8/4	Light yellowish pink (skin)	
TCS14	5 GY 4/4	Moderate olive green (leaf)	
TCS15	1 YR 6/4	Asian skin	

CQS = Color  
Quality Scale  
(15 swatches)

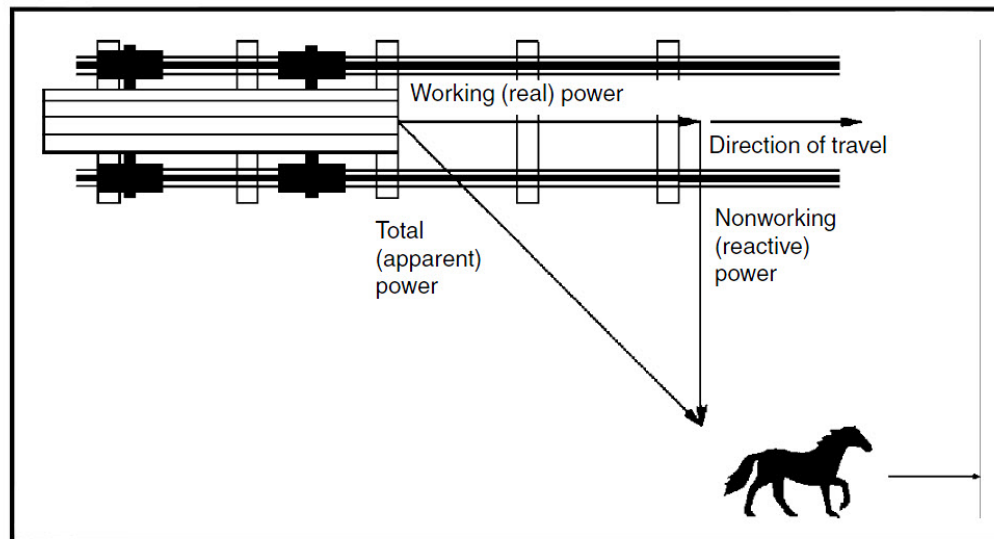
# L.E.D. PASS - #19 - Dimmability

- Issues
  - Dimming range
  - Visual flicker
  - Color shift
  - Human perception of dimming %
  - # fixtures per dimmer
- Request list of compatible dimmers
- Lutron has website devoted to their test results:
  - <http://www.lutron.com/Service-Support/Technical/Design-SelectionTools/Pages/LEDDimmerMatrix.aspx>

# L.E.D. PASS - #20 – Power Factor

- Many utilities have demand charges if your PF is less than .95
- Energy Star requires greater than .7 PF

## What is Power Factor?



$$\text{Power Factor} = \frac{\text{Real Power}}{\text{Apparent Power}}$$

# L.E.D. PASS - #24 – Transformers

- LED MR16 & LV Transformer Compatibility Issues:
  - May not illuminate at all
    - Wattage is so low that transformer does not recognize it
  - May flicker
  - May “blow” lamp
  - May “blow” transformer
- Magnetic tend to perform better than electronic
- Ask manufacturer for list of compatible transformers
- Educate client of potential issues prior to mock-up
- If not compatible, consider replacing transformer

# L.E.D. PASS - Case Study

- Charles Schwab

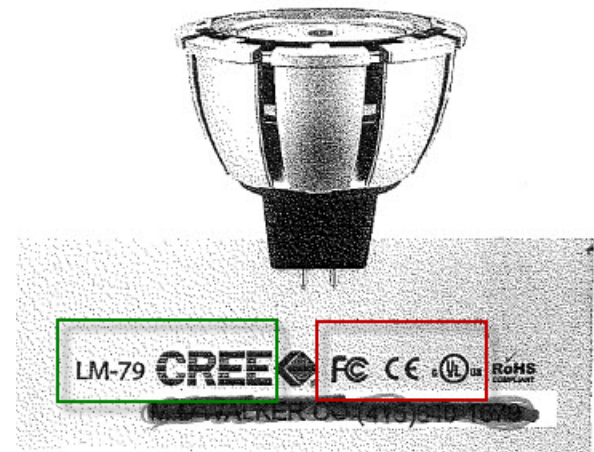
- SF facility had capitol approved to retrofit 35W and 50W Halogen MR16s with an LED MR16 claiming to be equivalent to a 35W MR16.

## Benefits & Features

- 1 High Power LED with CREE latest technology
- 2 Dimmability depends on transformer
- 3 Low Lumen Depreciation  
L70 >25,000 hrs
- 4 Low Power Consumption
- 5 High Color Rendering Index (>80)
- 6 25,000 hrs Rated Lifetime
- 7 3 Year Warranty
- 8 CE, FCC cUL, and UL Pending
- 9 RoHS Compliant

## Energy & Utility Savings

	Incandescent	MR16-6.5W
Power Consumption	35W	6.5W
Energy Saving	--	82%
Utility Saving*	--	\$78.38



*charles* SCHWAB

Wiedenbach-Brown's  
**L.E.D. PASS.**  
LED Product Assessment & Screening System





# LED Technology

- Integrated Luminaires vs. LED Lamps
- How to specify for equivalent performance?
  - Currently: “I need a Fixture with Lamp Type, Wattage, and Optics”
  - Market Shift: “I need an LED Fixture with Delivered Lumens, Efficacy, and Optics”
  - Familiarize yourself with comparable Incand/Halogen/CFL/MH fixture performance





# LED Lamps

- PAR38
  - Replace existing 75 – 90W halogen PAR38
  - With 12 – 21W LED PAR38
  - 75%+ energy savings
- PAR30
  - Replace existing 50 – 75W halogen PAR30
  - With 8 – 18W LED PAR30
  - 75%+ energy savings
- PAR20
  - Replace existing 50W halogen PAR20
  - With 6 – 12W LED PAR20
  - 75%+ energy savings



# LED Lamps

- MR16
  - Replace existing 20 – 50W halogen MR16
  - With 5 – 12W LED MR16
  - 75%+ energy savings
- A-Lamp
  - Replace existing 40 – 60W incand. A-Lamp
  - With 8 – 13W LED A-Lamp
  - 75%+ energy savings
- Candelabra
  - Replace existing 20 – 40 W incand. candelabra
  - With 6 – 8W LED candelabra
  - 75%+ energy savings



# LED Fixtures

- Almost every fixture type today is available with integrated LED
- Downlights
  - Replace existing 100W Incandescent Downlights
  - Or, existing 26 – 32W CFL Downlights
  - With 12 – 18W LED Downlights
  - Up to 80%+ energy savings
- Street/Area Lighting
  - Replace up to 400W Metal Halide/HPS
  - 1000W developments are in the works
  - Generally 50%+ energy savings



# Controls

- Occupancy Sensors vs. Vacancy Sensors
- Daylight Harvesting
- Dimming & T24 CA 2013



# Thank You

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