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Association of Energy Engineers



A Practical Guide to LED Product Selection & Applications

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What we will cover...

- **Types of LED's**
- **LED Metrics**
- **Controls**
- **ASHRAE 90.1 - 2010**



Types of LED's

- **Tubes**
- **Retrofit Kits**
- **New Fixtures**



Types of LED - Interior

Tubes - UL Type A

- Operates directly from compatible existing ballasts
- No mechanical or electrical modification is required

Advantages

- Easy installation
- Lowest upfront cost

Disadvantages

- Compatibility issues with existing ballast
- Still have ballast as point of failure and energy consumer
- Backwards compatible



Types of LED - Exterior

Tubes - UL Type B

- Operates on line voltage (no ballast)
- Both single and double ended options

Advantages

- No power loss due to ballast
- No ballast = reduced maintenance costs
- Not backwards compatible with fluorescent tubes

Disadvantages

- More labor intensive than Type A
- Some facilities may require an electrician to change lamps.



Types of LED - Interior

Tubes UL Type C

- System that includes an external LED driver and LED tubes

Advantages

- Drivers are more efficient than fluorescent ballasts
- Dimmable
- Not backwards compatible with fluorescent tubes

Disadvantages

- Still has a driver present – maintenance item
- Higher cost than Type A or B



Types of LED - Interior

Retrofit Kits - Board and Driver

- External driver with LED Boards

Advantages

- Can be used on any linear fluorescent fixture
- Dimmable
- Lower cost than a new fixture
- Longer rated life than tubes

Disadvantages

- Additional maintenance components
- Higher cost than tubes



Types of LED - Interior

Retrofit Kits - Volumetric Kit

- External driver with LED Boards
- Door frame Kits – change the look and light distribution of the fixture

Advantages

- Optional integral controls
- Lower cost than a new fixture

Disadvantages

- Can only be used on troffers
- Additional maintenance components
- Higher cost than tubes



Types of LED - Interior

New Fixtures - Troffers

- Complete new housing
- External driver and LED boards

Advantages

- Designed around LED technology
- Optional integral controls
- Upgrade aesthetics
- Longer life

Disadvantages

- Highest upfront cost
- Additional maintenance components



Types of LED - Interior

New Fixtures – High Bays

- Complete new housing
- External driver and LED boards
- Applications: Gyms, manufacturing and warehouse

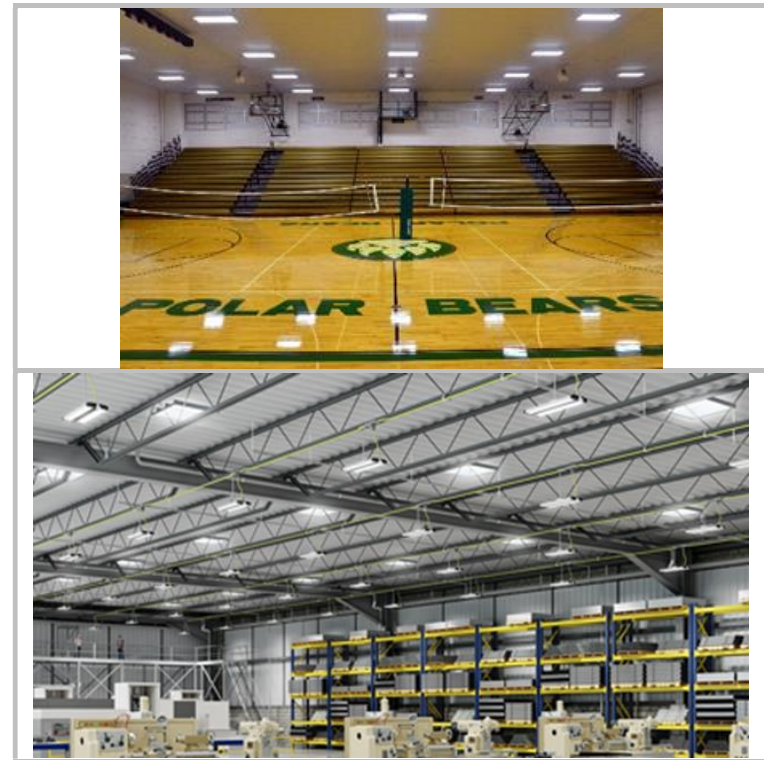


Advantages

- Multiple lumen and optics options
- 480v options
- Optional integral controls
- Longer life

Disadvantages

- Highest upfront cost
- Additional maintenance components

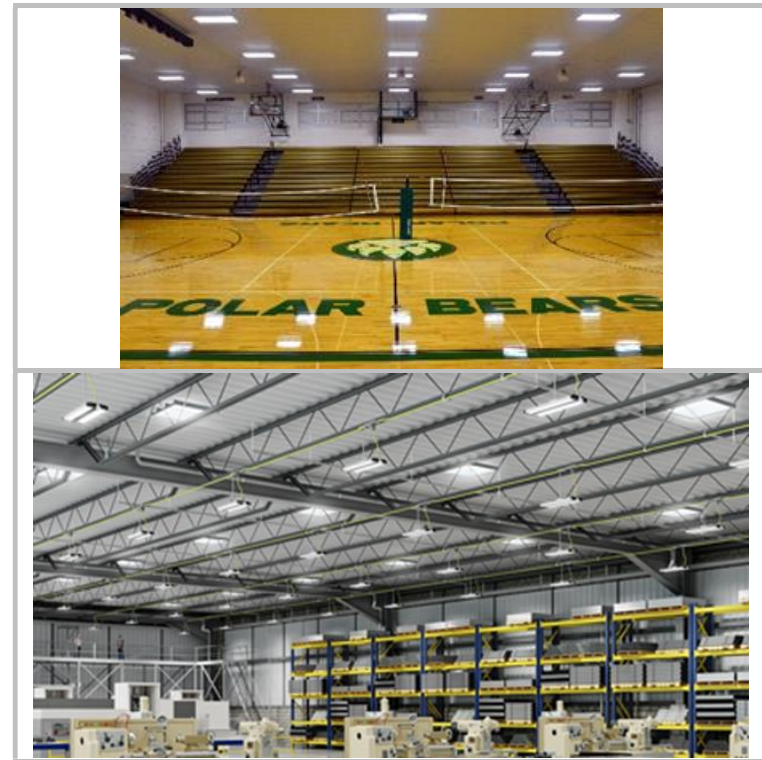


Types of LED - Interior

New Fixtures – High Bays

Why a new fixture?

- 6 - 12.5w TLED tubes = 10,500L
- 6 - 18.5w TLED tubes = 15,600L
- This is **INITIAL** - at 50k hours your at 7,000 or 11,000
- If you started with an 18L fixture **you'll** be at over 15,000L at 100,000k hours...**twice** as long



Types of LED - Exterior

Retrofit – Corn Cob

- New driver and boards with a base that matches the existing lamp

Advantages

- Re-use the existing fixture housing
- Low Cost

Disadvantages

- Inconsistent quality
- Fit can be a challenge
- No optics
- No surge protection
- Shorter rated life than a new fixture



Types of LED - Exterior

Retrofit – Externally driven units

- Used for acorn or post top fixtures

Advantages

- Keep the existing fixtures
- Low cost (not as low as the corn cob)
- Some units have optics
- Optional built-in controls
- Surge protection

Disadvantages

- Limited applications



Types of LED - Exterior

New Fixtures

- Complete new housing
- External driver and LED boards

Advantages

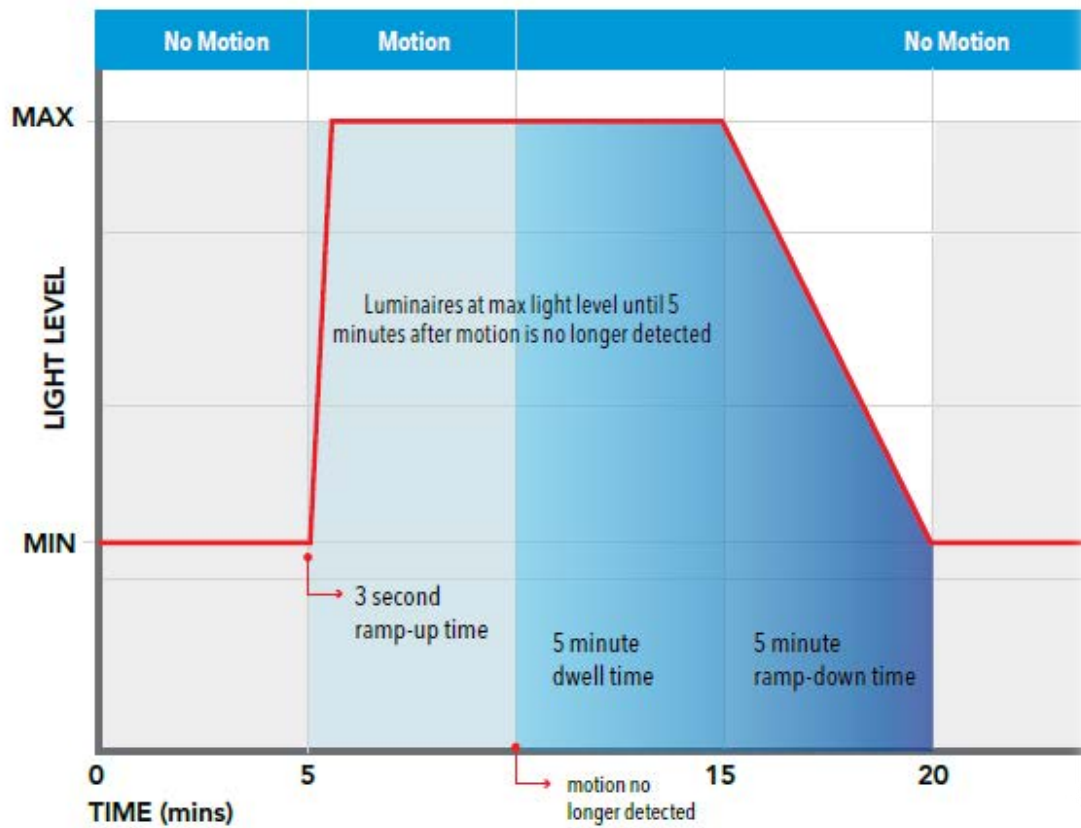
- More efficient than a retrofit
- Aggressive savings – not lumen for lumen
- Directional – precision optics
- Multiple options for every application
- Longest rated life
- Dimmable/Controllable

Disadvantages

- Higher cost than a retrofit



Exterior Control



LM79	<p>IESNA approved method for the Electrical and Photometric Measurements of Solid-State Lighting. It measures an LED luminaire or integral lamp as a whole system according to a standard process using specified equipment.</p>
LM80	<p>IESNA approved standard for measuring lumen maintenance of LED light sources. LM-80 apply to the LED package, array, or module alone, not a complete system, it is testing a component level</p>
TM21	<p>IESNA approved method for taking LM-80 data and making useful LED lifetime projections. The standards apply to lifetime projection of LED package, array or module alone.</p>
L70	<p>A term used to express the useful life span of an LED by indicating the # of hours before the light output drops to 70% of it's initial output.</p> <ul style="list-style-type: none">• Reported vs. calculated

Why is an L rating important?

- A longer L70 allows designers to use lower wattage fixtures on the upfront design
- Provides insight to the quality of the fixture
- Everyone SHOULD be using the same metrics – even playing field



LED High Bay



ELECTRICAL — L88 at 60,000 hours, L70 > 100,000 hours. Utilizes a 90°C case temperature driver for maximum life at high temperatures. 0.90 power factor and 3kA/6kV level of surge protection is standard. Optional 5kA/10kV surge protection available. Available as 120-277V or 347-480V input. 0-10V dimming standard for a dimming range of 100% to 10%.

LED High Bay

PROJECTED LUMEN MAINTENANCE

IBG 2ft & 4ft						
Operating hours	0	15,000	30,000	45,000	60,000	100,000
Lumen maintenance factor	1	0.97	0.95	0.93	0.91	0.86
IBGN						
Operating hours	0	15,000	30,000	45,000	60,000	100,000
Lumen maintenance factor	1	0.97	0.93	0.90	0.87	0.81

AMBIENT TEMPERATURE RATINGS

Mounting	Suspended	Surface
Standard temperature rating	113°F (45°C)	95°F (35°C)
HA option temperature rating	131°F (55°C)	113°F (45°C)



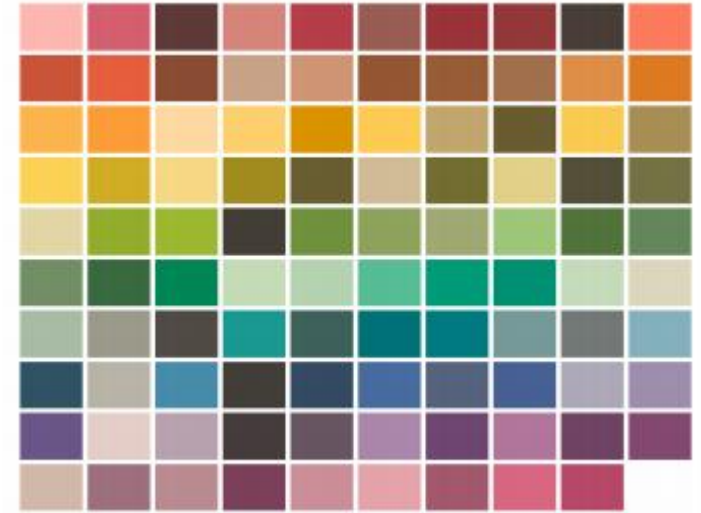
LED High Bay

LUMENS VS. AMBIENT TEMPERATURE

Ambient °C	Ambient °F	Lumen Multiplier
0	32	1.04
5	41	1.03
10	50	1.02
20	68	1.01
25	77	1.00
30	86	0.99
35	95	0.99
40	104	0.98
45	113	0.97
50	122	0.96
55	131	0.96

TM30

A New Method for Evaluating color quality



OLD Method – Color Rendering Index

- Uses Outdated color science
- Few samples - only pastel samples
- Can be selectively optimized
- Ignored R9 – saturated red



R1 – R8 used to calculate CRI or Ra

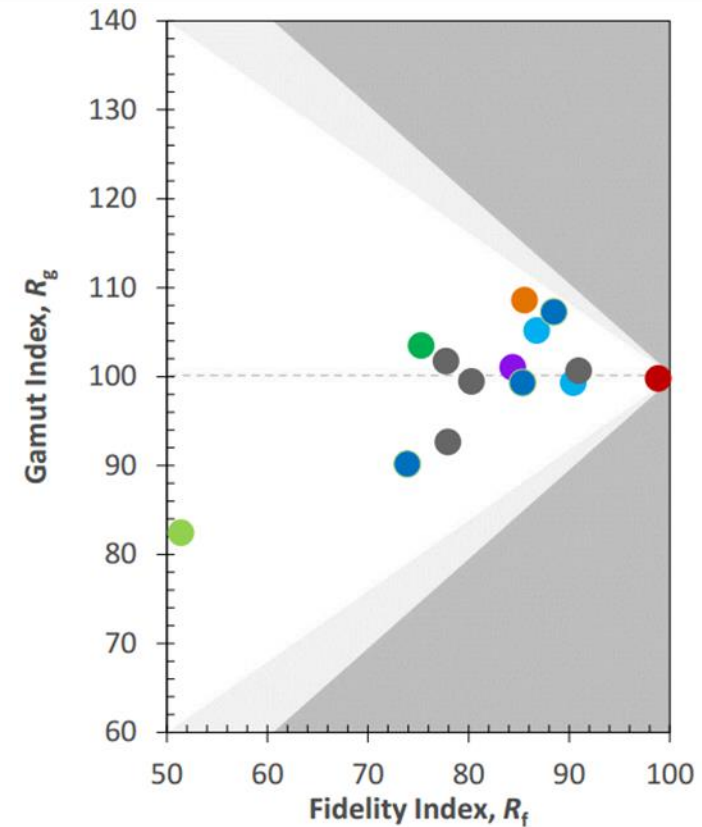
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New Metrics

- R_f : Average Color Fidelity
- R_g : Average Color Gamut

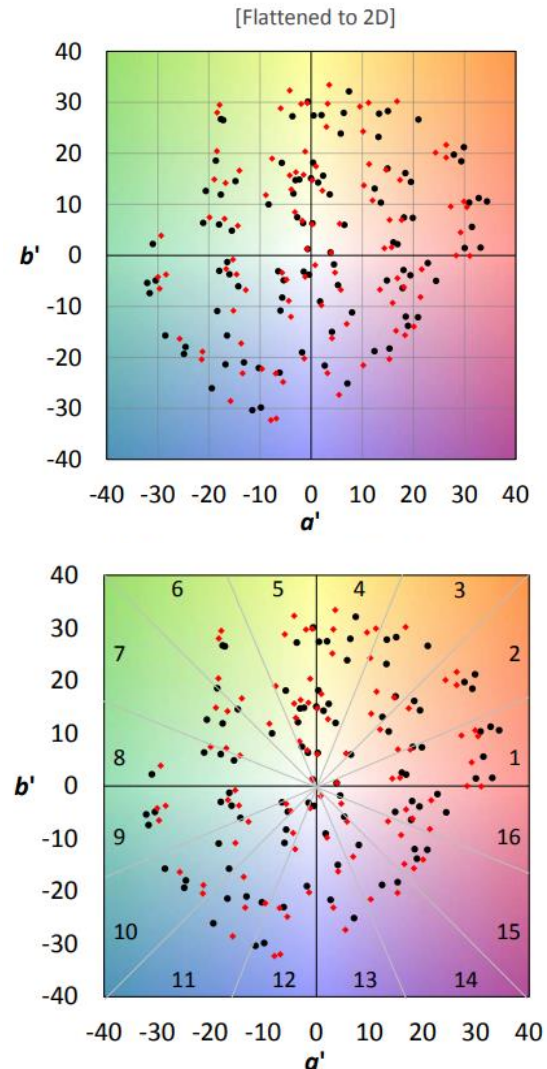
Based On

- 99 color evaluation samples
- Color space and wavelength uniformity
- Skin Tone Color Fidelity



Fidelity: The Accurate rendition of color so that they appear as they would under familiar (reference) illuminants.

Gamut: The average level of saturation relative to familiar (reference) illuminants.



AMA – Blue Light (white)

- 2016 - guidance to reduce harm from high intensity street lights
- LED lighting (high kelvin temp) emits a large amount of blue (white) light creating worse night time glare
- Recommend 3,000K or less
- Blue wavelength suppresses melatonin – disrupts circadian rhythm
- Disorients birds, turtles and fish



What do we do with this?

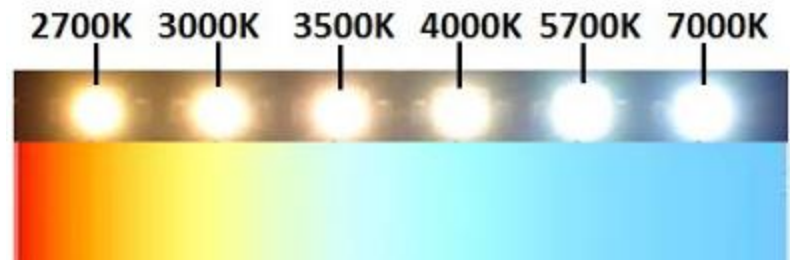
Know the region your project is in and the type of exterior project it is:

- Is it residential street lighting?
- Is it highway / roadway lighting?
- Is it on the coast?

<https://www.cnn.com/2016/06/21/health/led-streetlights-ama/index.html>

Typical color temperatures by application are:

Residential:	3,000K
Commercial:	4,000K
Industrial:	5,000K



Controls - Local

- Local occupancy
 - low/line voltage
 - Wireless
- Photocells/Daylight harvesting
- Personal Control



Controls – Networked



- Uses web based control
- BAS Integration
- Central reporting
- Multiple Protocols
 - ZigBee
 - Wi-Fi
 - Bluetooth

IoT – Internet of Things



With the connectivity of wireless and Bluetooth the amount of data that can be collected and sent to consumers is endless.

Retail chains are deploying this technology to increase sales and help consumers find what they are looking for in their stores.

Data collection from facility management systems can help operators run their facilities more efficiently.

"IoT has sparked a revolution in the lighting industry"

ASHRAE 90.1 – 2010

Most important lighting related items:

Applies to:

- Alterations affecting more than 10% of the connected lighting load, including basic retrofits
- Interior and exterior

Must comply with

- Lighting Power Density (LPD)
- Auto shutoff requirements.



LPD – What is it?

Lighting Power Density (LPD) is the load of lighting equipment in a defined area or the watts per sf of the connected lighting load. There are (2) calculation methods:

Space by Space Method: A defined list of potential spaces in a building and the associated watts per sf allowance.

Whole Building Area Method: A defined list of potential building types and the associated watts per sf allowance.



Questions?



Thank You



Thank you for your time and consideration.

Converting science into savings

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