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Designers Lighting Forum

Is it Time for LED-to-LED Lighting Conversions?

Tom Nowakowski

Tuesday, March 7, 2023
1:00pm – 2:00pm EST

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AIA Approved Course

One LU/HSW Hour will be earned upon the completion of this course and will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Course Description

The rapid adoption of LED lighting that began more than a decade ago has dramatically reduced the amount of energy require to light our homes and businesses. This reduced energy consumption has not only delivered environmental good but has also helped disperse significant energy saving dollars across the country. However, like legacy light sources, LEDs also shed light over time, and many of the early LED installations have now likely fallen below their original lighting design intent, leaving these applications compromised and in need of luminaire replacements. In this course we'll examine the need and value of LED-to-LED lighting conversions.

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Learning Objectives

At the end of this course, participants will be able to:

1. Understand why we need to consider LED-to-LED conversions…today
2. Identify the most common applications likely to benefit from a LED-to-LED conversion…today
3. Discuss the shifting value today's LED luminaires can deliver compared to the predecessors
4. Identify how to remove existing LED luminaires from service in an environmentally-responsible way

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What Year Was the First iPhone Released?

How Many of You Have Owned More Than One Smartphone Since 2007?

What Year Where the First Commercially-viable LED Fixtures Released?

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Why Does This Grocery Store Light Their Parking Lot at Night?

- LED Luminaires Don't Last Forever
- Lighting Floors, Not Ceilings
  - Define Lowest "in-service" Light Levels
    - Understand Rate of Lumen Depreciation Over Time

So People Can See

- Functional Light to Perform a Task(s)
- To Keep People Safe
- Manage Risk
- To Attract Business

Some Minimum Light Level is Required to Meet the Lighting Goals of this Store

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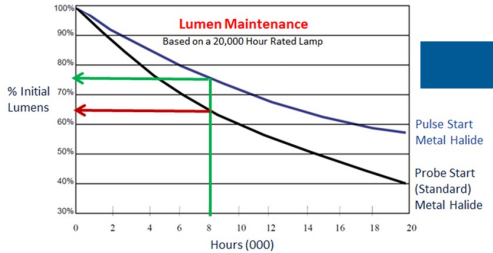
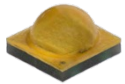
Predicting the Future – Understanding Lumen Depreciation

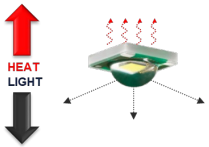
- Legacy Lamps Had Rules Regarding Lumen Depreciation
- Fixture Design Had No Influence on Lumen Depreciation



- LED Luminaire Design Can Greatly Influence Lumen Depreciation
- The Need For Luminaire Specific Lumen Depreciation Data from Manufacturers



An Identical LED's Performance May Vary Greatly Base on Product Design



L_{70}

Lumen Depreciation Impacts ALL Lighting Applications and Our Ability to Continue to Meet Our Lighting Goals

The Rules Have Changed, But There Are Still Rules

LED Lumen Depreciation Happens, But Much More Slowly

Lowest "in-service" Light Level = Luminaire Replacement

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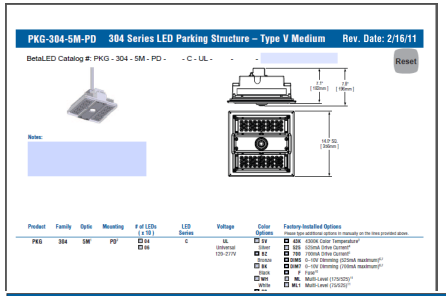
L70 is Misapplied and For Purchasers of Light, the Wrong Metric

There's More to "Life" Than L70

L70 is ONLY a Predictor of Lumen (Light) Depreciation of the LED

L70 is NOT a Predictor of "System" Life

What the L70 Just Happened?



Assumption:
4,000 Lumens are Required to Proper Light my Parking Garage

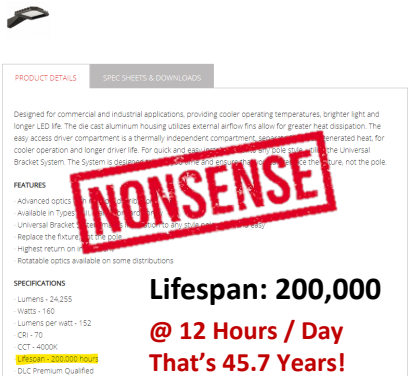
Day 1, Hour 1 Metrics:
5,429 Lumens; 99W; 55 LPW
(I'm over lighting my space by 36%; overconsuming (spending) on energy as well.)

Day 2,791 (7.6 Years @ 24 Hours/Day), Hour 67,000 Metrics:
3,800 Lumens; 99W; 38 LPW
(I'm under lighting my space by 5%; same energy consumption as Night 1)

L70 = 30% Reduction in Lumens AND 30% Reduction in Efficacy

LED SERIES C PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – Type V Medium @ 6000K	B	U	G	Initial Delivered Lumens – Type V Medium @ 4300K	B	U	G	System Watts 120–277V	Total Current @ 120V	Total Current @ 230V	Total Current @ 277V	L_{70} Hours* @ 25° C (77° F)
		Rating**				Rating**							
350mA (Standard) Fixture Operating at 25° C (77° F)													
40	3,774 (04)	3	1	1	3,310 (04)	2	1	1	48	0.40	0.23	0.20	152,000
60	5,571 (06)	3	2	1	4,886 (06)	3	2	1	77	0.64	0.35	0.30	136,000
525mA Fixture Operating at 25° C (77° F)													
40	5,057 (04)	3	2	1	4,436 (04)	3	2	1	71	0.60	0.32	0.28	96,000
60	7,465 (06)	3	2	2	6,547 (06)	3	2	1	114	0.95	0.51	0.43	82,000
700mA Fixture Operating at 25° C (77° F)													
40	6,189 (04)	3	2	1	5,429 (04)	3	2	1	99	0.84	0.44	0.37	67,000
60	9,136 (06)	4	3	2	8,013 (06)	3	3	2	150	1.26	0.66	0.55	56,000



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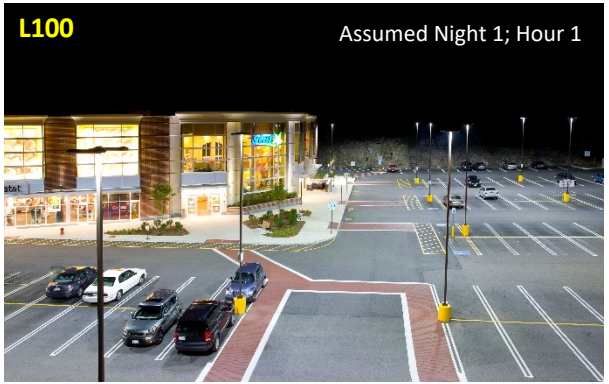
Design Criteria: Recommended Practice or Original Design Intent

Begin with the End in Mind



IES RP-8+Addendum 1
"Values cited are to be ***maintained*** over time on the area of coverage."

Theoretical "End-of-Life"
Most of Today's Products are Designed to Be Replaced Well Before L70

- **Applications at L70 or Lower Have Reached "End-of-Useful" Life**
- Many Early LED Applications Above L70 May Now Be Below Their Original Design Intent
  - Lowest "in-service" Light Levels

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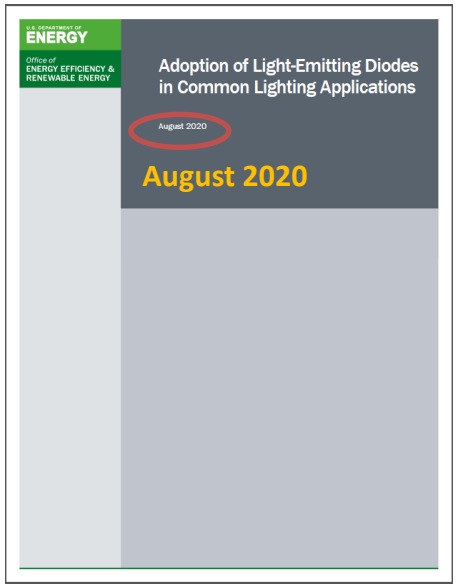
Adoption of LEDs in Common Lighting Applications (2018)



Application	2018 LED Installed Penetration (%)	2018 LED Units Installed[1] (Millions)
A-Type	32.9%	1 1,144
Decorative	16.0%	207.0
Directional	43.0%	228.3
Small Directional	49.7%	43.7
Downlighting	44.8%	2 308.0
Linear Fixture	20.1%	224.0
Low/High Bay	17.1%	18.0
Total Indoor	**29.8%**	**2,173**
Street/Roadway	48.6%	24.2
Parking Garage	1 69.1%	19.0
Parking Lot	2 54.0%	27.1
Building Exterior	45.8%	39.5
Total Outdoor	**51.4%**	**109.7**
Other	14.5%	29.2
Connected Controls	**0.2%**	**13.5**
Total All[3]	**30.0%**	**2,325**

Source:
www.energy.gov/sites/prod/files/2020/09/f78/ssl-led-adoption-aug2020.pdf

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The Clock is Ticking

Parking Garage Luminaires

(Any 24 Hours Per Day, 7 Days a Week Application)

Hours of Operation = 24 Hours Per Day, 365 Days Per Year

8,760 Hours Per Year

Parking Lot Luminaires

(Any 12 Hours Per Day, 7 Days Per Week Application)

Hours of Operation = 12 Hours Per Day, 365 Days Per Year

4,380 Hours Per Year

Assume L70 = 50,000 Hours

4,380 Hours Per Year = 11.4 Years

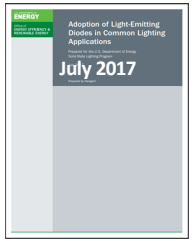
8,760 Hours Per Year = 5.7 Years

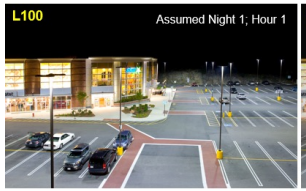
Parking Garage Luminaires from 2016 or Earlier

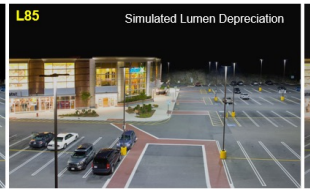
Parking Lot Luminaires from 2010 or Earlier

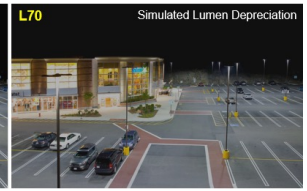
(Likely More Recent Installs for Retailers or Other Higher Risk Applications)

Application	2016 LED Adoption	
	2016 LED Installed Penetration (%)	2016 LED Units Installed[1] (Millions)
A-Type	13.5%	436
Decorative	6.7%	58.9
Directional	15.3%	82.4
Small Directional	47.6%	21.0
Downlighting	19.8%	137
Linear Fixture	6.0%	68.0
Low/High Bay	9.4%	8.6
Total Indoor	**12.3%**	**812**
Street/Roadway	28.3%	12.5
Parking Garage	32.5%	8.5
Parking Lot	26.2%	7.1
Building Exterior	31.2%	18.1
Total Outdoor	**29.7%**	**46.1**
Other	7.7%	15.6
Connected Controls	**<0.1%**	**4.0**
Total All	**12.6%**	**874**









Site audits can help confirm current state and urgency of need.

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– Cost of Waiting

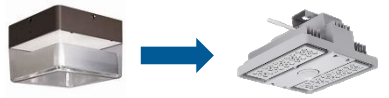
LED-to-LED Conversations; Results May Vary

The 2011 Sale
Energy Savings Versus 175W MH Legacy Technology

LED = 99W
175W MH = 215W
54% Energy Savings

The 2014 Sale
Energy Savings Versus 175W MH Legacy Technology

LED = 46W
175W MH = 215W
79% Energy Savings

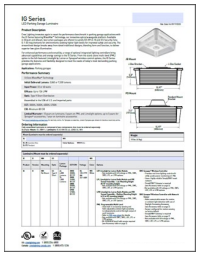


Updated Platform w/2014 Technology

Today's Sale vs. 2011 LED
Energy Savings Versus 2011 99W LED Technology

2011 LED = 99W
Today's LED= 33W
67% Energy Savings

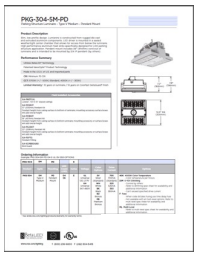
2011



2021

Today's Sale vs. 2014 LED
Energy Savings Versus 2014 46W LED Technology

2014 LED = 46W
Today's LED= 33W
28% Energy Savings



2014

Watts the Big Deal?

46W vs 33W

~**$15.00** Per Fixture Per Year in Energy Spend

200 Fixtures Per Level
$3,000 Per Level Per Year

6 Levels
$18,000 Per Garage Per Year

*Assume Cost per kWh = $0.1319; 24 Hours/Day Operation / No Controls

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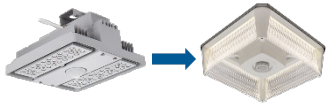
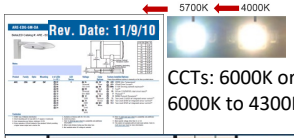
LED-to-LED Conversations; Results May Vary

The Added Value of LED-to-LED Conversion Today (OUTDOOR)

- Possibility for a Much Improved Lighting Experience
- Warmer Color Temperatures Are Now Economically Viable
- Possibility for Much Lower Lumen Depreciation Over Time
- Broader, Higher Value and More Sophisticated Controls Offering
- Higher Efficacy Solutions (Improved Lumens Per Watt)
- Comparatively Lower First Cost Solutions vs. Early LED Solutions

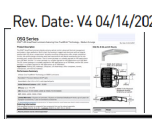




CCTs: 6000K or 4300K
6000K to 4300K = 12% Less LPW

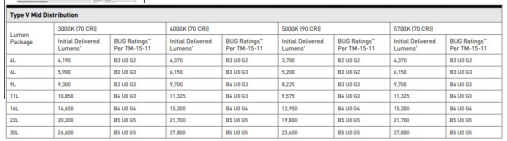
# of LEDs	Initial Delivered Lumens – Type V Medium @ 6000K	B	U	G	Initial Delivered Lumens – Type V Medium @ 4300K	B	U	G	System Watts 120–277V
		Rating***				Rating***			
525mA Fixture Operating at 25° C (77° F)									
20	2,331 (02)	2	1	1	2,044 (02)	2	1	1	37
40	4,662 (04)	3	1	1	4,089 (04)	3	1	1	69
60	6,993 (06)	3	1	2	6,133 (06)	3	1	1	110
80	9,324 (08)	4	2	2	8,178 (08)	3	2	2	138
100	11,655 (10)	4	2	2	10,222 (10)	4	2	2	177
120	13,986 (12)	4	2	2	12,267 (12)	4	2	2	217

L70 = 61,000 Hours



CCTs: 5700K, 5000K, 4000K, 3000K
5700K to 3000K = 4% Less LPW

> L95 @ 50,000 Hours



Lumen Package	3000K (70 CRI)		4000K (70 CRI)		5000K (70 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
4L	4,190	B3 U0 G2	4,370	B3 U0 G2	3,700	B2 U0 G2	4,370	B3 U0 G2
6L	5,900	B3 U0 G3	6,150	B3 U0 G3	5,200	B3 U0 G2	6,150	B3 U0 G3
9L	9,300	B3 U0 G3	9,700	B4 U0 G3	8,225	B3 U0 G3	9,700	B4 U0 G3
11L	10,850	B4 U0 G3	11,325	B4 U0 G3	9,575	B4 U0 G3	11,325	B4 U0 G3
16L	14,650	B4 U0 G4	15,300	B4 U0 G4	12,950	B4 U0 G4	15,300	B4 U0 G4
22L	20,200	B5 U0 G5	21,700	B5 U0 G5	19,800	B5 U0 G5	21,700	B5 U0 G5
30L	26,600	B5 U0 G5	27,800	B5 U0 G5	23,600	B5 U0 G5	27,800	B5 U0 G5

Category	General Application	Minimum Light Output (lm)	Minimum Efficacy (lm/W)	
			DLC Standard	DLC Premium
Outdoor Luminaires	Low Output	250-5,000	105	120
	Mid Output	5,000-10,000	105	120
	High Output	10,000-30,000	105	120
	Very High Output	≥30,000	105	120
Indoor Luminaires	Interior Directional	≥250	80	95
	Case Lighting	≥50 lm/ft	95	110
	Troffer	≥1,500	110	125
	Linear Ambient	≥375 lm/ft	115	130
	High-Bay	≥10,000	120	135
	Low-Bay	5,000-10,000	115	130
Outdoor Retrofit Kits	Low Output	250-5,000	105	120
	Mid Output	5,000-10,000	105	120
	High Output	≥10,000	105	120
	Very High Output	≥30,000	105	120
	Troffer	≥1,500	110	125

V5.1 Efficacy Requirements for Luminaires and Retrofit Kits [DLC Standard and DLC Premium Classifications]

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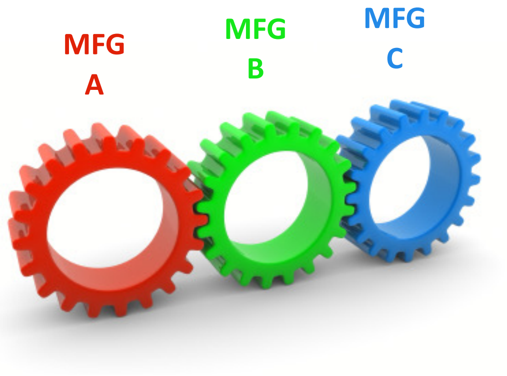
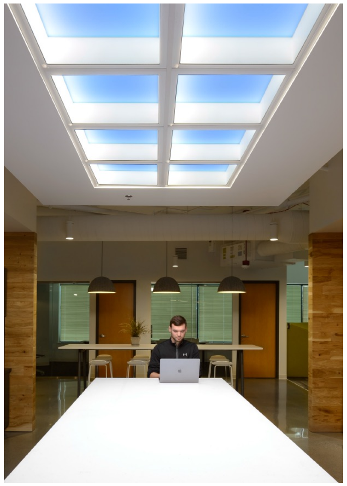
LED-to-LED Conversations; Results May Vary

The Added Value of LED-to-LED Conversion Today (INDOOR)

- Possibility for a Much Improved Lighting Experience
  - Lighting for Health and Well-Being
- Broader, Higher Value and More Sophisticated Controls Offering
  - Greater Interoperability Across Manufacturers' Products
- Possibility for Much Lower Lumen Depreciation Over Time
- Higher Efficacy Solutions (Improved Lumens Per Watt)
- Comparatively Lower First Cost Solutions vs. Early LED Solutions





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Environmentally-Responsible End of Useful Life

No Mercury, No Problem?

- Unlike Incumbent Light Sources LEDs DO **NOT** Contain Mercury
- LED Bulbs & Fixtures Contain Electronic Circuit Boards
  - Likely Considered e-waste or Universal Waste in Most Communities

LED Bulbs vs. LED Fixtures

- Many Big Box Stores May Accept LED Bulbs for Recycling
- Contact Your Local Recycling Center for Guidance on LED Bulbs & Fixtures

Recycle for All the Right Reasons

- It's the Right Thing To Do
- Not Recycling Is Throwing Money Away
  - Most Contractors Can Generate Additional Revenue/Profits Through Recycling Efforts

Ask Your Contractor About Their Recycling Policy

Constructed of Die Cast and extruded aluminum components.

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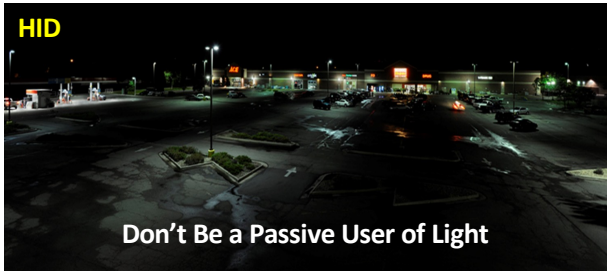
Closing Comments

Don't Leave Your Business in the Dark and at Risk

- Establish and Commit to Meeting Your "Maintained" Lighting Goals First
- Value Lighting Design
  - Begin with the End in Mind (Lowest "in-service" Light Level)
  - L_{70} is the <u>WRONG</u> Metric to Consider
    - Use Manufacturer, Product Specific Lumen Depreciation Data
    - Lumen Depreciation Data Should Be Based on Your "Reasonable" Application Life Timeframe
  - "Reasonable" Timeframe for "Non-Commodity" LED Solutions?
    - 10 Years?
      - 50,000 Hours (12 Hours/Day Applications) = 11.4 Years
      - 100,000 Hours (24 Hours/Day Applications) = 11.4 Years
- Periodic Lighting Surveys Can Help Confirm Lighting Goals are Being Met
- You Don't Need to Be an Expert
  - Partner with People You Trust
  - Ask Questions

"Functional" Smartphones Are Replaced Everyday Because They No Longer Meet Our Needs.

Shouldn't Your LED Luminaires Also Be Replaced?
Unlike Your Smartphone, They'll Reliably Put Money in Your Pocket.



Those who fail to learn from history are doomed to repeat it.

Your "Functional" LED Luminaires May No Longer Be Meeting Your Needs Either.

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