



A Northwest utility funded lighting education facility promoting commercial and industrial energy conservation.

# LARGE VOLUME SPACES

## A Design Approach for Lighting Retrofits

PRESENTED BY:

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Spring, 2013



# LIGHTING DESIGN LAB

A Northwest utility funded lighting education facility promoting commercial and industrial energy conservation.





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**IESNA PRESIDENT ELECT  
DAN SALINAS**



## OUR FACILITY



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- Lighting Classes (local and regional)
- Demonstration Area
- LDL LED Qualified Products List
- Lighting Consultations
- Website Resources
- Outdoor Lighting Center
- Technical Information
- Product Evaluations
- Mock-Up Facility
- Lighting Library
- Tours of Facility
- Newsletter
- Lighting Guides
- General Information

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### LED LIST

View all things associated with the LDL LED list.  
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### CLASSES

Registration for spring 2013 classes is now open.  
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### EVENTS

View upcoming events around the region.  
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## CONTENT OUTLINE

### Part 1: The Basics

- Context
- Existing Conditions
- Goals / Expectations
- Upgrade
- Retro-Fit
  - Small Step
  - Full Scale
- Redesign
- New Construction

### Part 2: The Details

- The Technologies
  - Lamps
  - Ballasts
  - Luminaires
  - Controls

### Part 3: The Applications

- Warehouses
- Manufacturing
- Gymnasiums
- Parking Lots

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## THE BASICS

### ▪ Some 2013 Context

- 90% of all lighting work currently underway in the country is retrofit.
- In a 'quote' normal year, the economy grows by about 3.5 %, and the retro-fit market only represents about 20% of the work.
- 3.3% decline in NEMA's Lighting System Index in the 3<sup>rd</sup> Quarter 2012.
- 1.4 billion 4' lamps are currently burning in this country, half of which, (or 700,000,000) are T12, magnetically ballasted.
- 9 out of 10 new lighting products involve LED's.
- LED's are mentioned only a hand full of times in the 9<sup>th</sup>.Ed. of the IES Handbook, (1999). In the 10<sup>th</sup>. Ed. that number is almost 500!

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## THE BASICS

- **Some 2013 Context, (cont.)**

There are (2) major forces at work currently in our country which are almost completely responsible for the state of frenzied innovation:

- Energy Codes, now adopted in some form almost everywhere, driving down electrical usage for lighting with each iteration.
- LED's, making their way into every niche of the industry, and causing conventional technologies to get better.

**Consider this . . . .**

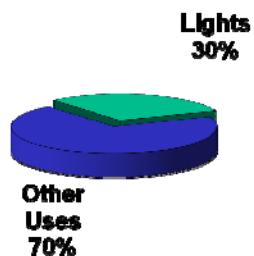
The DOE has determined the upper limit of performance of LED's will be  
**300 LPW!**

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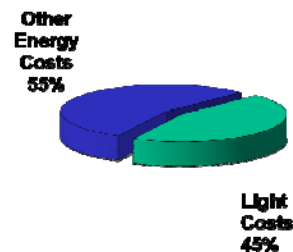


## Existing Energy Picture

### Lighting Energy Use 20 - 40%



### Lighting Energy Cost 30-60%



Source: NEMA

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## New Opportunities

*Designers and specifiers should be ready to tap into Utility rebate programs that will increasingly be targeted to LED applications in the coming years.*



*The strongest rebate opportunities are in the commercial arena, specifically in areas that have 24/7 lighting needs, such as parking garages, parking lots and warehouses.*



LD+A Jan. 2013

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## Rebate Snapshot

### Prescriptive LED Programs

TYPE of LED	# of Rebates	Amount Minimum	Amount Average	Amount Maximum
Replacement Lamps	424	\$2	\$11	\$45
Down Light Fixtures	561	\$2	\$11	\$100
Track Heads	93	\$20	\$49	\$100
High Bay Fixtures	156	\$19	\$89	\$225
Parking Garage Fixtures	395	\$25	\$79	\$400
Canopy Fixtures	233	\$40	\$92	\$300
Linear Panels	68	\$10	\$26	\$64

Source: BriteSwitch North American Rebate and Incentive Database – 1/ 2013

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## To Retrofit or to Redesign?

A 'Retrofit' involves modifying the lighting system so as to lower its operating costs, or to improve the performance of that system while not changing the original intent of the design. It May involve only changing lamps and ballasts, delamping with reflectors, or replacing luminaires one-for-one without relocating them.

A 'Redesign' involves modifying the lighting system so as to *intentionally* alter the goals of the existing design. Essentially a new design with some practical limitations, may involve relocating luminaires, or adding and/or removing luminaires.

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## Retrofitting

### Going back to the late 1980's

Main thrust was to replace T12 lamps and magnetic ballasts with T8 lamps and electronic ballasts.

Energy savings of 30% or more was achieved, and the market transformed.

Currently however, only 60% of T12 troffers have been retrofitted.

Other retrofitting activities:

Replacing Low Bay HID fixtures with new T5 and T8 fixtures

### OCTRON® Lamp Ballast Options

Best T12 Retrofit Options

Best Options	Fluorescent Lamp Electronic Ballast	Energy Savings	Average Rated Life
Standard T8, Low Power Ballast	OCTRON T80 32W QUICKTRONIC T8 ISL	29%	28,000 @ 12 hrs/start
High Efficiency, High Lumen	OCTRON 800XP SUPERSAVER 29W High Efficiency QUICKTRONIC T8 ISL	42%	40,000 @ 12 hrs/start
High Efficiency, Long Life	OCTRON 800XP XL SUPERSAVER 25W High Efficiency QUICKTRONIC T8 ISN	40%	75,000 @ 12 hrs/start

DOE 2009 Rulemaking: F34T12/CW Lamp Phase Out 7/14/2012  
Need to retrofit existing luminaires with T8 lamps & ballasts



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## Old Thinking

Because innovations weren't making their way into the market at the same rate as today, there was no need to consider a retrofit until the back half of a lighting system's expected lifetime.

Then as the system approached end-of-life, it made more economic sense to replace it.

### 'Full Scale' Measures:

- De-lamping, which ruined light distribution.
- Swapping out lamps and ballasts.
- Using complete retrofit kits, which ended up costing enough to justify replacement of the whole luminaire.



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## New Thinking

Now with new technologies coming onto the market seemingly every week, a retro-fit can make sense within a few years after installation.

### 'Small Step' retro-fits now possible:

*(Especially if spaces are overlit)*

- Use lamp wattage to adjust light levels
- Use **Ballast Factor** to adjust light levels
- Use wireless controls to maximize savings



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## Retrofit Kits

To retrofit a fluorescent or HID product in the field with an LED array and electronic driver is complicated. The kit must be evaluated by an **NRTL** to the **ANSI/UL** safety standards **UL8750** for the LED portion and **UL1598** for the luminaire portion.

The kit must include installation instructions that will then become a major part of the safety investigation. That investigation will include thermal and mechanical tests to ensure that the **NEC** and the ANSI/UL codes are met when the kit is installed. Of special concern is whether the kit has been tested with the specific luminaire.



**Get written confirmation from the kit manufacturer and a copy of the NRTL report, which will delineate the specific luminaires that can be retrofitted with that kit.**

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## Retrofit Kit Installation

There are two ways to get a kit installed either in the field or in the factory. If the kit is NRTL Listed, anyone qualified can install the kit, per installation instructions. If the kit is a **Recognized Component**, it can only be installed in the field by a qualified person, and the final assembly must be inspected by a representative of the NRTL that is acceptable to the **AHJ**.



If the product is to be removed for renovation, it can be sent back to the factory where the final product will be NRTL labeled and inspected by the NRTL factory rep.

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## New Construction

### Best Practice

Energy efficiency designed in from the start:

Refer to the IES Design Guidelines: 10<sup>th</sup>.Ed. Handbook

Energy Codes:

Based on ANSI/ASHRAE/IES 90.1 – 2007, Energy Standard for all Buildings except Low-Rise Residential

Minimum requirement specified by EAct 2005

Legislation Updates:

EAct 1992, EAct 2005

Required States to certify they have state energy codes in place at least as stringent as 90.1 – 2007

Additional requirements for federal buildings

EISA 2007

- Specific reduction levels for federal buildings
- Mandated phase-out of incandescent A-lamps starting in 2012

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## Trends in Energy Efficient Lighting

- **Changes in Metrics:** (How rates will be determined)  
From W/ft<sup>2</sup>. (power density) to kWh/ft<sup>2</sup>. (energy density)
- Increased use of lighting controls, especially wireless
- Remote control of lighting for load shedding, (utility based)
- Increased use of fluorescent and LED sources in commercial applications
- Accelerating, (unstoppable?), popularity of LED sources and luminaires

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# THE DETAILS

## Linear Fluorescent

Fluorescent solutions include two technologies, T8 and T5. Both lamps offer lamp life out to 40,000+ hours, (**up to 84,000**), and since fluorescent lamps achieve mean lumens at 50% of lamp life, they may have a working mean lumen lamp life of as long as 30,000+ hours, three times that of the metal halide, as well as many other improvements including better color quality over the life of the lamps, and instant on/off. With the multi-lamp systems required to achieve the lumen packages for the task of lighting Large Volume Spaces, there is built in multi-light level switching, additionally easy access to low cost dimming for additional energy savings.

### T8

- 92+ LPW
- 85 CRI
- 60,000+ hour rated life
- 90% Lumen Maintenance
- Good optical package



### T5

- 93(HO) – 104 LPW
- 85 CRI
- 50,000 hour+ rated life
- 92% Lumen Maintenance
- Better optical package



# New T5's

www.sylvania.com

## PENTRON® C HO ECOLOGIC® High Output T5 Linear Fluorescent Lamp



### Key Features & Benefits

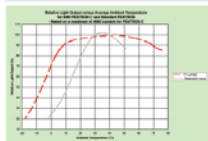
- Produces at least 90% of full light output over 80% CRI range
- Designed for easy on/off
- Suitable for both cold and hot environments
- T5LP compliant
- 3500K, 4100K, 5000K – 85 CRI
- Instant start method – 4.5SFI for 3500K and 4100K, 4.8SFI for 5000K (P104 – 1.2SFI for 4100K)
- 90% lumen maintenance factor
- Programmed start method
- 35,000 hours life @ 12 hours/day
- 25,000 hours life @ 3 hours/day
- GLOBE GUARANTY system warranty when paired with ECOLOGIC electronic ballasts

PENTRON C HO ECOLOGIC lamps provide consistent light output over a wide temperature range – at least 90% of full light output from 10°C to 70°C (50°F - 158°F) – through the use of advanced technology. This enables the lamps to provide much more light in both cooler and hotter environments than standard fluorescent technology. PENTRON C lamps are an alternative lighting solution for many traditional HO applications with all the benefits of fluorescent – immediate availability, selection of color temperatures, consistent color through life, excellent color rendition and long life.

SYLVANIA PENTRON C HO ECOLOGIC luminaires have an integrated system for instant start. Characteristics include: PENTRON C HO ECOLOGIC luminaires are T5LP compliant. 1. T5LP use results are based on ANSI, U.S. Series standards and are available on request. 2. Lamp output regulations may vary, check your local utility regulations.

### Product Offering

Ball Number	Lamp Description
2500	PENTRON C HO ECOLOGIC
3500	PENTRON C HO ECOLOGIC
4100	PENTRON C HO ECOLOGIC
5000	PENTRON C HO ECOLOGIC



### Application Information

- Applications:** Industrial, shop lighting, facade lighting, industrial and warehouse lighting, canopy lighting, security lighting.
- Features:** Contact your local Sylvania agent for available features.
- Ballast Information:** Contact your Sylvania representative for a list of compatible electronic operating systems.
- Application Notes:**
1. All PENTRON lamps are about 2" shorter than T8 and T12 pin lamps.
  2. Miniature pin base cannot be installed into T8 & T12 sockets.
  3. Miniature pin base requires U.S. Listed HOV and RV sockets.
  4. HOV/ECOLOGIC lamps require Programmed Start electronic ballasts for T5 HO lamps, equipped with end-of-lamp life sensing circuit.
  5. Not recommended for use in dimming circuits.
  6. The warm up time is longer than for standard PENTRON HO. This may be more noticeable when some lamps in a fixture are controlled by occupancy sensors.

- High Efficacy: 100+ LPW
- 28w. Standard\*
- 36,000+ hrs. Ave. Rated Life
- 54w. High Output (HO)
- 36,000+ Ave. Rated Life
- 49w. & 45w.\*\* versions
- High surface brightness (glare)
- (Lower efficacy than 28 watt)

\*Also available in 35w.

\*\*Fewer Lumens, less Light



## Small Aircraft Hangar



400w. Standard MH, (465w. per fixture). Retro-fitted with 4-Lamp T5HO sheet metal luminaires, (216w. per fixture). Light level increase to 50fc from 30fc.

**Project: Aircraft Hangar**  
147th Aviation  
Truax Field - Madison, Wisconsin

**Energy Savings Results:**  
Annual Energy Savings: 50,000 kwh  
Energy Reduction 67.6 %

**Key Points:**

- Eliminated 1 maintenance cycle
- Eliminated fixture sway
- Reduced CO<sub>2</sub> emissions by over 108,893 pounds
- Increased light levels 4x to meet ANSI 90.1 standards



**Challenge:** EPS audited this aircraft hangar's lighting and found it not only inefficient, but the light levels were seriously deficient creating a serious problem for the airplane maintenance staff. The original light fixtures were Metal Halide 400 lamps and were producing 15-20 foot candles. The Metal Halide fixtures also swayed violently when the doors opened.

**Solution:** Energy Performance Specialists increased light levels to IES/ANSI's recommendations of 75 foot candles by removing the existing fixtures and installing high efficiency fluorescents. Upon completion light levels were raised to 80 foot candles. EPS also took into account lumen depreciation and installed lamps that lose only 7% of their lumens versus the existing system that lost 60% of their lumens. By properly mounting the new fixtures to the ceiling the sway was completely eliminated. In the end EPS was able to boost light levels while still achieving over 67.6 % energy savings.

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## Extra Efficient T8 Lamps



### “Octron 28 Super Saver”

Lamps use 12.5% less power than 32w. T8 systems.

1.6% increase in mean lumens more than 700\* series lamps.

\*Some 700 Series lamps now meet EISA standards @78 CRI

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## HP T8 Lamps & Ballasts

### 'Super' T8's


Produce 3100+ Initial Lumens  
 Maintain 2915 or greater Mean Lumens  
 Higher LPW than standard T8 (92 vs 86)  
 Must use **'Programmed Start'** ballast  
 Now achieve a rated life of ~~24,000~~  
~~32,000~~ ~~40,000~~ ~~48,000~~ ~~60,000~~  
**84,000** hours.



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## 28w. T8 Lamp

	LUMENS	LIFE		LLD
	Initial / Mean	3hr- Inst / Programmed	12hr- Inst / Programmed	
Osram	2725 2588	24,000 36,000	36,000 42,000	95%
GE	2750 2585	36,000 (IS) 42,000	--- ---	94%
Philips	2725 2645	24,000 30,000	32,000 38,000	97%

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## 25w. T8 Lamp

	LUMENS Initial / Mean	LIFE		LLD
		3hr- Inst/ Programmed	12hr- Inst/ Programmed	
Osram	2475 2351	24,000	36,000*	95%
GE	2400 2256	40,000	46,000	94%
Philips	2500 2425	24,000 30,000	30,000** 36,000	97%

\* Quicktronic PS ballast

\*\* Advance Optanium PS ballast

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## Instant Start Alternative



Replace existing 32w. T8 lamps on any **Instant Start, (IS)** system for an immediate savings of 7 watts, or approximately 25% energy savings over **Rapid Start, (RS)**.

Replace existing 34w. T12 lamps on magnetic ballasts with ALTO Energy Advantage 25w. T8 on an **Instant Start** ballast can result in savings of up to 60 watts per fixture, or approximately 40% energy savings.

**NOTE: May be incompatible with dimming ballasts!**

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## Standard T8's Get Better

### OVERVIEW

## OCTRON 800XP® XL and XP XL SUPERSAVER® ECOLOGIC®3 T8 Fluorescent Lamps

Save energy now with up to 44% longer life!

- High performance XP XL lamps providing up to 2.7 times longer life than standard T8 lamp & ballast systems
- Couple XP XL SUPERSAVER lamps with high efficiency QUICKTRONIC® ballast for maximum energy savings
  - Easily qualify for utility rebates based on CEE reduced wattage specifications
- For additional energy savings, use POWERSENSE® dimming ballasts and SYLVANIA daylight & occupancy sensors
  - Turn off lights when spaces are unoccupied
  - Take advantage of daylight harvesting benefits



- Applications**
- Recessed troffers
  - Linear recessed
  - Indirect/direct pendant
  - Soffit & cove
  - Wall wash
  - Stairways

Product Offering	Lamp		Average Rated Life (12 hrs per start)		CRI	Lumen Maintenance
	Wattage	Rated Lumens	Instant start	Program start		
F0328000XPXL/ECOS	32	2950	52,000	57,000	85	Up to 36%
F0288000XPXL/S/ECOS	28	2600	75,000	84,000		
F03225W8000XPXL/S/ECOS	25	2400	75,000	84,000		



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## Impressive Numbers

### FEATURES & BENEFITS

## OCTRON 800XP® XL and XP XL SUPERSAVER® ECOLOGIC®3 T8 Fluorescent Lamps

Reduce maintenance cost without sacrificing performance

All testing done at 15 min. OFF



- Substantial life increase for 25 & 28W XP XL SUPERSAVER lamps
  - Up to 44% improvement on instant start
    - 50,000 hour life @ 3 hours/start
    - 75,000 hour life @ 12 hours/start
  - Up to 35% improvement on QUICKTRONIC® PROStart® systems
    - 80,000 hour life @ 3 hours/start
    - 84,000 hour life @ 12 hours/start
- Life ratings increased for 32W XP XL lamps on PROstart®
  - Up to 8% improvement on QUICKTRONIC® PROStart® systems
    - 65,000 hour life @ 3 hours/start
    - 67,000 hour life @ 12 hours/star
  - Life on instant start remains the same
    - 36,000 hour life @ 3 hours/start
    - 52,000 hour life @ 12 hours/start

T8 and T5 lamps have features that overlap, both have pros and cons. T8 systems cost less. T5 lamps can be had in less costly 'sheet metal' fixture designs.

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## Metal Halide



### STANDARD:

Neutral CCT (3500K - 4300K)  
 Magnetic Ballast  
 'Probe Start'  
 Noticeable color shift over time  
 Lamp life: 12,000 - 20,000 hrs.  
 Cold starting: down to -12c  
 LPW: ~85  
 CRI: 60 - 75  
 High LLD: ~30%



### CERAMIC:

CMH has 2 electrodes  
 'Pulse Start'  
 Ceramic arc tube stabilizes color shift  
 Improves lumen maintenance  
 Improves lamp efficacy (LPW)

### PULSE START:

10-15% Higher Initial Lumens  
 LLD:80%  
 Better color stability  
 Reduced warm-up / re-strike time



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## Mean Lumens

LAMP	WATTS	INITIAL LUMENS	MEAN LUMENS	MEAN LPW	LIFE (HOURS)
400w. MH	460	36,000	<b>23,500</b>	51	20,000
350w. PS MH	400	37,000	<b>26,000</b>	65	20,000
320w. PS MH	368	32,000	<b>23,000</b>	63	20,000

Pulse Start lamps require pulse start ballasts. Retrofitting to pulse start lamps requires a re-ballast as well.

Ceramic Metal Halide and many newer low wattage metal halide lamp types are pulse start.

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## BF Goodrich Aviation

1000w. Standard MH High Bays @ 80 ft.+  
Possible Retrofits vs. Common conceptions:  
Pulse Start MH will not match lumens?  
Space is too high for fluorescent?  
No LED equivalent soon?

1,000w. MH is rated at 71,000(v) M.L.  
54w.T5HO is rated at 4700 M.L.  
 $71,000 / 4700 = 15+$  T5HO lamps

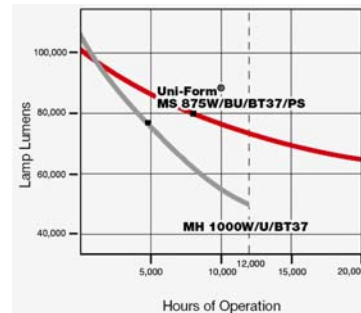


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## High Watt Metal Halide

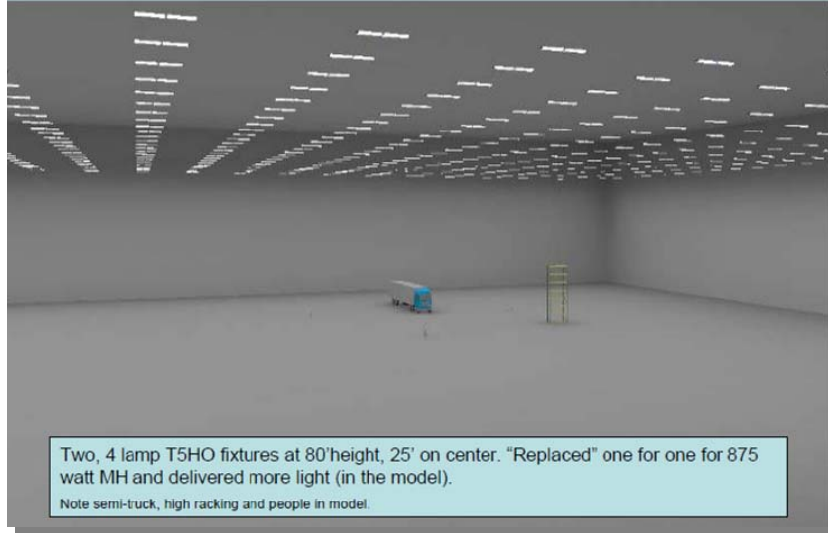
	LAMP	INITIAL LUMENS	MEAN LUMENS	AVE. LIFE	CCT	CRI
Venture	MH 1000	110,000	71,000	12,000	4000K	65
Venture	MS 875	100,600	80,500	12,000	4000K	65
Philips	MS 750	82,000	57,400	16,000	4000K	65
G.E.	MVR 750	82,000	60,000	16,000	4000K	65
Sylvania	MS 750	75,000	63,000	16,000	3700K	70



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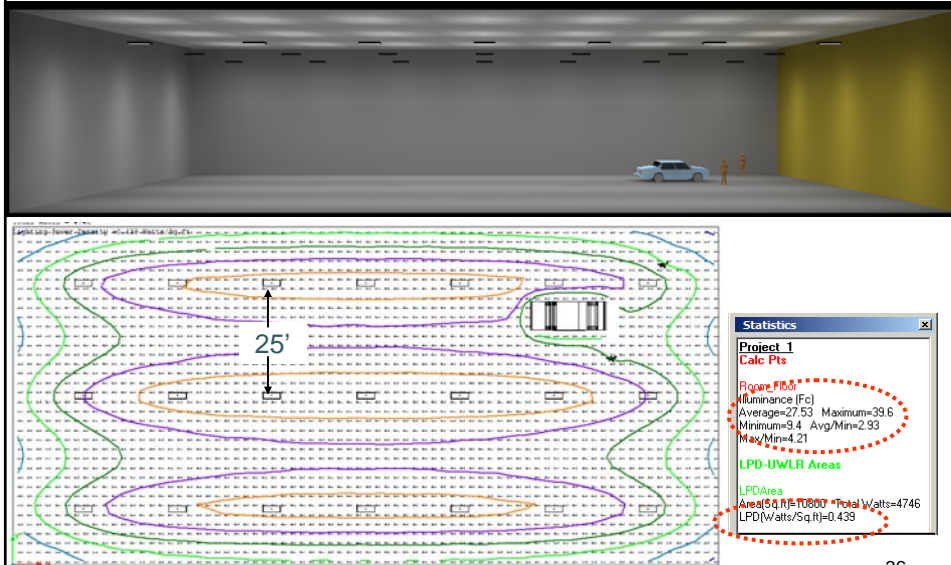
## T5HO Alternative



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## T5HO 5000 Lumens 226w.



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# T5HO 5000 Lumens 226w.

General

Label: IB\_454-5000-Lm-p87

Description: IB 454

Definition:

Lumens Per Lamp: 5000    Number Of Lamps: 4

Luminaire Lumens: 20045    Efficiency (%): 100

Luminaire Watts: 226

Total LLF: 0.870

Luminous Box:

	X	Y	Z
LLHC	-1.875	-0.69	-0.01
URHC	1.875	0.69	0

Arrangement: SINGLE

Arm Length: 0

Symbols: 1200x300 MM DOWN

Render Mode: Housing, Luminous, Model Mode, Line Width/Color, Pixel

Photometric File:

Description: C:\Documents and Settings\All Users\Application Data\... [TEST] I TL14006 [ISSUE DATE] 1/31/2008 [MANUFACT] Lithonia Lighting [LUMCAT] IB 454 [LUMINAIRE] I-BEAM FLUORESCENT HIGH BAY, 4 LAMP, F54 [LAMP CAT] FP54/835/HO/ECO [LAMP] FOUR (4) 54 WATT T5 HIGH OUTPUT LINEAR FLUOR

IESNA91 [TEST DATE] 1/31/2008 [BALLAST CAT]

3D Model and Candela/LCS Diagrams

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# Lithonia I-Beam LED 24,000 Lumens 264w.



Lighting layout diagram showing beam patterns and footcandle distribution.

Statistics

Project\_1

Calc Pts

Beam Footcandle

Illuminance (Fc)

Average=32.54    Maximum=42.5

Minimum=12.1    Avg/Min=2.69

Max/Min=3.51

LPD-UW/LR Areas

LPD

Avg/Sq Ft=10800    Total Watts=5541.899    LPD(Watts/Sq Ft)=0.513

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# Lithonia I-Beam LED 24,000 Lumens 264w.

General

Label: IBeamLED-24

Description: IBL 24L WD SD125 LP740 DLC

Definition:

Lumens Per Lamp: N.A.    Number Of Lamps: 1

Luminaire Lumens: 21152    Efficiency (%): N.A.

Luminaire Watts: 263.9

Total LLF: 1.000

Luminous Box:

LLHC	X	Y	Z
	-1.78	-0.645	-0.01
URHC	X	Y	Z
	1.78	0.645	0

Arrangement: SINGLE

Arm Length: 0

Symbols:

1200x300 MM DOWN

Render Mode: Housing, Luminous, Model Mode, Line Width/Color, Pixel

Photometric File:

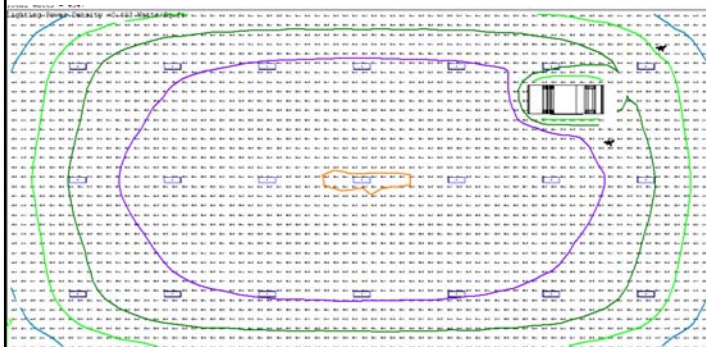
Description	Classification	LCS
Filename: D:\My documents\LED stuff\AGI:2013\IBL_24L_WD...		
[TEST] LTL21671		
[TEST LAB] ACUITY BRANDS LIGHTING CONYERS LAB		
[ISSUE DATE] 2/27/2013		
[MANUFAC] Lithonia Lighting		
[LUMCAT] IBL 24L WD SD125 LP740 DLC		
[LUMINAIRE] 24L I-BEAM LED, 70 CRI WIDE DISTRIBUTION		
[LAMP CAT] 501-00132-001		
[LAMP] LED		
[BALLAST] LEDINTA700C21000		
IESNA: LM-63-2002		

3D Model and Candela/LCS Diagrams

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# Lithonia I-Beam LED 18,000 Lumens 207w.



Statistics

Project\_1

Calc Pts

Room: P001

Illuminance (Fc)

Average=26.92    Maximum=35.1

Minimum=10.0    Avg/Min=2.69

Max/Min=3.51

LPD-UWLR Areas

LPD Areas

Area(Sq Ft)=10800    Total Watts=4347

LPD(Watts/Sq Ft)=0.403

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## Lithonia I-Beam LED 18,000 Lumens 207w.

General  
 Label: IBeamLED-18  
 Description: IBL 18L WD SD125 LP740 DLC

Definition  
 Lumens Per Lamp: N.A.  
 Luminaire Lumens: 17495  
 Luminaire Watts: 207  
 Total LLF: 1.000  
 Luminous Box: LLHC (-1.78, -0.645, -0.01), URHC (1.78, 0.645, 0)

Arrangement: SINGLE, Arm Length: 0

Symbols: 1200x300 MM DOWN (Housing, Luminous, Model Mode, Line Width/Color, Pixel)

Photometric File  
 Description: IESNA-LM-63-2002  
 Classification: LCS  
 File name: D:\My documents\LED stuff\AGI-2013\IBL\_18L\_WD\_...  
 (TEST) LTL21671S2  
 (TEST LAB) SCALED PHOTOMETRY  
 (ISSUE DATE) 2/27/2013  
 (MANUFACT) Lithonia Lighting  
 (LUMCAT) IBL 18L WD SD125 LP740 DLC  
 (LUMINAIRE) IBL 1-BEAM LED, 70 CRI WIDE DISTRIBUTION  
 (LAMP CAT) 501-001S2-001  
 (LAMP) LED  
 (BALLAST) LEDINTA700C21000

MOCK-UP ROOM, SWITCH D

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## LED Alternatives

### Helius ST.6 LED High Bay Lighting Systems



Item	Specifications	
Input Voltage	100-300 VAC; 50/60Hz	
LEDs	CREE XLamp XT-E	
Minimum Net Lumen Output <sup>(1)(2)</sup>	ST.6	11,500 lumens
Approximate Power Consumption <sup>(1)</sup>	ST.6	130 W
CRI	≥70	
Color Temperature	5250 K	
Beam Angle	40, 100 degree	
Power Supply	Overload/Short circuit/Surge/Over Temp. Protection	
	Power Factor	≥0.9
	THD	≤20%
Operating Temperature Extremes	-25 °C to +50 °C	
IP Rating	IP65	
Life	≥50,000 Hours	
Limited Warranty	5 Years	
Automatic Dimming	0-10 VDC	
Fixture Material	Aluminum Alloy	
Weight	≈ 8 lbs	
Standard Accessories	5 ft. 3/4" Cable Mounting Hook	



Shown ST.6  
 PATENT PENDING

@ L70

EQUIVALENT TO 175w. MH

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# LED Alternatives

## Helius XL LED High Bay Lighting Systems

Item	Specifications	
Input Voltage	100-300 VAC; 50/60Hz	
LEDs	Philips LUXEON Rebel ES	
Minimum Net Lumen Output <sup>(1)</sup>	XL 4	12,000 lumen
	XL 5	15,000 lumen
	XL 6	18,000 lumen
Approximate Power Consumption <sup>(2)</sup>	XL 4	178 W
	XL 5	210 W
	XL 6	260 W
CRF	≥ 70	
Color Temperature <sup>(3)</sup>	3000 K, 4500 K, 5250 K	
Beam Angle	40/90/150 Degree	
Power Supply <sup>(4)</sup>	Overload/Short circuit/Surge/Over Temp. Protection	
	Power Factor	≥ 0.94
	THD	≤ 20%
Operating Temperature Extremes	-25 C to +50 C	
IP Rating	IP65	
Life	≥ 50,000 Hours	
Limited Warranty	5 Years	
Automatic Dimming	0-10 VDC	
Occupancy Sensing	12/24 VDC	
Onboard Power for External Light Sensor	10/12/24 VDC	
Independent Constant Current Channels	Up to 6	
Fixture Material	Aluminum Alloy	
Weight	≈ 21 lbs	
Standard Accessories	5 ft. 3/4" Cable Mounting Hook	



ROUGHLY EQUIVALENT TO 250w. MH



@ L70



# Future LED Alternatives

## LED HIGHBAY

SKU	Type	Approx

- APPLICATIONS**
  - The new Helius LED highbay is designed to efficiently light any large interior space such as busy industrial settings, warehouses, gyms, distribution and shipping docks.
- FEATURES**
  - High performance LED design delivering up to 100 lumens per watt.
  - Optimized thermal management allowing a 40°C ambient temperature rating.
  - LED rated output from 25,000 to 40,000 lumens per fixture at L70.
  - Meets E.C. compliance standards.
  - Fixture weight: 25 lbs. Shipped weight: 33 lbs.
- LED ARRAY**
  - Direct Lighting Information
    - 1.5A array @ 270V AC
    - 0.6A array @ 277V AC
    - 0.6A array @ 277V AC
  - Power factor greater than 0.99
  - Standard 0 to 10V dimmable drivers
  - 100% CRI (Color Rendering Index)
- IP 65 SYSTEM**
  - Industrial engineered LED optics
  - Three different distributions: wide, narrow and wide
  - Standard optics for long life and durability
- LED ARRAY**
  - Optic tested to UL 1584 Wet Location
- WARRANTY**
  - Five Years from Date of Purchase



16,808 Lumens @169w. (99 LPW)  
100,000 Hrs. @ L70

LED SYSTEM INFORMATION

Color Temp	Power (W)	Beam Angle	Beam Diameter (ft)	Beam Diameter (in)	Beam Spread (ft)	Lumens (lm)	LPW (lm/w)	Ambient Temperature (°C)
3000K	112	40	5.000	61	11.256	1528	13.6	40°C
3000K	112	40	5.000	61	10.776	96	40°C	
3000K	112	40	5.000	61	10.213	91	40°C	
3000K	112	40	5.000	61	14.027	121	40°C	
3000K	112	40	5.000	61	13.472	97	40°C	
3000K	112	40	5.000	61	12.776	92	40°C	
3000K	112	40	5.000	61	16.808	99	40°C	
3000K	112	40	5.000	61	96	40°C		
3000K	112	40	5.000	61	91	40°C		

**ORDERING INFORMATION**

ORDERING EXAMPLE: HEL-72L-5000K-070-MH

HEL - HELIUS  
72L - 72" (1828mm) H  
5000K - 5000K  
070 - 70" (1778mm) W  
MH - MOUNTING HOOK

ACCESSORIES (order as separate part #)

OPTIONAL ACCESSORIES

WARRANTY

LED ARRAY

LED SYSTEM INFORMATION

WARRANTY

HEL-72L-5000K-070-MH





## Life After Metal Halide

Despite improvements, the venerable 400w. pulse start metal halide lamp should be put in the lamp museum. At 24,000 hours of rated lamp life in the vertical position, and mean lumens reached at only 40% of lamp life, we have a lamp of just 28,000 lumens and a mean lamp life of just 9,600 hours. So, less light through 9,600 hours, and less than was designed for, not to mention its associated color shift through the slide into end of life at 24,000 hours.

Improvement in fluorescent and LED technologies, are rendering the metal halide to the bone yard of lamps.

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## High Pressure Sodium

Very warm CCT: 2200°K  
Decent Ave. Life: 24,000+ hrs.  
Cold starting: down to -30c  
High measured LPW: ~120  
Poor color rendering: 25 CRI  
Still the dominant source in street lighting, *(but not for long)*.



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# Induction

www.sylvania.com

## ICETRON® ECOLOGIC® Inductively Coupled Fluorescent System



### Key Features & Benefits

- Unparalleled lamp life
  - 100,000 hour life
  - 10 years of continuous operation
- Wide Light
  - 3500K, 4100K, 5000K
- Constant color over long lamp life
- Instant on/starts
- Low temperature starting
  - 25°F with IC240 and IC270
  - 40°F with IC2100 and IC210
- Broad operating temperature range
- Simple connector assembly
  - Small profile 2-prong connector with 18 to 24" leads
  - Fits through 1/2" hole conduit
- Ballast remote mounting possible up to 95'-feet
- Universal voltage ballast (700-277V)

SYLVANIA ICETRON ECOLOGIC fluorescent lamps pass the Federal Energy Commission's Lighting Procedures (FLTP) which is the distribution of which has been made in most states.

1. FLTP test results are based on NEMA 61, Color rendering and on the methods in report.
2. Lamp fixture requirements may vary, check your local & state regulations.

### Product Offering

Lamp	Watts	CRI
ICETRON IC200	40	3000K, 4100K, 5000K
ICETRON IC210	40	3000K, 4100K, 5000K
ICETRON IC2100	100	3000K, 4100K, 5000K
ICETRON IC2100	150	3000K, 4100K, 5000K



### Application Information

#### Applications

- Energy Efficient
- Endusers
- Process/work storage
- High/Low bay
- Industrial
- Indoor & outdoor
- Signage
- Street and area lighting

#### Application Notes

1. Low-voltage operation - For non-industrial lamp operation, the armature tip should be painted green.
2. Universal input voltage: 120-277 volts, 50/60Hz.
3. Low ILM - complies with FCC Non-Consumer limits.

#### Thermal Characteristics

1. Fixture must not be used as a heat sink for lamp induction coils and ballast - good thermal coupling required.
2. Maximum bulb wall temperature at 302°F (150°C).
3. Maximum fixture temperature at lamp base mounting of 212°F (100°C).

4. Ambient air temperature for 90% light output for 70W, 100W, 150W types at 35-50°F (0-10°C) and 100-150°F (40-60°C) for the 40W type.
5. Max. 150°F (65°C) ballast temperature at ballast tip on ballast cable for 071105 (IMV-F, 1-6PF) and 071105 (IMV-T and 071140 (IMV-T, 1-6PF) ballasts.
6. Ballast may be mounted up to 66 feet from lamp. Please request remote mounting instructions.
7. For cold temperature applications, use suitable enclosed fixture to minimize lamp output.
8. Ambient air covers (IMV-F, 20300) available for better warm-up under very cold operating conditions.
9. ICETRON TYP-1 outdoor ballast must be with overall electrical enclosure and fully protected from any exposure to moisture.
10. 24" wiring substation harness available (IMV-40750).

Fluorescent technology  
RF signal energizes the lamp

Cold starting: -25°F.

Soft Instant Start

60,000 hrs. @ L<sub>70</sub>

Wattages: 40 – 200

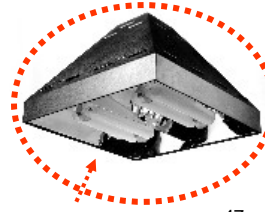
LLD: ~ 65%

80 CRI

3500°K

4100°K

5000°K



MOCK-UP ROOM, SWITCH B

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# Plasma

## L.E.P LIGHT EMITTING PLASMA

A single LEP source, smaller than the US quarter, can produce up to 45,000 lumens of brilliant white light.



Now available in 90+ CRI, and colors more appropriate to broad usage, plasma presents a significant improvement in optical control and compact source architecture that HID and LED can't equal. While limited in real utility to applications where greater than 10,000 lumens are needed, such as open areas, roadway interchanges, large flood, and sports lighting, plasma is an excellent companion to LED technology.

Architectural SSL Magazine

COMING SOON?

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# MH Dimming Ballasts

www.sylvania.com

**QUICKTRONIC® MH Metal Halide Dimming Systems**

**Electronic Metal Halide Controllable Lighting Systems**

**High Efficiency Series**

**Energy Efficient Code**

QUICKTRONIC 200-277V DIM M13L C150  
 QUICKTRONIC 200-277V DIM M13L M14 C151  
 QUICKTRONIC 200-277V DIM M13L M14 C154  
 QUICKTRONIC 200-277V DIM M13L  
 QUICKTRONIC 200-277V DIM M13L M15

**Key System Features**

- Low frequency square wave
- Suitable for both quartz and ceramic lamps
- Constant power regulation
- High power factor
- Continuous dimming (0-100)
- Step dim to 50% of rated power
- 15 minutes of full power warm-up time during
- Full light output from 50% in less than 1 minute
- Low harmonic distortion
- Compact size and lightweight
- MPC case temperature
- EMI/RFI
- 100% dimming life test done
- Internal OTP Protection Detection (Thermal Protection)
- QUICKTRONIC® warranty
- 120V warranty track, up to 200K
- Compliant with Energy Independence and Security Act of 2007
- ENEC compliant
- Lead free solder and manufacturing process

**Application Information**

SYLVANIA QUICKTRONIC High Efficiency MH dimming ballasts are ideally suited for:

- High bay
- Institutional
- Commercial
- Big box retail

**Electronic Metal Halide Controllable Lighting Systems**

**Dimmed Energy Efficiency**

- Ballasts provide up to 10% efficiency allowing maximum energy savings when compared to magnetic ballast

**Industry's Most Adaptable Dimming**

- Ballasts allow 100% to 50% in less than 1 minute during dimming which provides free variability in controls selection
- Dimmed switches (0-10V dimming)
- Low voltage controls (Professionals 0-10V dimming control)
- Any line voltage from 200V to 277V

**Energy Management Strategies**

- Ballasts allow simple energy management strategies
- Occupancy control by using 0-10V dimming

**System Information**

- Provides a robust system with respect to acoustic disturbance and to minimize its radiation in lamp geometry fit ceiling and recessed applications
- Superior constant power regulation design
- High yield consistent light output and color throughout the life of the lamp
- Provides constant light output during periods of fluctuating supply voltage
- End-of-lamp life protection
- Prevents continuous dimming of the lamp until 15 minutes warm-up time
- Ballasts will operate longer at full power for the first 15 minutes to allow the lamps to warm up before dimming

**Ballast Compliance**

QUICKTRONIC MH ballasts are ENEC compliant and feature lead-free solder and manufacturing process

**QUICKTRONIC® Warranty**

Setting the standard for quality, QUICKTRONIC MH ballasts are covered by a 200K-hour warranty, the best comprehensive system warranty in the industry

**Simple Installation**

- Installation is simplified by a drop-in-place ballast that incorporates the ballast, capacitor, resistor and mounting brackets of conventional systems

**Image:** A photograph showing several MH dimming ballasts and lamps.

**SYLVANIA**

MEET THE WORLD IN A NEW LIGHT

Step Dimming to 50% rated power (light output to 60%)

Full light output from 50% in less than 1 minute

Wattages:

200, 250, 320, 350, 400



# Before he gets Cranky, Let's Take a Quick ...





## LED Technology

### SSL – LED's

*Just a few short years ago, the use of Solid State Lighting was limited to traffic signals, exit signs, and holiday lights, as LED manufacturers struggled to produce white light that was suitable for general illumination.*

James Broderick  
NEMA electroindustry Magazine  
February, 2013

**REMEMBER:** LED's were hardly mentioned in the 9<sup>th</sup>, Ed. of the IES Handbook.

*In 2012 plenty of positives were achieved, particularly on the products side, but standards are lagging, cost remains an issue, and "must-have" value is not there.*

Architectural SSL Magazine

*SSL is at a turning point. Their ultimate success, and the energy savings that will result, depends on technology, (which is already outperforming earlier generations) continuing to improve.*

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## LED's

### ▪ Advantages

- Quickly gaining in efficacy on fluorescent tubes.\*
- Since LED's are imbedded, fixtures are directional, allowing for more efficient optics.
- Quality of White Light LED's now comparable to fluorescent, recent advances assure better consistency in color and CCT.
- Significantly longer 'useful' life.



\*Remember, DOE has theorized the LED maximum LPW to be 300!

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## LED's

### ▪ Advantages (cont.)

- Light output has improved by 35% per year
- Costs have dropped by 20% per year
- No infrared, (IR) radiation
- No ultraviolet, (UV) rays
- Mercury free
- Can operate in cold environments
- Can withstand impact and vibrations
- Inherently digital for ease of control??
- Instant on
- Growing trend toward . . . .

*SSL is a technology that lends itself to being controlled, so why are there so many issues, especially with dimming? Lots of reasons, including incompatibility with older technologies not suited for SSL. But the greatest barrier is a lack of an open dimming protocol.*

Architectural SSL Magazine

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## Modularity

### Zhaga consortium, (and others)

Creates interface specifications for light engines with the goal of promoting interchangeability among manufacturers.

Has defined a 5-phase process to balance the need for differences with the need for uniformity.

[www.zhagastandard.org](http://www.zhagastandard.org)

*Zhaga is an industry-wide cooperation between LED companies aimed at enabling the interchangeability of LED light sources made by different manufacturers, in the hope that it will prevent market fragmentation and incompatible products.*



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## LED's

### ▪ The Trouble with Lumen Evaluation

- The way that lumen output is traditionally measured, reported and interpreted is a problem for evaluating and comparing LED fixtures.
- Lumens are an imperfect measurement of '**perceived**' intensity of light.
- LED fixtures and conventional fixtures are tested differently, hence some photometric data is reported differently.
- A fixture's total lumen output does not account for wasted light.
- LED fixtures typically waste less light than conventional fixtures.
- 'Eye Sensitivity Curve' adjusts lumen content by source's Spectral Power Distribution.

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## LED's

### ▪ Useful Life

- **Rated Lamp Life of Conventional Sources**
  - Well established methodology: LM-49-01, LM-65-01
  - Life rated at 50% failure point
- **Lumen Maintenance and Depreciation**
  - IES publication LM-80-08
  - Counterpoint to LM-49 and LM-65
  - Instead of rated life, LM-80 measures lumen depreciation
  - Factors include:
    - Drive current
    - Heat generated within the device



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## LED's

### Useful Life (cont.)

- Lumen Maintenance and Depreciation (cont.)
  - Maintenance measurements –  $L_p$
  - $L$  is initial output
  - $P$  is the percentage maintained over a number of hours
    - i.e.  $L_{70}$  measure how long a source will retain 70%, (or lose 30% of its initial output)

Knowing an LED's '**Useful Life**' is important because they continue to deliver light after initial output has decreased by 50%, or more. Users need to know how long an LED fixture will retain a meaningful percentage of its initial light output, **NOT** how long will it take to fail.

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## LED's

### ▪ Useful Life (cont.)

- Useful Life Defined
  - The length of time a light source delivers a minimum acceptable level of light in a given application.
  - Changes in light levels go undetected down to 70% of initial levels, especially if change is gradual.
  - For general lighting applications, Useful Life could therefore be defined as the length of time it takes an LED source to reach 70% of its initial output,  $L_{70}$

Solid State LED fixtures offer many improvements and certainly are the big winners for lower power density, and longer life systems with mean or design lumens for a typical  $L_{70}$  expected life of 50,000 hours. This is the **6-times lamp life rule** from TM-21-11. Many manufactures are also publishing "**predicted**" LED system lamp life in the 100,000-150,000 hour range.

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## LED's

### ▪ Useful Life (cont.)

- Additional Testing Criteria
  - LM-80 requires testing of LED sources for 6,000 hrs. though it recommends 10,000 hrs. and enforces the '**6 Times Lamp Life Rule**'.
  - TM-21 establishes criteria for projecting long term lumen maintenance of LED sources.



Solid state LED systems have another advantage in lamp life that the fluorescent systems do not have. At 20,000 hours the fluorescent system has 50% lamp failure while the LED system boast no fixtures out at L70 lamp life. This much longer lamp life and 100% fixture on system gives the end user a significantly better ability to maintain light levels in the space to the levels design for the application and reduced maintenance cost over the life of the system.

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## Large Volume Spaces

### Typically:

- Large open spaces
- Visual Obstructions
- Moderate Level Ambient Lighting
- Task Lighting used where needed
- Skylights
- Light Levels: 25fc – 100fc
- Safety Concerns (controls needed)

### Trends:

- More acceptable 'White' Light
- T5HO Fluorescent or LED's
- Lighting Controls
- Energy / Cost Consciousness



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## Industrial Applications



*Industrial facilities often have high hours of operation and illumination throughout large areas which make them ideal for an efficient lighting and controls retrofit.*

Lighting Retrofits Guidelines for Industrial Facilities

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## LARGE VOLUME SPACES

### SEATTLE ENERGY CODE 2009

	WAREHOUSE	
TYPE OF STORAGE	LPA	SPACE-BY-SPACE
ALL	0.50 W/FT. <sup>2</sup>	NA



### IES RECOMMENDED ILLUMINANCE LEVELS

	WAREHOUSE	
TYPE	HOR. LEVELS	VERT. LEVELS
OPEN	10-30 fc	NA
STORAGE	10-30 fc	5-15 fc

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## Typical Lighting Systems

### Low Bay Luminaires:

Typically mounted less than 20' - 25' above the work plane.

Historically, either MH, MV, HPS, or Linear Fluorescent.



### High Bay Luminaires:

Typically mounted more than 25' above the work plane.

Historically either MH, MV, or HPS.

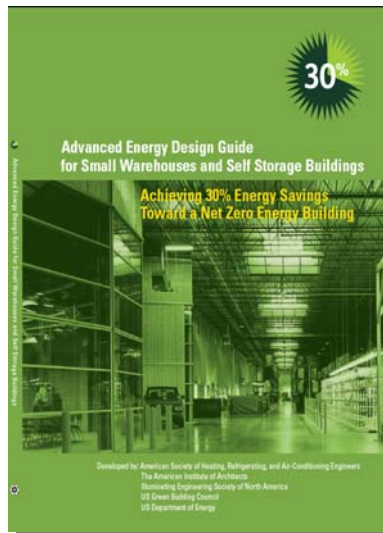


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## Advanced Energy Design Guide

### Small Warehouses and Self Storage Buildings



The fourth in a series designed to provide recommendations for achieving 30% energy savings over the minimum code requirements of ANSI/ASHRAE/IESNA Standard 90.1.

This Guide focuses on warehouses up to 50,000 sq.ft and self storage buildings.

The recommendations in this guide will allow Contractors, Consulting Engineers, Architects and Designers to easily achieve advanced levels of energy savings without having to resort to detailed calculations or analyses.

For more information on the entire Advanced Energy Design Guide series, visit the AEDG web page at [www.ashrae.org/aedg](http://www.ashrae.org/aedg).

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# Lighting Recommendations

Skylights	Area (percent of gross roof)	Climate zone 7 - 5-7% prismatic diffusing skylights required in warehouse areas (except in self storage areas) Climate zone 8 - No skylights recommended in warehouse areas due to winter heat loss and minimal daylight availability	
	Thermal transmittance	U-0.69	U-1.36
	Solar heat gain coefficient (SHGC)	0.64	No Recommendation above code
	Visible light transmittance (VLT)	0.59	
Interior Lighting	Lighting power density (LPD)	Warehouse (bulky & Self Storage) = 0.6 W/ft <sup>2</sup> Warehouse (fine storage) = 0.85 W/ft <sup>2</sup> Office area = 0.9 W/ft <sup>2</sup>	
	Linear fluorescent lamps	T5HO or T8 high-performance with high-performance electronic ballast	
	Controls for daylight harvesting	Automatic dimming or switching of all luminaires in daylight areas	
	Occupancy controls	Auto-on/off for all luminaires in the warehouse and self storage areas, manual-on/auto-off for all office areas	
	Ceiling surface reflectance	80%	
Exterior Lighting	Canopied areas	0.5 W/ft <sup>2</sup>	

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# Storage Warehouse – T8HP

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 2

### ROOM CHARACTERISTICS

Length: 72'  
Width: 100'  
Height: 28' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 20%  
Floor = 20%  
Product = 20%

### PRODUCT SPECIFICATIONS

Dimensions: 9 7/8" x 90"  
Lenses: Blue  
Lamps: 28 F32/T8 HP  
Lumens per Lamp: 3100  
Ballast Factor: 0.88<sup>1</sup>  
Lamp Lifetime: 20,000 hrs  
Total Fixture Efficiency: ~83%  
Watts: 82

<sup>1</sup> If the light levels are higher than required, consider a lower ballast factor (BF) for greater savings (see options on back).

## WAREHOUSE

T8 HP FLUORESCENT



**THE OPPORTUNITY**  
In a typical high, open ceiling warehouse application, it is possible to provide high quality lighting that adequately illuminates the warehouse aisles while meeting or beating the local energy code. The situation requires luminaires with optical control capable of effectively distributing light onto the vertical surfaces, which provides excellent product recognition and improved productivity.

**THE SOLUTION**  
Install industrial high bay fluorescent luminaires located over the center of each aisle. Luminaires equipped with T8 HP electronic ballasts and (3) 28w T8 high performance lamps will deliver 10x average maintained vertical footcandles on the face of the stacks.

**DESIGN CONSIDERATIONS**  
Stacks have a large impact on the illumination of the space. Vertical surfaces absorb and block light. The stack layout must correspond to the lighting layout to minimize shadows if luminaires are installed off center of the aisles.



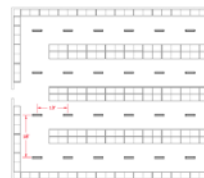
The Lighting Design Group is a Northern California lighting education facility providing commercial and industrial energy conservation. Additional guides are available on our website.

WWW.LIGHTINGDESIGNGROUP.COM  
209.325.4711 or Toll Free (800) 354-3844  
2705 6th Avenue South, Seattle, WA 98134



### LAYOUT OPTIONS

Warehouse (2) T8 HP Fluorescent | 18' x 12' Spacing



### INSTALLATION SPECS

Number of Luminaires: 44  
Luminaire Spacing: 18' x 12'  
Mounting Condition: Pendant  
Mounting Height: 24'  
Average Illuminance: ~15 fc, horizontal  
~11 fc, vertical  
Wattage, ft<sup>2</sup>: ~0.34  
IES Recommended Footcandles (fc):  
10 - 20 fc, horizontal  
5 - 10 fc, vertical

### CONTROLS

Occupancy sensors or building energy management systems now MUST be used to turn lights off automatically when occupants are away, or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Daylight harvesting controls, by code, must be used on all luminaires within the Daylight Zone, which is typically 70% of the ceiling height in all directions from the edge of a skylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near skylight)	-17w (dim to 20%)	80%	Maintained from daylight
Integrated occupancy sensors	-82w (average)	20% to 40%	Equal to base design
Lower ballast factor	-7w (BF of 0.77)	22%	10% lower

<sup>1</sup> \*Data Analysis of Energy Savings from Lighting Controls in Commercial Buildings\*, 2006, SORREL, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (W/WHOUSE)
Seattle	2009 Seattle Energy Code	0.50 w/wh. ft.
Washington	2009 WSEC	0.50 w/wh. ft.
Chicago	2010 CIESCC	0.73 w/wh. ft.
Illinois	2009 IECC	0.80 w/wh. ft.
Montana	2009 IECC	0.80 w/wh. ft.

LIGHTING LAYOUT GUIDE SERIES:

WAREHOUSE | T8 HP FLUORESCENT



# Storage Warehouse – T8HP

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 2

### ROOM CHARACTERISTICS

Length: 72'  
 Width: 150'  
 Height: 28' Open Ceiling  
 Reflectivity:  
 Ceiling = 80%  
 Walls = 30%  
 Floor = 20%  
 Product = 30%

### PRODUCT SPECIFICATIONS



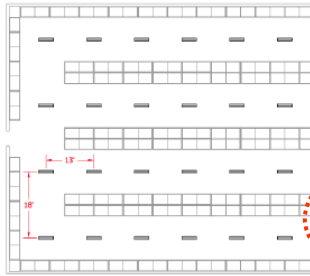
Courtesy: Columbia Lighting

Dimensions: 9.75" x 96"  
 Louvers: Blade  
 Lenses: (3) F52T8 HP  
 Lumens per Lamp: 3100  
 Ballast Factor: 0.88\*  
 Lamp Lumen Depreciation: 0.95  
 Total Fixture Efficiency: ~83%  
 Watts: 63

\* If the light levels are higher than required, consider a lower ballast factor (BF) for greater savings (see options on back).

## LAYOUT OPTIONS

Warehouse (3) T8 HP Fluorescent | 18' x 13' Spacing



### INSTALLATION SPECS

Number of Luminaires: 44  
 Luminaire Spacing: 18' x 13'  
 Mounting Condition: Pendant  
 Mounting Height: 24'  
 Average Illumination:  
 -15 fc horizontal  
 -11 fc vertical  
 Watts/sq. ft.: ~0.34  
 IES Recommended Footcandles (fc):  
 10 - 30 fc horizontal  
 5 - 15 fc vertical

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# Storage Warehouse – T5HO

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 1

### ROOM CHARACTERISTICS

Length: 72'  
 Width: 150'  
 Height: 33' Open Ceiling  
 Reflectivity:  
 Ceiling = 80%  
 Walls = 30%  
 Floor = 20%  
 Product = 30%

### PRODUCT SPECIFICATIONS



Courtesy: Columbia Lighting

Dimensions: 9.75" x 48"  
 Louvers: Blade  
 Lenses: (2) F54T5HO  
 Lumens per Lamp: 4400  
 Ballast Factor: 1.0  
 Lamp Lumen Depreciation: 0.95  
 Total Fixture Efficiency: ~83%  
 Watts: 120

## WAREHOUSE

T5HO FLUORESCENT



### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide high quality lighting that adequately illuminates the warehouse aisles while meeting or beating the local energy code. When provided with targeted optical control, this layout takes advantage of "stack" lighting strategies and distributes light onto the vertical surfaces—allowing for better product recognition and ultimately improved productivity.

### THE SOLUTION

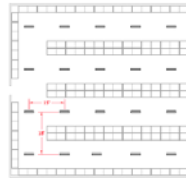
Install industrial high bay fluorescent luminaires located over the center of each aisle. Luminaires equipped with T5HO electronic ballasts and (2) 54w T5HO lamps will deliver 10x average maintained vertical footcandles on the face of the stacks.

### DESIGN CONSIDERATIONS

Stacks have a large impact on the illumination of the space. Vertical surfaces absorb and block light. The stack layout must correspond to the lighting layout to minimize shadows (if luminaires are installed off center of the aisle).

## LAYOUT OPTIONS

Warehouse (2) T5HO Fluorescent | 18' x 15' Spacing



### INSTALLATION SPECS

Number of Luminaires: 40  
 Luminaire Spacing: 18' x 15'  
 Mounting Condition: Pendant  
 Mounting Height: 24' to bottom of luminaire  
 Average Illumination:  
 -16 fc horizontal  
 -11 fc vertical  
 Watts/sq. ft.: ~0.45  
 IES Recommended Footcandles (fc):  
 10 - 30 fc horizontal  
 5 - 15 fc vertical

### CONTROLS

Occupancy sensors or building energy management systems now MUST be used to turn lights off automatically when occupants are away or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Daylight harvesting controls, by code, must be used on all luminaires within the Daylight Zone, which is typically 70% of the ceiling height in all directions from the edge of a skylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near skylights)	-24w (50m to 20%)	-60%	Maintained from daylight
Integrated occupancy sensors	-120w	20% to 40%	Equal to base design

\* IESNA Analysis of Energy Savings from Lighting Controls in Commercial Buildings, LBNL, 2006, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (WAREHOUSES)
Seattle	2009 Seattle Energy Code	0.50 wh/sq. ft.
Washington	2009 WAC	0.50 wh/sq. ft.
Oregon	2010 ORSEC	0.71 wh/sq. ft.
Idaho	2009 IECC	0.80 wh/sq. ft.
Montana	2009 IECC	0.80 wh/sq. ft.

LIGHTING LAYOUT GUIDE SERIES:

WAREHOUSE 1 T5HO FLUORESCENT



The Lighting Design Lab is a Northwest utility-funded lighting education facility providing commercial and industrial energy conservation. Additional guides are available at the Lighting Design Lab website.

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 3700 4th Avenue South, Seattle, WA 98134





# Storage Warehouse – T5HO

## LIGHTING LAYOUT GUIDE SERIES WAREHOUSE GUIDE 1

### ROOM CHARACTERISTICS

Length: 72'  
 Width: 150'  
 Height: 28' Open Ceiling  
 Reflectivity:  
 Ceiling = 80%  
 Walls = 30%  
 Floor = 20%  
 Product = 30%

### PRODUCT SPECIFICATIONS

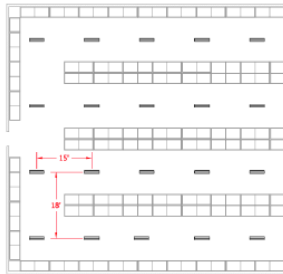


Courtesy: Lithonia Lighting

Dimensions: 9.75" x 48"  
 Louvers: Blade  
 Lamps: (2) T5HO  
 Lumens per Lamp: 4400  
 Ballast Factor: 1.0  
 Lamp Lumen Depreciation: 0.95  
 Total Fixture Efficiency: ~83%  
 Watts: 120

## LAYOUT OPTIONS

Warehouse (2) T5HO Fluorescent | 18' x 15' Spacing



### INSTALLATION SPECS

Number of Luminaires: 40  
 Luminaire Spacing: 18' x 15'  
 Mounting Condition: Pendant  
 Mounting Height: 24' to bottom of luminaire  
 Average Illumination:  
 ~16 fc horizontal  
 ~11 fc vertical  
 Watts/sq. ft.: ~0.45  
 IES Recommended Footcandles (fc):  
 10 - 30 fc horizontal  
 5 - 15 fc vertical

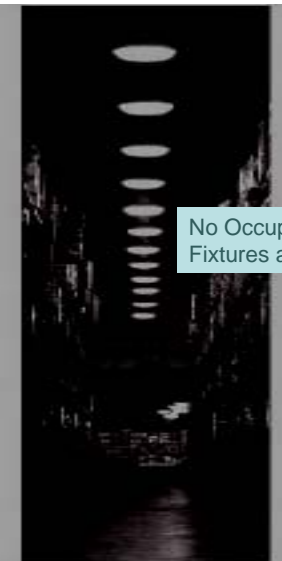
69



# Bi-Level Aisle Lighting



Occupancy Detected,  
Fixtures at Full Output



No Occupancy Detected,  
Fixtures at Half Output

70



# Open Warehouse – T8 HP

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 4

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Courtesy: Columbia Lighting  
Dimensions: 17" x 48"  
Reflector: Specular Aluminum  
Lamps: (6) F32T8 HP  
Lumens per Lamp: 3100  
Ballast Factor: 1.15\*  
Lamp Lumen Depreciation: 0.95  
Total Fixture Efficiency: 87%  
Watts: 217  
\*If the light levels are higher than required, consider a lower ballast factor (BF) for greater savings (see options on back).



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2015 4th Avenue South, Seattle, WA 98148



## OPEN WAREHOUSE

T8 HP FLUORESCENT



### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide high quality lighting that illuminates the warehouse floor area to recognized standards, and meets or beats the local energy codes. This layout provides broad, even lighting throughout the space, allowing for better product recognition and improved productivity.

### THE SOLUTION

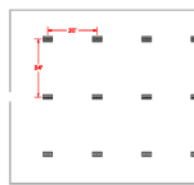
Install industrial high bay fluorescent luminaires on 20' x 24' centers, equipped with T8 electronic ballasts and (6) 32w T8 high performance lamps. For this application, uniformity of illumination is desirable, and vertical illumination is far less important. This layout distributes light evenly throughout the space, at a contrast ratio of about 3.0:1.0, and maintains an average illumination level of about 29 footcandles.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal illumination, but on uniformity as well. The layout achieves a desirable contrast ratio.

## LAYOUT OPTIONS

Open Warehouse (6) T8 HP Fluorescent | 20' x 24' Spacing



### INSTALLATION SPECS

Number of Luminaires: 21  
Luminaire Spacing: 20' x 24'  
Mounting Condition: Pendant  
Mounting Height: 28'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.42

IES Recommended Footcandles (fc):  
10 - 30 fc

### CONTROLS

Circummetry sensors or building energy management systems now MUST be used to turn lights off automatically when occupants are away, or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Daylight harvesting controls, by code, must be used on all luminaires within the Daylight Zone, which is typically 70% of the ceiling height in all directions from the edge of a skylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near skylights)	-43w (8% to 20%)	80%	Maintained from daylight
Integrated occupancy sensors*	-217w	20% to 40%	Equal to base design
Lower ballast factor	-167w (BF of 0.88)	25%	20% lower

\*Waters Analysis of Energy Savings from Lighting Controls in Commercial Buildings\*, IAPWS, 2005, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (WAREHOUSE)
Seattle	2009 Seattle Energy Code	0.50 w/sq. ft.
Washington	2009 WSEC	0.50 w/sq. ft.
Oregon	2010 ORESC	0.73 w/sq. ft.
Idaho	2009 IEC	0.80 w/sq. ft.
Montana	2009 IEC	0.80 w/sq. ft.

LIGHTING LAYOUT GUIDE SERIES:

OPEN WAREHOUSE | T8 HP FLUORESCENT



# Open Warehouse – T8 HP

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 4

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

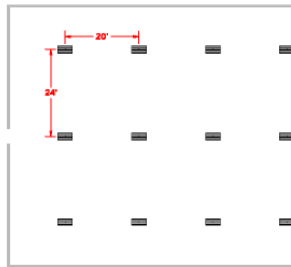
### PRODUCT SPECIFICATIONS



Courtesy: Columbia Lighting  
Dimensions: 17" x 48"  
Reflector: Specular Aluminum  
Lamps: (6) F32T8 HP  
Lumens per Lamp: 3100  
Ballast Factor: 1.15\*  
Lamp Lumen Depreciation: 0.95  
Total Fixture Efficiency: 87%  
Watts: 217

## LAYOUT OPTIONS

Open Warehouse (6) T8 HP Fluorescent | 20' x 24' Spacing



### INSTALLATION SPECS

Number of Luminaires: 21  
Luminaire Spacing: 20' x 24'  
Mounting Condition: Pendant  
Mounting Height: 28'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.42

IES Recommended Footcandles (fc):  
10 - 30 fc

MOCK-UP ROOM, SWITCH E



# Open Warehouse – T5HO

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 3

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 20%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Courtesy: Columbia Lighting

Dimensions: 12" x 48"  
Reflector: Specular Aluminum  
Lamps: (4) F54T5HO  
Lumens per Lamp: 5000  
Ballast Factor: 1.0\*  
Lamp Lumen Depreciation: 0.95  
Total Fixture Efficiency: 87%  
Watts: 226

## OPEN WAREHOUSE

T5HO FLUORESCENT



### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide high quality lighting that illuminates the warehouse floor and task areas to recognized standards, and meets or beats the local energy codes. When equipped with appropriate optical controls, this layout distributes light primarily on horizontal surfaces—allowing for better task lighting, ultimately improving productivity.

### THE SOLUTION

Install industrial high bay fluorescent luminaires on 20' x 24' centers, equipped with (4) T5HO electronic ballasts and (4) (4) F54T5HO lamps. For this application, uniformity of illumination is desirable, and vertical illumination is far less important. This layout distributes light evenly throughout the space, at a contrast ratio of about 3.0:1.0, and maintains an average illumination level of about 20+ footcandles.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal illumination, but on uniformity as well. The layout achieves a desirable contrast ratio.

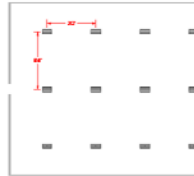


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### LAYOUT OPTIONS

Open Warehouse (4) T5HO Fluorescent | 20' x 24' Spacing



### INSTALLATION SPECS

Number of Luminaires: 31  
Luminaire Spacing: 20' x 24'  
Mounting Condition: Pendant  
Mounting Height: 28'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.45

IES Recommended Footcandles (fc):  
10 | 30 fc

### CONTROLS

Occupancy sensors or building energy management systems now MUST be used to turn lights off automatically when occupants are away, or after hours. One cost effective solution is specifying luminaires with manual occupancy sensors. This will minimize wasted labor costs.

Daylight harvesting controls, by mode, must be used on all luminaires within the Daylight Zone, which is typically 70% of the ceiling height in all directions from the edge of daylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight harvesting sensors (near daylight)	~10w (due to 20%)	~60%	Maintained from daylight
Energy code occupancy sensor	~20w	30% to 40%	Equal to base design

\*See Analysis of Energy Savings from Lighting Controls in Commercial Buildings, DOE, EERE, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (WAREHOUSES)
Nevada	2010 Nevada Energy Code	0.10 w/sq. ft.
Washington	2009 WSEC	0.50 w/sq. ft.
Oregon	2010 OESCC	0.75 w/sq. ft.
Idaho	2009 IEC	0.80 w/sq. ft.
Minnesota	2009 ECCC	0.80 w/sq. ft.

LIGHTING LAYOUT GUIDE SERIES:

OPEN WAREHOUSE | T5HO FLUORESCENT



# Open Warehouse – T5HO

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 3

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

### PRODUCT SPECIFICATIONS

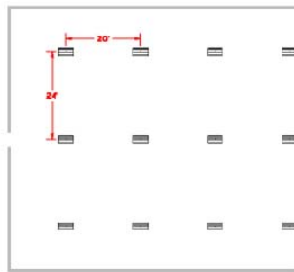


Courtesy: Columbia Lighting

Dimensions: 12" x 48"  
Reflector: Specular Aluminum  
Lamps: (4) F54T5HO  
Lumens per Lamp: 5000  
Ballast Factor: 1.0\*  
Lamp Lumen Depreciation: 0.95  
Total Fixture Efficiency: 87%  
Watts: 226

### LAYOUT OPTIONS

Open Warehouse (4) T5HO Fluorescent | 20' x 24' Spacing



### INSTALLATION SPECS

Number of Luminaires: 21  
Luminaire Spacing: 20' x 24'  
Mounting Condition: Pendant  
Mounting Height: 20'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.45

IES Recommended Footcandles (fc):  
10 | 30 fc



# Open Warehouse – Induction

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 5

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Courtesy: Deco Lighting

Dimensions: 22" Diameter  
Reflector: Prismatic Acrylic  
Lamps: 200w Induction  
Lumens per Lamp: 25,760  
Ballast Factor: n.a.  
Lamp Lumen Depreciation:  
-65,000 hrs. at L<sub>70</sub>  
Total Fixture Efficiency: ~93%  
Watts: 280

### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide superior quality lighting that illuminates the warehouse floor area to recognized standards, and meets or beats the local energy codes. Induction technology will produce lower, even lighting throughout the space, allowing for better product recognition and improved productivity. Advantages of this option are longer life span resulting in reduced maintenance costs, enhanced color rendering, instant on capability and full-range dimming. In addition, it can be used in dual mode as a lighting and emergency lighting system.

### THE SOLUTION

Install industrial high bay induction luminaires on 27' x 30' centers, equipped with a single 200w induction lamp and prismatic acrylic reflectors. For this application, installers should seek uniformity of illumination on the horizontal plane. This layout should distribute light evenly throughout the space at a contrast ratio of about 3.0:1.0 and an average illumination level of 20+ footcandles.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate light levels, but on maintenance as well. These luminaires are capable of producing more than 90 lumens-per-watt, with an average life of ~60,000 hours at L<sub>70</sub>.  
\*L70 is the useful life or the length of time an LED light source to reach 70% of its initial lumen output.

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With support from



## OPEN WAREHOUSE

HIGH BAY INDUCTION



### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide superior quality lighting that illuminates the warehouse floor area to recognized standards, and meets or beats the local energy codes. Induction technology will produce lower, even lighting throughout the space, allowing for better product recognition and improved productivity. Advantages of this option are longer life span resulting in reduced maintenance costs, enhanced color rendering, instant on capability and full-range dimming. In addition, it can be used in dual mode as a lighting and emergency lighting system.

### THE SOLUTION

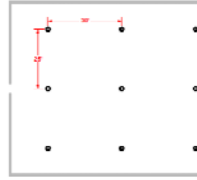
Install industrial high bay induction luminaires on 27' x 30' centers, equipped with a single 200w induction lamp and prismatic acrylic reflectors. For this application, installers should seek uniformity of illumination on the horizontal plane. This layout should distribute light evenly throughout the space at a contrast ratio of about 3.0:1.0 and an average illumination level of 20+ footcandles.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate light levels, but on maintenance as well. These luminaires are capable of producing more than 90 lumens-per-watt, with an average life of ~60,000 hours at L<sub>70</sub>.  
\*L70 is the useful life or the length of time an LED light source to reach 70% of its initial lumen output.

## LAYOUT OPTIONS

Open Warehouse High Bay Induction | 27' x 30' Spacing



**INSTALLATION SPECS**  
Number of Luminaires: 15  
Luminaire Spacing: 27' x 30'  
Mounting Condition: Pendant  
Mounting Height: 28'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.4

IES Recommended Footcandle (fc): 10 - 30 fc

### CONTROLS

For the average reader, occupancy sensors or building energy management systems need to be used to turn lights off automatically when occupants are away or during after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Daylight harvesting controls, by code, must be used on all luminaires within the daylight zone, which is typically 20% of the ceiling height in all directions from the edge of a skylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near skylight)	-50w (50% to 20%)	30%	Maintained from daylight
Integrated or add on occupancy sensors	~20w	20% to 40%	Equal to base design

\*Based on Analysis of Energy Savings from Lighting Controls in Commercial Buildings, U.S. DOE, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (FOOT-CANDLES)
Seattle	2009 Seattle Energy Code	0.50 watts/ft <sup>2</sup>
Washington	2009 WAC	0.75 watts/ft <sup>2</sup>
Illinois	2010 ICS&NEC	0.75 watts/ft <sup>2</sup>
Ohio	2009 EEC	0.80 watts/ft <sup>2</sup>
Minnesota	2010 MFC	0.80 watts/ft <sup>2</sup>

LIGHTING LAYOUT GUIDE SERIES: **OPEN WAREHOUSE | HIGH BAY INDUCTION**



# Open Warehouse – Induction

## LIGHTING LAYOUT GUIDE SERIES

WAREHOUSE GUIDE 5

### ROOM CHARACTERISTICS

Length: 150'  
Width: 72'  
Height: 32' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Courtesy: Deco Lighting

Dimensions: 22" Diameter  
Reflector: Prismatic Acrylic  
Lamps: 200w Induction  
Lumens per Lamp: 25,760  
Ballast Factor: n.a.  
Lamp Lumen Depreciation:  
-65,000 hrs. at L<sub>70</sub>  
Total Fixture Efficiency: ~93%  
Watts: 280

### THE OPPORTUNITY

In a typical high, open ceiling warehouse application, it is possible to provide superior quality lighting that illuminates the warehouse floor area to recognized standards, and meets or beats the local energy codes. Induction technology will produce lower, even lighting throughout the space, allowing for better product recognition and improved productivity. Advantages of this option are longer life span resulting in reduced maintenance costs, enhanced color rendering, instant on capability and full-range dimming. In addition, it can be used in dual mode as a lighting and emergency lighting system.

### THE SOLUTION

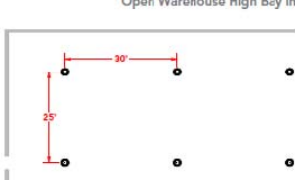
Install industrial high bay induction luminaires on 25' x 30' centers, equipped with a single 200w induction lamp and prismatic acrylic reflectors. For this application, installers should seek uniformity of illumination on the horizontal plane. This layout should distribute light evenly throughout the space at a contrast ratio of about 3.0:1.0 and an average illumination level of 22+ footcandles.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate light levels, but on maintenance as well. These luminaires are capable of producing more than 90 lumens-per-watt, with an average life of ~60,000 hours at L<sub>70</sub>.  
\*L70 is the useful life or the length of time an LED light source to reach 70% of its initial lumen output.

## LAYOUT OPTIONS

Open Warehouse High Bay Induction | 25' x 30' Spacing



**INSTALLATION SPECS**  
Number of Luminaires: 15  
Luminaire Spacing: 25' x 30'  
Mounting Condition: Pendant  
Mounting Height: 28'  
Average Illumination: ~22 fc  
Watts/sq. ft.: ~0.4

IES Recommended Footcandle (fc): 10 - 30 fc



# Cold Storage - LED

## LIGHTING LAYOUT GUIDE SERIES

COLD STORAGE GUIDE 1

## COLD STORAGE

LED HIGH BAY

### ROOM CHARACTERISTICS

Length: 150'  
Width: 32'  
Height: 28' Open Ceiling  
Reflectivity:  
Ceiling = 80%  
Walls = 30%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Direct Indirect Lighting

Dimensions: 22" diameter  
Reflector: Aluminum  
Lamp: 100w LED  
Lumens per Fixture: 7187  
Absolutes, as opposed to  
Relative photometry\*  
Lamp Lifetime Depreciation:  
~95% at 50,000 hours  
Total Fixture Efficiency: ~52%  
Watts: 146

\*The standard method for testing light output of LED lighting is to measure the total lumen output of the luminaire with lamp installed.



### THE OPPORTUNITY

Provide high quality lighting that illuminates the stacks and floor area of the cold storage facility to recognized standards, meets or beats the local energy codes, while extending the maintenance schedule (and saving maintenance dollars) by using longer lasting sources, compatible with fluorescent systems.

### THE SOLUTION

Install industrial high bay LED luminaires on 15' x 18' centers, equipped with aluminum reflectors and LED arrays which have superior color rendering properties. In addition, fixture options allow for integrally mounted occupancy sensors and photo cells.

### DESIGN CONSIDERATIONS

Stacks have a large impact on the illumination of the space. Vertical surfaces absorb and block light. The stack layout must correspond to the lighting layout to minimize shadows, if luminaires are installed off center of the aisles.



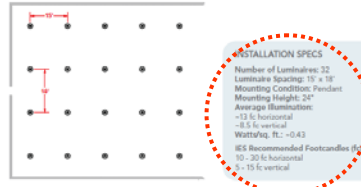
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WWW.LIGHTINGDESIGNLAB.COM  
206.325.4711 or Toll Free: 800.334.3864  
2915 4th Avenue South, Seattle, WA 98148



## LAYOUT OPTIONS

Cold Storage LED High Bay | 15' x 18' Spacing



**INSTALLATION SPECS**  
Number of Luminaires: 32  
Luminaire Spacing: 15' x 18'  
Mounting Condition: Pendant  
Mounting Height: 24"  
Average Illumination:  
~13 fc horizontal  
~3.5 fc vertical  
Wattage, Ft. ~0.43  
IES Recommended Footcandles (fc):  
10 - 20 fc horizontal  
10 - 15 fc vertical

### CONTROLS

Because of energy codes, occupancy sensors or building energy management systems MUST now be used to turn lights off automatically when occupants are away or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Also by code, daylight harvesting controls must be used on all luminaires within the daylight zone, which is typically 70% of the ceiling height in all directions from the edge of a daylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near daylight)	~20w (6m to 20%)	~80%	Maintained from daylight
Integrated, or add-on occupancy sensors*	~146w	20% to 40%	Equal to base design

\*Data Analysis of Energy Savings from Lighting Controls in Commercial Buildings, LBNL, 10/10, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (WAREHOUSES)
Seattle	2009 Seattle Energy Code	0.50 w/ft. ft.
Washington	2009 WSEC	0.50 w/ft. ft.
Oregon	2010 ORESC	0.73 w/ft. ft.
Idaho	2009 IDECC	0.80 w/ft. ft.
Montana	2009 MDECC	0.80 w/ft. ft.

LIGHTING LAYOUT GUIDE SERIES

COLD STORAGE | LED HIGH BAY



# Large Volume Spaces

## SEATTLE ENERGY CODE 2009

	GYMNASIUMS	
TYPE OF SPACE	LPA	SPACE-BY-SPACE
WHOLE BLDG.	0.95 W/FT. <sup>2</sup>	NA



## IES RECOMMENDED ILLUMINANCE LEVELS

	GYMNASIUM	
TYPE	CLASS	LEVELS
PRO	I	125fc
COLLEGE	II	80fc
H.S.	III	50fc
ELEM.	IV	30fc

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# GYMNASIUMS – New Thinking

No more 'one color fits all' installations. The traditional "gym" space in a school is no longer used just for physical education classes, it has evolved into a truly multi-purpose space. To that end the LED systems can once again offer a design solution by being able to tune the color temperature to the activity in the gym. Easily done with simple controls this approach allows the end user to customize the space for a brighter whiter fast paced physical education activity, and mid-range classroom color temperature for instruction periods, and a warmer lower light level for other activities such and school plays and dances.

As with the technology changes of the past, one should stay away from luminaires designed for metal halide and fluorescent lamps with "LED's Inside". Luminaires designed for solid state LED's have different requirements and should use luminaires designed for the source you plan to use.

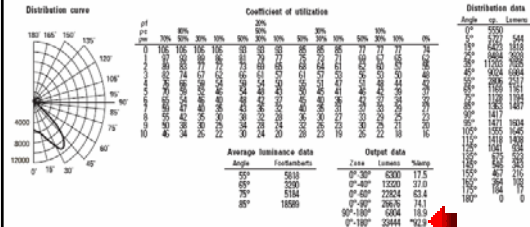


# Standard Practice

TH PA22 High Bay

Acrylic Refractor – Wide Beam

TH 400MP PA22, lug position 3 (wide), 400W, coated metal halide lamp, 38,000 rated lumens, Test No.1190121010.



Spacing criterion: 1.8  
Spacing-to-mounting height: 2.1

General Label: Acrylic Wide  
Description: TH 400MP PA22 LEG 3 SC+L 7  
Lumens Per Lamp: 38000  
Total Watts: 400  
Luminaire Beam: LLHC  
Photometric File: TEST11190121010



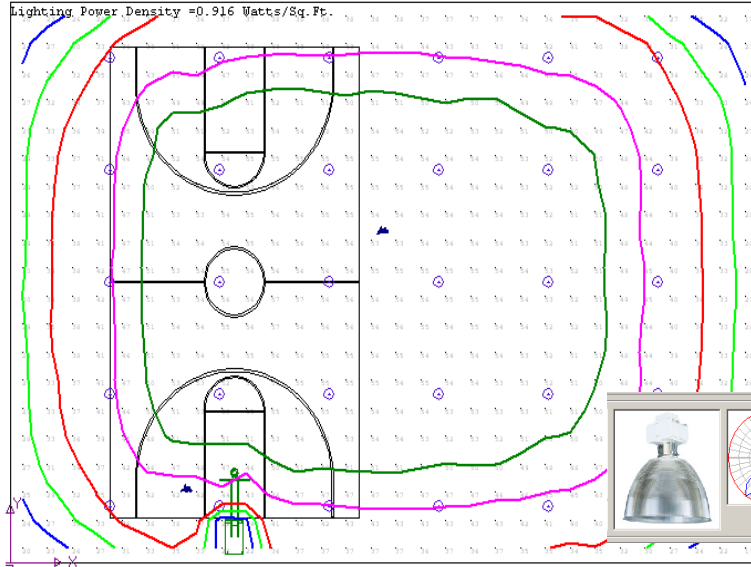




# Wide Beam – 22' Aperture

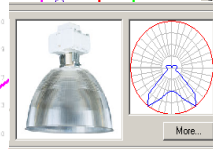
## Acrylic Refractor

Total Watts = 13740  
Lighting Power Density = 0.916 Watts/Sq.Ft.



**Project 1**  
**Calc Pts**  
 Gym-Study-07  
 Floor  
 Illuminance Values (Fc)  
 Average=43.96  
 Maximum=57  
 Minimum=19  
 Avg/Min=2.31  
 Max/Min=3.00

**LPD-UWLR Areas**  
 MH 400 x 30  
 Area(Sq.Ft.)=1500  
 Total Watts=13740  
 LPD(Watts/Sq.Ft.)=0.916



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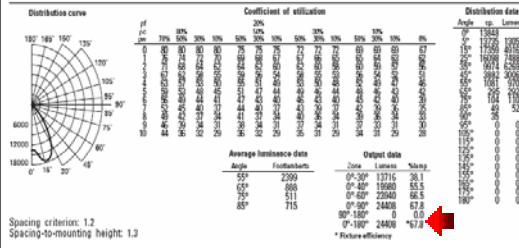


# Standard Practice

## TE E17 High Bay

## Aluminum Reflector – Narrow Beam

TE 400M E17M, (medium), 400W, clear Metal Halide lamp, 36,000 rated lumens, Test No. 11942.



**General**  
 Label: **AlumReflector**  
 Description: TE 400M E17M (SC=1,1)

**Definition**  
 Lumens Per Lamp: 36000  
 Number Of Lamps: 1  
 Total Watts: 400  
 EPA: 0  
 C: 0  
 Sg.Ft.: 0  
 Sg.M.: 0  
 Total LLF = LLF [0.85] × LDD [1] × BF [1] × 0.85  
 Luminous Box: LH.C [0.7] × Y [0.7] × Z [0.03]  
 URHC [0.7] × 0.7 × 0

**Photometric File**  
 Filename: D:\My Document\AGI32\PhotometricData\_Files\Lithon (TEST)11942 (ISSUE DATE)  
 (MANUFACTURER) LITHONIA LIGHTING  
 (LUMINAIRE) TE 400M E17M (SC=1,1)  
 (LUMINAIRE) ENCLOSED ALUMINUM OPTICAL 400 MH W\_ME

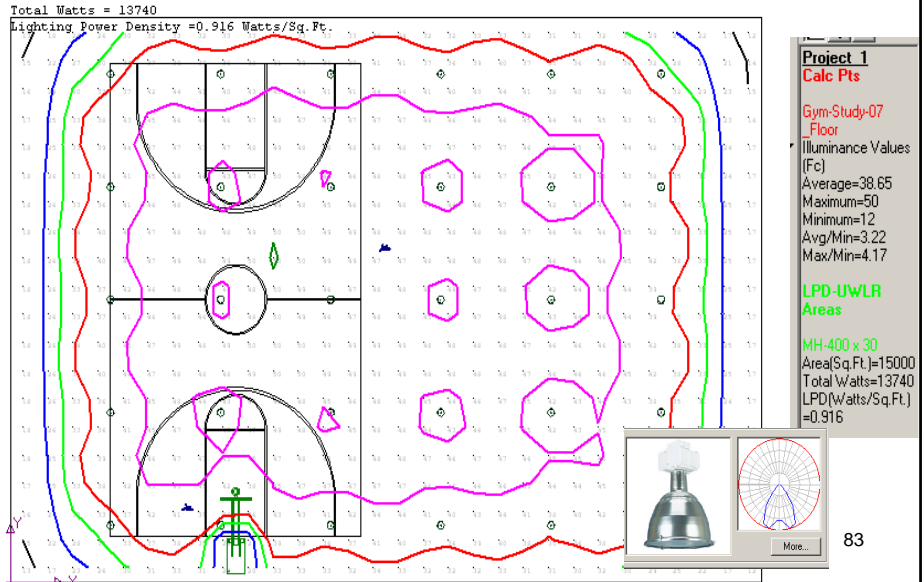


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# Narrow Beam – 17" Aperture

## Aluminum Reflector



# Gymnasium



### High-Bay Fixtures:

400w. MH (458-watts/fixture)  
30 FC ave.  
CRI = 65



### Industrial Strip Fixtures:

(6) – F32T8 lamps (224 watts/fixture)  
50 FC ave.  
CRI = 85







# Gymnasium – T8 HP

## LIGHTING LAYOUT GUIDE SERIES

GYMNASIUM GUIDE 2

### ROOM CHARACTERISTICS

Length: 140'  
Width: 120'  
Height: 30' Open Ceiling  
Reflectivity:  
Ceiling = 50%  
Walls = 50%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Dimensions: 24" x 48"  
Reflector: Specular Aluminum  
Lamp: 057270 10'  
Lumens per Lamp: 3100  
Ballast Factor: 0.88  
Lamp Lumen Depreciation: 0.99  
Total Fixture Efficiency: 95%  
Watts: 100

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal and vertical illumination, but on uniformity as well. This layout achieves a desirable contrast ratio of less than 4 to 1. Note: Some collegiate sports require higher minimum light levels for competition or for televised events.

## GYMNASIUM

### T8 HP FLUORESCENT



### THE OPPORTUNITY

Provide high quality lighting that illuminates the gymnasium floor area to recognized light level standards, and meets or beats the local energy codes. Like all fluorescent systems, this design option has the advantage of coming to full brightness quickly compared to the HID systems they replace, which allows the use of automated and manual controls, dimming and emergency lighting.

### THE SOLUTION

Install industrial high bay fluorescent luminaires on 12' x 15' centers, equipped with high performance T8 electronic ballasts and 08 12w T8 high performance lamps, which have superior color rendering properties. The use of T8 lamps may also allow the school to step with the same lamp type throughout the building for consistency or when ceiling heights are lower.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal and vertical illumination, but on uniformity as well. This layout achieves a desirable contrast ratio of less than 4 to 1. Note: Some collegiate sports require higher minimum light levels for competition or for televised events.



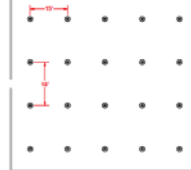
The Lighting Design Lab is a Northwest public building lighting education facility providing commercial and industrial energy simulation. Additional guides are available within Lighting Design Lab materials.

WWW.LIGHTINGDESIGNLAB.COM  
(206) 225-9711 or 1-888-380-3844  
2705 4th Avenue South, Seattle, WA 98134



## LAYOUT OPTIONS

Cold Storage LED High Bay | 15' x 18' Spacing



**INSTALLATION SPECS**  
Number of Luminaires: 32  
Luminaire Spacing: 15' x 18'  
Mounting Condition: Pendant  
Mounting Height: 24'  
Average Illuminance:  
-13.5 fc horizontal  
Watts/ftq, FL: -0.43  
IES Recommended Footcandles:  
10 - 20 fc horizontal  
10 - 15 fc vertical

### CONTROLS

Because of energy codes, occupancy sensors or building energy management systems MUST now be used to turn lights off automatically when occupants are away or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Also by code, daylight harvesting controls must be used on all luminaires within the daylight zone, which is typically 70% of the ceiling height in all directions from the edge of a daylight.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming sensors (near daylight)	-20w (5lm to 20%)	-80%	Maintained from daylight
Integrated or add-on occupancy sensors*	-10w	20% to 40%	Equal to base design

\*Watts Analysis of Energy Savings from Lighting Controls in Commercial Buildings, LBNL 2005, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (WATTS/HOUSE)
Seattle	2009 Seattle Energy Code	0.50 whsq. ft.
Washington	2009 WSEC	0.50 whsq. ft.
Oregon	2010 ORESC	0.73 whsq. ft.
Idaho	2009 IECC	0.80 whsq. ft.
Montana	2009 IECC	0.80 whsq. ft.

LIGHTING LAYOUT GUIDE SERIES

COLD STORAGE | LED HIGH BAY



# Gymnasium – T5HO

## LIGHTING LAYOUT GUIDE SERIES

GYMNASIUM GUIDE 1

### ROOM CHARACTERISTICS

Length: 140'  
Width: 120'  
Height: 30' Open Ceiling  
Reflectivity:  
Ceiling = 50%  
Walls = 50%  
Floor = 20%

### PRODUCT SPECIFICATIONS



Dimensions: 24" x 48"  
Reflector: Specular Aluminum  
Lamp: 01947510  
Lumens per Lamp: 5000  
Ballast Factor: 1.0  
Lamp Lumen Depreciation: 0.99  
Total Fixture Efficiency: 90%  
Watts: 302

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal and vertical illumination, but on uniformity as well. This layout achieves a desirable contrast ratio of less than 4 to 1. Note: Some collegiate sports require higher minimum light levels for competition or for televised events.

## GYMNASIUM

### T5HO FLUORESCENT



### THE OPPORTUNITY

Provide high quality lighting that illuminates the gymnasium floor area to recognized light level standards, and meets or beats the local energy codes. Like all fluorescent systems, this design option has the advantage of coming to full brightness quickly compared to the HID systems they replace, which allows the use of automated and manual controls, dimming and emergency lighting. In addition, compared to using T8s, this option allows you to substantially reduce the number of fixtures (48 vs. 88) to achieve the same light levels—78 footcandles.

### THE SOLUTION

Install industrial high bay fluorescent luminaires on 16' x 20' centers, equipped with T5HO electronic ballasts and (6) 54w T5HO lamps, which have superior color rendering properties. Fixture options allow for integrally mounted occupancy sensors, photo cell, emergency lighting, lamp guards, and multiple switching of lamps.

### DESIGN CONSIDERATIONS

In this application, the emphasis is not only on appropriate horizontal and vertical illumination, but on uniformity as well. This layout achieves a desirable contrast ratio of less than 4 to 1. Note: Some collegiate sports require higher minimum light levels for competition or for televised events.



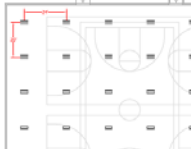
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2705 4th Avenue South, Seattle, WA 98134



## LAYOUT OPTIONS

Gymnasium (6) T5HO Fluorescent | 20' x 24' Spacing



**INSTALLATION SPECS**  
Number of Luminaires: 36  
Luminaire Spacing: 20' x 24'  
Mounting Condition: Pendant  
Mounting Height: 22'  
Average Illuminance:  
-49 fc  
Watts/ftq, FL: -0.65  
IES Recommended Footcandles:  
125 fc Class I - Professional  
80 fc Class II - College  
50 fc Class III - High School  
30 fc Class IV - Elementary

### CONTROLS

Occupancy sensors or building energy management systems must be used to turn lights off automatically when occupants are away or after hours. One cost effective solution is specifying luminaires with integral occupancy sensors. This will minimize wiring labor costs.

Daylight harvesting controls, by code, must be used on all luminaires within the Daylight Zone, which is typically 70% of the ceiling height in all directions from the edge of the skylight or equal to the window height away from the wall and the window width plus 2' at each side.

### ADDITIONAL ENERGY SAVING STRATEGIES

STRATEGY	WATTS/LUMINAIRE	SAVINGS	LIGHT LEVELS
Daylight dimming ballasts (Primary daylight zone)	-60w (5lm to 20%)	80%	Maintained from daylight
Integrated or zone control occupancy sensors*	-30w	20% to 40%	Equal to base design

\*Watts Analysis of Energy Savings from Lighting Controls in Commercial Buildings, LBNL 2005, September 2011.

### ENERGY CODE INFORMATION

JURISDICTION	CODE	LIGHTING POWER ALLOWANCE (GYMNASIUM)
Seattle	2009 Seattle Energy Code	0.95 whsq. ft.
Washington	2009 WSEC	0.95 whsq. ft.
Oregon	2010 ORESC	1.07 whsq. ft.
Idaho	2009 IECC	1.10 whsq. ft.
Montana	2009 IECC	1.10 whsq. ft.

LIGHTING LAYOUT GUIDE SERIES

GYMNASIUM | T5HO FLUORESCENT





## Round LED Luminaires



90w. 11,000 Lumens ~ 175w. MH  
 130w. 14,400 Lumens ~ 250w. MH  
 (Remember: T5HO = 4700 lumens)



These round forms are specifically designed to take advantage of the LED array shape, NOT a matter of fitting the LED's into an existing form. Note, each has a center location for a motion sensor, making it easy to add controls.

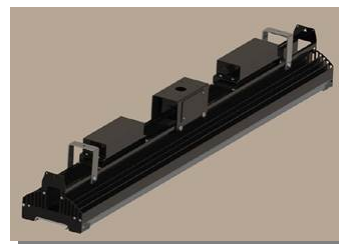
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## Linear LED Luminaires



Here again are fixtures designed around the LED form. Note the significant heat sinks, instead of LED strips stuffed into existing fluorescent fixtures. A heat test will reveal if a fixture cannot remove the heat fast enough to keep the LED's at operating temperatures.



Ask for LM-79 and LM-80 test reports, especially if the fixture looks like a cross-over product.

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## Large Volume Spaces

### MANUFACTURING

TYPE	FACILITY DESCRIPTION	LEVELS	
		HOR.	VERT.
MACHINING	DETAILED EXACTING	300fc	300fc*
FINE	EXACTING	100fc	100fc*
MEDIUM	DIFFICULT	50fc	50fc
LARGE	SIMPLE	30fc	30fc



### IES RECOMMENDED ILLUMINANCE LEVELS

TYPE OF SPACE	FACILITY	
	LPA	SPACE-BY-SPACE
WHOLE BLDG.	1.11 W/FT <sup>2</sup>	NA

\*Task lighting needed to meet these illumination levels

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## Boeing



400W MH High Bays  
~475W / Luminaire  
Occupancy Control isn't feasible



4 lamp T5HO High Bays  
~240 watts / luminaire  
Simple Occupancy Sensor Control

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# Large Volume Spaces

## PARKING LOTS

### SEATTLE 2009

ZONE
4
0.10w./FT <sup>2</sup>



\*Will defer to updated RP-28 when published

### IES RECOMMENDED ILLUMINANCE LEVELS\*

	PARKING	LOTS	
TYPE	ZONE	AVE. LEVELS	MAX. / MIN.
UNCOVERED	4	2.0fc H 0.2fc V	10:1



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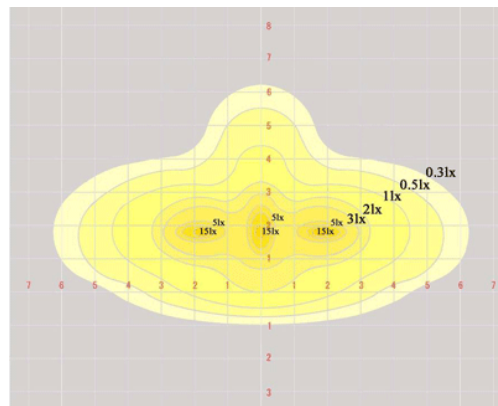
# Large Volume Spaces

## Parking Lot Lighting

Uniform lighting of parking lots to appropriate horizontal illuminances requires detailed attention to the proper spacing of poles, (no less than 0.2 fc)

Proper spacing, in turn depends upon pole height and luminaire photometric distribution

Uniformity is typically expressed as "max to min" or "average to min" values over the defined area, in this case, no more than 10:1.



Vertical illuminance, measured at 5 ft. above grade, is also important, in most cases the recommended minimum is 2.0 fc.

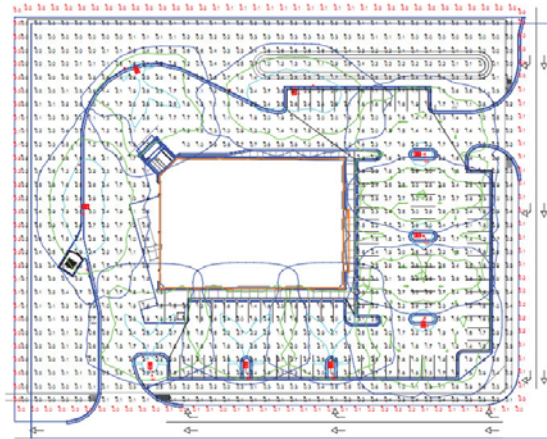
96





## Small Parking Lot

400w Pulse Start MH  
Horiz. burn Shoebox  
Mounted at 30 ft.



ILLUMINATION DATA	
Maximum:	3.3 fc
Minimum:	1.0 fc
Average:	2.1 fc
Max/Min:	3.3
Avg/Min:	2.1

Lamp Lumen Depreciation	.72
Luminaire Dirt Depreciation	.95
Light Loss Factor	.68

Segmented reflector cost analysis example	
Quantity of luminaires/poles	22
Total installed cost*	\$26,316.00
Input watts per fixture	400
Annual hrs per fixture @ 11 hrs/day	4015
Total site annual KWH	88335
Annual energy costs @ \$0.10 per KWH	\$1,647.76

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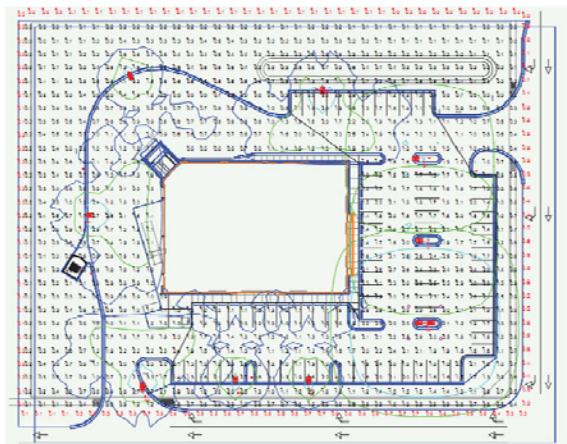


## Small Parking Lot

210w LED  
Horiz. burn Shoebox  
Mounted at 30 ft.



**SIMPLE PAYBACK:  
11.75 YRS.**



ILLUMINATION DATA	
Maximum:	3.3 fc
Minimum:	1.0 fc
Average:	1.8 fc
Max/Min:	3.3
Avg/Min:	1.8

Lamp Lumen Depreciation	.85
Luminaire Dirt Depreciation	.95
Light Loss Factor	.81

Cimarron LED cost analysis example	
Quantity of luminaires/poles	22
Total installed cost	\$35,683.00
Input watts per fixture	210
Annual hrs per fixture @ 11 hrs/day	4015
Total site annual KWH	84335
Annual energy costs @ \$0.10 per KWH	\$8,433.15

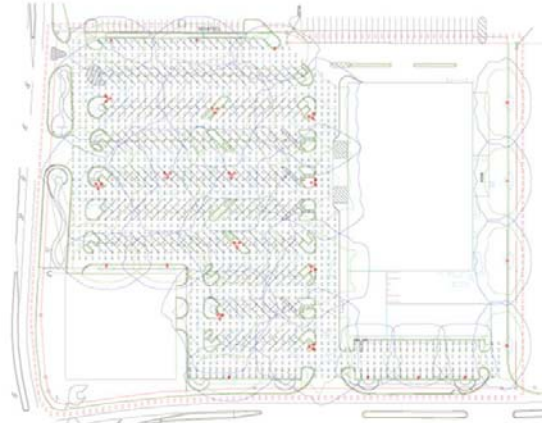
+ \$9,400

- \$800



## Large Parking Lot

400w Pulse Start MH  
Horiz. burn Shoebox  
Mounted at 30 ft.



ILLUMINATION DATA	
Maximum:	5.0 fc
Minimum:	1.0 fc
Average:	2.0 fc
Max/Min:	5.0
Avg/Min:	2.01

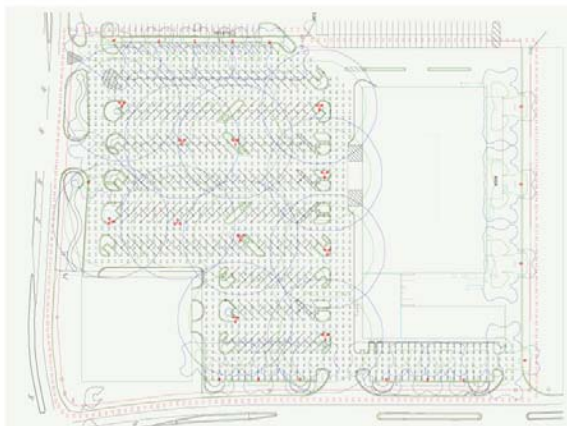
Lamp Lumen Depreciation	.72
Luminaire Dirt Depreciation	.95
Light Loss Factor	.68

Segmented reflector cost analysis example	
Quantity of luminaires/poles	174,720.00
Total installed cost*	\$74,720.00
Input watts per fixture	4015
Annual hrs per fixture @ 11 hrs/day	4015
Total site annual KWH	704,310
Annual energy costs @ \$0.10 per KWH	\$8422

99



## Large Parking Lot - LED



210w. LED  
Horiz. burn Shoebox  
Mounted at 30 ft.



ILLUMINATION DATA	
Maximum:	4.1 fc
Minimum:	1.0 fc
Average:	2.4 fc
Max/Min:	4.1
Avg/Min:	2.38

Lamp Lumen Depreciation	.85
Luminaire Dirt Depreciation	.95
Light Loss Factor	.81

Cimarron LED cost analysis example	
Quantity of luminaires/poles	174,720.00
Total installed cost*	\$116,500.00
Input watts per fixture	2100
Annual hrs per fixture @ 11 hrs/day	4015
Total site annual KWH	704,310
Annual energy costs @ \$0.10 per KWH	\$4,131

**SIMPLE PAYBACK:**  
9.75 YRS.

+ \$42,000

- \$4,300

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## CONTROLS

*The deployment of SSL's can lead to exciting new intelligent controls approaches. The sooner the industry can develop a universal foundation for this, the sooner the manufacturers can deliver.*

Kevin Willmoth  
Architectural SSL Magazine Jan. 2013

SPACE TYPE	CONTROL	EXPECTED SAVINGS
Warehouse	Occupancy Sensor	60%
	Bi-Level Switching	40%

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## ACRONYMS & TERMS

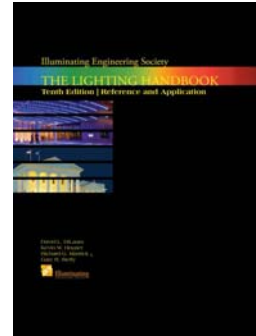
L <sub>70</sub>	Time to 70% lumen maintenance
NRTL	Nationally Recognized Testing Laboratory
AHJ	Authority Having Jurisdiction
NEMA	National Electrical Manufacturers Association
ANSI	American National Standards Institute
IES	Illuminating Engineering Society
NEC	National Electrical Code
CEE	Consortium of Energy Efficiency
UL	United Laboratories

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## REFERENCES

- IES LEM-3-07 Guidelines for Upgrading Lighting Systems in Commercial and Institutional Spaces, *(due to be updated this year)*
- IES Lighting Handbook, 10<sup>th</sup> Ed.
- Advanced Energy Design Guide for Small Warehouses and Self-Storage Buildings
- Advanced Lighting Guidelines
  - [www.algonline.org](http://www.algonline.org)
- Architectural SSL Magazine
  - [www.architecturalsl.com](http://www.architecturalsl.com)
- LEDs Magazine
  - [www.ledsmagazine.com](http://www.ledsmagazine.com)
- Electroindustry Magazine
  - [www.nema.org](http://www.nema.org)



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