# 103 Fundamentals Light Sources and Luminaires



Eric Strandberg LC, MIES Senior Lighting Specialist Fall 2021







#### **During the Webinar**

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions every ~10 minutes

• Please participate in the online polls.

#### **Following the Webinar**

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to <u>LightingDesignLab@seattle.gov</u> with comments or questions.



# **Seattle City Light**

#### Who We Work With



It takes a village...



#### Who We Work With



### LDL's Four Core Service Areas



# 103 Fundamentals Light Sources and Luminaires



Eric Strandberg LC, MIES Senior Lighting Specialist Fall 2021









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Since 1995 Eric Strandberg LC, has been one of the lighting specialists at the Lighting Design Lab promoting energy efficiency and quality lighting design. With a passion for "all things lighting", he has over 30 years in the lighting industry. This work encompasses almost every aspect of lighting design and conservation including; developing and presenting classes, writing articles, technology evaluation and project consultation.

# Today's Learning Objectives

- Identify major light source families and basic characteristics
- Understand lighting metrics as they relate to light sources and luminaires
- Understand typical luminaire families
- Understand basic photometry and cut sheet data
- Gain familiarity with basic luminaire specifications



Light(ing) enables our sense of sight.

Vision informs our *conscious* mind more than any of our other senses.

As much as 80% of our perception is visual.

Lighting also has strong social and emotional significance.

# Sight- How does it work?



Light is the frequency range of the electromagnetic spectrum to which our visual system is sensitive.



# **Color and Perception**



# Light must be given meaning

Light stimulus that can be recognized in meaningful patterns is accepted as information.



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Light stimulus that can be recognized in meaningful patterns is accepted as information.



# Light Source Characteristics

#### Luminous Shape

- Point
- Linear
- Planar

Intensity / Lumen Output

Efficacy

Rated Life

Correlated Color Temperature Color Rendering





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#### **Point Sources**

- Direct sun, incandescent, HID, LED
- Can be easily aimed and focused
- May cast sharp shadows
- They may create interest, sparkle, and emphasis





#### Linear Sources

- Neon, fluorescent, linear skylights, LED
- May provide general ambient light over a large area.
- Tends to minimize contrast and shadow.
- May be used to outline or delineate a shape or space.







Planar lighting in architecture

- Planar sources- diffuse OLED or diffuse skylight
- Light reflected from a diffusing surface.
- Used to fill a space with gentle ambient light casting very soft, or no, shadows







# Poll- Which of these are lighting modifiers?

- A reflector
- The moon
- A wall
- A green candle
- The optic nerve



#### Intensity

 Lumen: Unit of Luminous Flux – a measure of the total light emitted by a light source.

Let's add a directional component and...

- Candela: Luminous intensity per unit solid angle. One candela is one lumen per steradian (lm/sr).
- Candlepower: Luminous intensity expressed in candelas (cd)





**Beam Angle-** The angle at which the light drops 50% from the CBCP\* **Field Angle-** The angle at which the light drops to 10% (not used much)



- Often the Beam is just referred to as "Flood, Spot, or Medium".
- This can be handy for casual conversation, but it is not precise and different manufacturers have different values for the same word.
- So it is best to use degrees, (i.e. 30 degree beam, or 15 degree beam).

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# Lumens, Footcandles & Perception



# Lumens, Footcandles & Perception



#### Definitions

**Protip:** IES RP-16-17 Nomenclature and Definitions for Illuminating Engineering:

https://www.ies.org/standards/ansi-ies-rp-16/



Light source efficacy (Lumens per Watt) for common light sources Efficacy is the ratio of light output to power input

- HPS- 70 145
- MH- 68- 120
  - Pulse Start CMH- 80- 125
- Induction- 48- 75
- Incandescent- 8- 13
  - Halogen- 10- 36(HIR)
- CFL- 50- 80
- Fluorescent- 60-90
- LED-delivered- 50- 175+





#### Efficacy

#### The trends are clear...





Note that this is source efficacy – not luminaire efficiency

#### Rated Lamp Life



#### Rated Lamp Life

50% burn out rate of a large sample on a pre-determined burn cycle.



#### Rated Lamp Life

"The life value assigned to a particular type lamp. This is commonly a statistically determined estimate of average or of median operational life."

#### Other life definitions

- Color shift
- Efficacy reduction
- Lamp starts to cycle
- Lamp becomes unstable
- Probability of failure increases
- Reduced light output
- L70 point at which only 70% of the initial lumens are still being emitted. (Service Life)



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#### Lamp Lumen Depreciation

All light sources lose light output as they age.

- Initial lumens
- Maintained lumens, (or design lumens) which is the light output at 40% of lamp life.



#### Lamp Lumen Depreciation

#### What about Solid State Sources?

- L-70: Time it takes to reach 70% light output.
  - (i.e.L70 at 58,000 hrs.)
- LM-80: IES Standard for measuring lumen maintenance and depreciation in LED sources
- TM-21 reported or calculated lifespan based on LM-80 data

Frequently, an LED "failure," is actually the driver...

	,
Description of LED light source tested (Manufacturer, model, catalog number)	LumiLeds Rebel ES
Sample Size	25
Number of Failures	0
LED Drive Current Used in Test (mA)	1000
Test Duration (Hours)	10,000
Test Duration Used For Projection (Hours)	10,000
Projected Case Temperature (°C)	67
a	1.2275E-06
В	1.0131
Calculated L <sub>70</sub> (Hours)	301,194
Reported L <sub>70</sub> (Hours)	60000

COOPED Lighting





TM-21 limits reported L70 hours to 6 times the LED test data and combines the Luminaire thermal report information with the LED manufactures LM-80 data to provide accurate prediction of lumen maintenance.

- L70 = 70% of initial light output.
- L80 = 80% of the initial light output.
- L90 = 90% of the initial light output.

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# Poll- How is the beam angle of a light source defined?

- A. In degrees.
- B. The angle at which the light from the CBCP drops to 50%.
- C. The angle at which the light from the CBCP drops to 10%.
- D. In foot-candles.
- E. As either Wide, Spot, or Narrow.



#### Color qualities of light



Electric light sources vary widely in their spectral content and should be carefully selected for their color characteristics.

#### **Correlated Color Temperature**

The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source.

Imagine heating a piece of iron that could not melt:

Heat it to ~2700° K it would glow the color of an incandescent lamp.

Heat it to ~5000° K and it's glow would approach the color of sunlight.


#### Describing the color of light – Correlated Color Temperature- Kelvin scale

		<b>1</b>		
	6500	Daylight		
Daylight Fluorescent	5000	Sunlight		
Cool Fluorescent	4100	MH / CMH		
Neutral Fluorescent	3500	LEDs any c	can be almost olor temperature	
Warm Fluorescent	3000	Halogen / CMH		
	2700 2200 1500	Incandescent HPS Candle		
			lighting	de

a b

#### Correlated Color Temperature and Applications

сст	Very Warm	Warm	Neutral	Cool	Daylight	
	2700К	3000K	3500K	4000K	5000K+	
	Incandescent	Halogen	Non-Threatening	Clean	Bright	
	Homey	Friendly		Efficient	Alert	
	Intimate	Inviting		Bright	Color Match	
	Personal	Personal				
Applications	Residential	Hospitality	Offices	Offices	Healthcare	
	Hospitality	Retail	Classrooms	Big Box Retail	Jewelry retail	
	Retail	Restaurants	Retail	Classrooms	Industrial	
	Restaurants	Offices	Fast food	Healthcare		
		Public Spaces	Grocery	Industrial		
		Healthcare	Airport			
		Museums				



CRI (Color Rendering Index)



Scale goes from ~ 0 to 100. Generally, higher is better.

#### Design Issues Color appearance and color contrast





#### High Pressure Sodium CRI- 22

High CRI & white light can be had w/ MH, Plasma, LED,FL, and Induction



Mercury Vapor CRI-15

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LED-CRI- 80

#### Color Spectrum

A red apple primarily reflects red wavelengths and absorbs other colors.





#### **Color Spectrum**

# A red apple primarily reflects red wavelengths and absorbs other colors.











#### Daylighting and View



Daylight can provide at least 5 important functions in buildings.

- Usable light levels for occupants.
- A connection to the outdoors.
- A view corridor allowing the eye muscles to relax.

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San Francisco Public Utilities Headquarters KMD

# Far field vision. Helps the body relax

#### Daylight as a Light Source



Figure 6-11 – Daylight Illumination on Horizontal Surface, San Francisco



Courtesy: Advanced Lighting Guidelines





### Daylight as a Light Source

- Direct sun
- Clear blue sky
- Partly cloudy sky
- Overcast sky

In general, we want to maximize diffuse natural illumination in buildings while rejecting direct sun penetration.

Courtesy: Advanced Lighting Guidelines

#### Daylight Spectrum



#### Daylighting and View



San Francisco Public Utilities Headquarters KMD

Daylight can provide at least 5 important functions in buildings.

- Usable light levels for occupants.
- A connection to the outdoors.
- A view corridor allowing the eye muscles to relax.
- A dynamic and variable workspace.
- A broad spectrum of light stimulation for the human physiology.

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Daylight can have different qualities even at the same moment.

East facing mixed overcast morning.

# Poll- Color Temperature;

- A. Tells how "cool or warm" a light source is.
- B. Tells whether a light is "bluish or yellowish".
- C. Is listed as CRI.
- D. Is listed in Kelvins.
- E. Is dependent on color rendering.

# Electric Light Sources

**Lamp**: a generic term for a source created to produce optical radiation.

A more accurate name for a **light bulb** 



Courtesy: Philips

### Lamp Designations

In the US most lamp types are designated according to: Nominal **Wattage Shape**:

- T Tubular
- G-Globe
- PAR Parabolic Aluminized Reflector
- MR Multi Mirror Reflector

#### Diameter in 1/8" increments

#### F32T<u>8</u>/830

- Fluorescent
- 32 Watts Nominal
- Tubular
- 8/8" = 1" Diameter
- 80+ CRI
- 3000k CCT "warm"



#### Common Lamp Shapes



#### **Three Broad Categories**

# **Electric Lamps**

- **Resistive** (Line voltage and low voltage)
  - . Incandescent
  - Halogen
- Discharge
  - . Fluorescent
  - Metal Halide
  - High Pressure Sodium
  - Low Pressure Sodium
  - Mercury Vapor
- Solid State
  - · LED
  - OLED
  - . Electroluminescent



Puyallup City Library Lighting Designs, Inc.

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#### Incandescent / Halogen:

#### A filament heated to incandescence by an electric current.



#### Fluorescent:

A low-pressure mercury electric-discharge lamp in which a fluorescing coating (phosphor) transforms some of the ultraviolet energy generated by the discharge into light.







## HID: High Intensity Discharge

- Metal Halide
- High Pressure Sodium
- Low Pressure Sodium
- Mercury Vapor
  - Compact arc tube at high temperature & pressure
  - Strike time from 2 to 10 minutes
  - Re-strike cool down period
  - Poor to excellent color properties
  - Behaves as a point source easily controlled, glare prone
  - High lumen packages





#### HID: High Intensity Discharge





REI Denver Flagship Store Mithun







#### **Discharge Source Ballasts**

- All discharge lamps require a ballast to function.
- Ballasts provide:
  - Lamp Starting Voltage
  - Lamp Starting Current
  - Current Regulation
  - Power Regulation

Considerations:

- Most ballasts need to be within 10' of the lamp to operate.
- Fluorescent ballasts may operate 1-4 lamps
- HID lamps generally require 1 ballast per lamp







#### LED – the de facto light source du jour....

- Solid state light source
- Extremely flexible
- Potentially long lamp life
- Dynamic color opportunities
- White light
- Poor to excellent color rendering







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### Architectural Impacts of LED:

- Smaller fixtures
- Better efficacy
- Possibly better color
- More flexibility in control
- Longer lamp life
- Reduced maintenance
- Better optics
- Back to dimming
- Better integration
- Potential confusion



Plymouth Church LMN

#### **LED** Color



A wide range of native colors are available with differing chip chemistry. Efficacy varies widely.



#### White LEDs

- Saturated colors of light are needed for some applications, but for many architectural uses white light is wanted
- Can get "white LED" light by mixing red, green and blue LEDs\*
- Most products use a blue LED (InGaN) with a photo luminescent phosphor (yellow)





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\*Most systems that want high quality white use RGB+A (amber), or RGB+W (white).

#### "White" LEDs

White light LEDs are generally made by taking a blue LED and "doping" it with yellow phosphors

This is similar to white light creation in fluorescent lamps







#### White LEDs

There are two main methods of phosphor color modification

- Remote phosphor
- Chip phosphor









#### PHILIPS LIGHTOLIER



### **LED CCT Descriptions**

# There is little consistency in color descriptions.

Particularly in the higher CCTs

If what you are expecting is like incandescent, (2700 to 3000 Kelvins), then you should be sure to read the CCT and not rely on descriptions.\*

\*What is a "Natural" color? Does "Soft" have a hue? Isn't "Bright" an intensity?





Color Temperature (Kelvin)	2700K – 3000K	3500K - 4100K	5500K - 6500K
Light Color	Warm / Soft White	Cool Bright White	Daylight or Natural



### **Tunable Color**

Relax Mode Sleep Mode		Read Mode	Study Mode
Warm White	Bright White		Daylight
2700K 3000	Ж	4500K	650

#### Color Rendering- Is CRI good enough for LED?



Table 8: CRI Spectra for Décor Products vs Alternative Light Sources																
Light Source	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
Bridgelux Décor	97	97	100	96	96	98	98	99	98	98	99	92	87	98	97	98
Typical Halogen	98	98	99	99	99	98	98	99	97	92	97	98	97	98	99	97
Typical Metal Halide	82	90	94	69	82	81	81	87	71	27	59	62	55	93	78	88
Typical Compact Fluorescent	87	91	93	86	91	89	90	88	70	17	76	91	81	93	92	81

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\*CRI= R average or Ra

**TM-30** IES Method for Evaluating Light Source Color Rendition

Developed as a new possible international standard, drawing from leaves, flowers, skin tones, paints, and some of the original Munsell chips.

Separate fidelity and gamut metrics, and 99 color samples.



Color evaluation samples

#### LED Lamps

Native LED sources come in a staggering variety of shapes and configurations.

# Consumer lamps tend to be cast into familiar shapes.













#### Potential unexpected consequences with retrofits







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University Station

#### **LED** Drivers

Microprocessor switching power supply:

- Voltage (typically 12-24)
- Direct Current
- Power Regulation
- Power Conditioning









Courtesy: Meanwell, Eldoled, Lutron, Jim Benya
#### **Dimming- The Complication**





#### Dimmable CFL & LED bulbs Compatible with C·L. dimmers

List updated March 7, 2014 For the most up-to-date list, visit www.lutron.com/dimcfiled

LED bulbs for Maestro® occupancy sensor C+L dimmers Maestro occupancy sensor C+L: MSCL-OP153M, MSCL-VP153M

Brand	Wattage	Model	Description
Commercial Electric	12.5W	CE-JB6-650L-27K (T67)	6" Downlight, 650 Lumen, Soft White, 2700K
	12.5W	CE-JB4-600L-27K (T47)	4" Downlight, 600 Lumen, Soft White, 2700K
Cooper Lighting	9.4W	RL560WH-R	Halo@ Downlight, 600 Lurnen, Warm White, 3000K
Cree	6W	BA19-045270MF-12DE26-1U100	A19, 450 Lumen, Warm Soft White, 2700K, Medium base
	9W	BA19-080500MF-12DE26-1U100	A19, 800 Lumen, Daylight, 5000K, Medium base
	9.5W	BA19-08027OMF-12DE26-1U100	A19, 800 Lumen, Warm Soft White, 2700K, Medium base
	9.5W	BBR30-06527FLF-12DE26-1U100	BR30, 650 Lumen, Soft White, 2700K
	9.5W	CR4-575L	4" Downlight, 2700K, Medium Base
	9.5W	CR6-575L	6" Downlight, 2700K, Medium Base
	9.5W	CR6-575L-GU24	6" Downlight, 2700K, GU24 Base
EcoSmart	6W	ECS GP19 WW 40WE 120 <sup>+</sup>	A19, 3000K
	7W	ECS 25 40WE W27 120 <sup>+</sup>	G25, Warm White, 2700K
	8W	ECS A19 WW 40WE 1201	A19, 3000K, 450 Lumen
	8W	ECS A19 CW 40WE 120 <sup>†</sup>	A19, 5000K, 480 Lumen
	8W	ECS A19 V1 WW 120	A19, Warm White, 3000K
	8W	ECS A19 V1 CW 120	BR20, Warm White, 2700K
	8W	ECS BR20 50WE W27 120	BR20, Warm White, 2700K
	8W	ECS 19 WW 1201	A19, Warm White, 3000K
	8W	ECS 19 CW 1201	A19, Cool White, 5000K
	8W	ECS 25 WW 120	G25, Warm White, 3000K
	8W	ECS 20 WW FL 50WE 120*	PAR20, 3000K, 450 Lumen
	8W	ECS 20 CW FL 50WE 1201	PAR20, 5000K, 490 Lumen
	8W	ECS 20 WW FL 120	PAR20, Warm White, 3000K
	8W	ECS 20 CW FL 120	PAR20, Daylight, 5000K, 490 Lumen
	9.5W	EOO4-575L	4" Downlight, 2700K, Medium Base
	9.5W	ECO4-575L-50K	4* Downlight, 5000K, Medium Base
	9.5W	ECO4-575L-50K-GU24	4" Downlight, 5000K, GU24 Base

# Dimming Compatibility

1 of 40 pages



## Dimming

Control Protocols include a wide range of options

- Phase cut Triac or SCR line voltage dimmer
- 0-10v- Analog
- Dali- Digital Addressable Lighting Interface
- DMX- Digital communication.
- KNX- Building automation.
- Proprietary flavors



- Do the research upfront to ensure compatibility
- When in doubt ask for samples and test
- When not really in doubt ask for samples and test

# **UTRON**

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#### Flicker

- All light sources can flicker under the right circumstances
- LED sources may be particularly susceptible with low quality drivers or in specific cases.
- This may be ok, *mildly annoying*, *hugely annoying*, or <u>disastrous.</u>
- Do the research upfront to ensure compatibility
- When in doubt ask for samples and test





Courtesy: Lutron, B+H

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#### OLED

An **OLED** (organic light-emitting diode) is a <u>light-emitting diode</u> (LED) in which the <u>emissive electroluminescent</u> layer is a film of <u>organic compound</u> which emits light in response to an electric current.





Courtesy: LG

lab

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- 4"Square OLED Panels
- 3K,35K & 4K
- >80 CRI OLEDs
- T70 Life 18,000 hours
- Dimmable
- ~ 60 lumens/watt

Courtesy: Acuity

#### Light Source or Luminaire?





Courtesy: Insight, Tech Lighting, Philips

### Luminaires

Enough about sources already.....

A **luminaire** is a complete lighting unit, designed to safely hold the light source in space and direct the light in the intended way while providing glare control and shielding the components that are not intended to be seen.

Also known as a light fixture or a light fitting.

Additionally the luminaire needs to be consistent with the overall design scheme of the architecture.



#### Luminaire Components

Electric luminaires generally consist of some or all of the following parts:

- Sources
- Ballasts/drivers
- Reflectors
- Refractors
- Shielding
- Housings

Effective luminaires use the most efficient light source available and appropriate for the use.



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Courtesy: Lightolier

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### Light Distribution

Effective lighting design means putting light where it's wanted and needed, and eliminating light where it's not wanted or needed.

Many lighting quality issues, such as task visibility, direct and reflected glare, and light pollution and trespass have to do with where light is directed and where it is minimized.

> Reebok World Headquarters NBBJ Architects Photo: Assassi



#### Luminaire Distribution

Fundamentally, a luminaire distributes the light from a light source.



PAE/Luma

Microsoft Building 17 Gensler Lighting design lab

#### Reflectors

Reflectors direct light where it is needed and may be used to shield the brightness of the lamp.

Reflecting materials can be matte or specular, metallic or white, hammered or ridged, or a combination of these.



Courtesy: Elliptipar, Alanod

**Specular Reflection** 



Figure 2



Courtesy: IESNA, Alanod

#### **Diffuse Reflection**





Courtesy: IESNA, Alanod

#### Spread Reflection





Courtesy: IESNA

#### **Compound Reflection**



Glighting<sup>ourtes</sup>d<sup>iesNA</sup>sign lab

#### Specular Reflectors



Parabolic





Spherical





Ellipsoidal



Courtesy: Altman, Osram

#### Asymmetric reflectors





#### Shielding and Refracting

Lenses, wave guides, diffusers, baffles, louvers, are used to reduce light emitted toward the user's eyes (glare), redirect light, concentrate light, widen the light pattern, or smooth out the light pattern.

These components may also serve to filter out heat or ultraviolet (UV) or radio frequencies (RF), or to provide safety protection.







#### Transmission



Courtesy: IESNA

Transmission

Diffuse















#### Methods of Light Control

Shielding

70

52°.



### Poll- Reflectors can be:

- A. Specular
- B. Diffuse
- C. Ellipsoidal
- D. Incidental
- E. Asymmetric



#### **Direct Luminaires**

The direct luminaire or "downlight" is a light fixture in which 90 to 100% of the light is directed down to the task surface.





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Microsoft One Cambridge Center SkB

#### **Indirect Luminaires**

The Indirect luminaire or "uplight" is a light fixture in which 90 to 100% of the light is directed upward away from the task surface.



Amgen Helix Campus NBBJ





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Microsoft Building 43 NBBJ

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#### **Indirect Luminaires**







Reebok World Headquarters NBBJ Architects

Courtesy: IESNA, Focal Point

#### Direct and Indirect in the same lobby...



It almost looks like two different buildings.

#### **Direct / Indirect**

The Direct/Indirect luminaire is a light fixture in which light is directed upward away from the task surface, and downward toward the task surface.





UW MEB ZGF Glighting design

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Miller Hull Studio Courtesy: Lara Swimmer

#### **Omni directional**

The Omni directional luminaire is a light fixture in which light is directed uniformly in all directions.





King Street Station Reed + Stem / ZGF

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It is rare to find a truly omni directional fixture

#### Adjustable

The Adjustable luminaire is a light fixture which can rotate and tilt to aim the light in any direction.









REI Denver Mithun

### Accent Lighting





Southberry Library

#### Wall Washing

#### Wall Grazing





Whitelaw Twining Gensler

Accent lighting, wall washing, and wall grazing usually require different types of fixtures in different locations.

Microsoft Building 16 Gensler


#### LINE-VOLTAGE PENDANTS/SUSPENSION

#### Paravo Pendant

#### DESCRIPTION

The Paravo pendant light from Tech Lighting features a precisely molded, ultra-smooth fiberglass shade that is offered in five dramatic colors including vivid tangerine, invigorating mint, deep ocean blue, arctic white and gloss black is encased within a die-cast aluminum exostructure which supports the lower diffusor of frosted plate glass. Together with its 15" diameter, 15" height and fully dimmable LED and incandescent lamping options, each of the high end materials and design elements combine to form a beautiful medium-scale contemporary pendant light fixture perfect for use as kitchen island lighting and dining room lighting as well as countless commercial lighting applications. Includes 53 watt medium base A19 lamp or 19 watt, 1680 delivered lumen, 2700K, medium base LED A21 lamp. Incandescent version dimmable with standard incandescent dimmer. LED version dimmable with LED compatible dimmer.



#### INSTALLATION

This product can mount to either a 4\* square electrical box with round plaster ring or an octagonal electrical box (not included).

#### ACCESSORIES & OPTICAL CONTROLS

Line-voltage Swag Hook

#### WEIGHT

10.7lb / 4.85kg ±



#### ORDERING INFORMATION

700	SYSTEM	PRVP		FINISH			LAMP
	TD LIN	E-VOLTAGE PENDANTS/SUSPENS	ION	US BLUE/S BB GLOSS BB GLOSS WWGLOSS GS MINT/S/ AS TANGEI	ATIN NICKEL BLACKIGLOSS WHIT BLACKIMATTE BLAC WHITEISATIN NICKI VITRI NICKEL RINE/SATIN NICKEL	re K EL	INCANDESCENT 120V -LED927 LED 90 CRI 2700K 120V
			Л		700 F	PRVP	
		TECHLIG	HTING		JOB NAME:		
		7400 Linder Avenue Skokie, Illinois 60077	T 847.410.4400 F 847.410.4500		NOTES:		
		Tech Lighting, L.L.C.					

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### Catalog Cutsheets

# Useful information to be gleaned from cutsheets:

- Appearance & Dimensions
- Specification
- Driver data
- Photometric Report
- Spacing Ratio
- Shielding & Cut-off Angles
- Efficiency





Numerican statistical statistice statiste statistati statistical statistical statistical s	BevelED <sup>2</sup> .1		00	🕂 ADJUSTABLE	3131
	Bevel         Bevel         Bevel         D210           1° Regress         1° Regress         If you want         IS         IS         Bevel         IS         Bevel         IS         Bevel         IS         Bevel         IS         Bevel         IS         Bevel         IS	NA         AlzoF         N/A           N/A         25°         30°           AL10E         N/A         N/A           AL10E         N/A         N/A           AL3E         N/A         N/A           AL3E         N/A         N/A           N/A         AL30F         N/A           N/A         AL30F         AL30F           N/A         AL30F         AL40F           N/A         AL30F         AL30F           Statter         N/A         AS41F           Statter         N/A         AS41F           Statter         Statter         Statter	3131 Housing Si NC Throw CP IC 347V cannot be offered with B	Emergency Solutions EM Integral ERVICE Test Switch 1 gh aperture N/A N/A EM	Remote Inverte lest Switch By Othe X X X X
22% (Plan View)       22% (Plan View)         SPECIFICATIONS         TRIM: 1/V 2 gause aperture with a 1'regressed bevel and 1/2' fange, retained by two mounting clips. Die cast allminum bevel is zelf-flanged and is available in white, ctatuary bronze, black, and metalized grey finiches. Also available in black and cide of clear meta analogica bevel with zelf-finich or with contracting painted flange. Cutom color finages available (in white cas on goin. Frozeide lens with a colfie lens unless celected is an option. Frozeide lens with a colfie lens unless celected is control are metalized grey finiches. Also color finages available (in white ear option. Frozeide lens with a colfie lens unless celected is constant current driver with a high power factor provided dranard and sources 2m.A. Specify 1200 or 2770.       CHLINC CUT OUT: 5-1/16' x 5-1/16' MICLING: SUBJECTION: International protech for lings and provided dranard and sources 2m.A. Specify 1200 or 2770.         TRIM LENS: 25° and 30° trim is chipped with integral zolitie ear option. Frozeide lens politic regulate device is provided with a clear lens.       CHLINC CUT OUT: 5-1/16' x 5-1/16' molecular policy control are with a cling interior provided dranard and sources 2m.A. Specify 1200 or 2770.         REFLECTOR: Interchangeable precision injection moled precision iprovided with a cling interior molecular provided with a cling provided with a cling interior with provided with a cling provided with a cling interior molecular provided with a cling provided with a cling interio	HOUSING INFORMATION New Construction. Universal Style Housing - NC	Plenum (24W and less) - CP ht (24W and less) - IC 7" 114" 7" 114" 13"	Chicago Plenum (33W) IC/Airtight (33W)-IC (Not evailable with E1)	Ight engine)           1000 1000 1000 1000 1000 1000 1000 100	
The Device Devi	22%** (Plan View)         22           SPECIFICATIONS         22           SIME 4-1/2" square appeture with a 1" regressed bevel and 1/2" flange, retained by two mounting clips. Die cast diuminum bevel is zelf-flanged and is available in white, statuary bronze, black, and metalized grey finishes. Also available in black anodized or clear matte anodized bevel with zelf-finish or with contrasting painted flange. Custom color flanges available (growide RALF).           TIMI LEWS: 25° and 30° tim is chipped with integral solite lens. 10° does not come with a colfa lens unless selected as an option. Frosted lens option available for both. 10° wet location is provided with a clear lens.           REFLECTOR: Interchangeable precision injection molded specular polycarbonate reflector optimized for 10°, 25° or 30° beam distribution. Note: 10° optic requires dedicated 10 light engine. 10° is not available with E I light engine.           ADJUSTMENT: True hot aliming with centre beam optics is adjutable, with a completely tool-less mechanism. 0°-40° lockable vertical Hill with 382° lockable rotation.	%* (Plan View) THERMAL MANAGEMENT: Pro aluminum die cast heatzink for n temperatures af ficture location during normal operation. FIELD REPLACEABLE DRIVER: 0 electronic constant current driv provided standard and sources 1 DIMMING OPTIONS: Multiple d See compatibility chart statches be experienced depending on co DIML&A and DIML&E logarithmic use with Lutron control system; DIMLS and DIML& forming driver EMERGENCY: Fictures provided re provided with a 24* lead len test owitch. Fictures that have n connected to an inverter (by oth	22%" (Plan View prietary high performance naximum LED life. Ambient should not exceed 40°C 2-10V, 100%-10% solid state er with a high power factor 2mA. Specify 120V or 277V. I surge protection. Imming drivers available. 4. Some on-time delay may ontrol aystem used. Note: c ontrol are intended for c DIML8B and DIML8F es with non-Lutron controls. rs source 2mA. Unith a remote test switch ght for location of the o USAI EM option may be erail for emergency lighting.	CEILING CUT OUT: 5-1/16" HOUSING: All-Ways Equar Pet. No: US 782,889 houx cquare aperture (up to 20" installation and prior to fini Pabricated of 20 g., galvan J-box, 4 in 4 out at min. 90" circuit winips. IC-rated hou 12W, and 16W light engine. contact with parry foam in rated housing is not availal LISTINGS: Dry/Damp. Wet with B1 tim only. NRTUCE tandards: IBEW union me under Luminaires Specifici Energy Star website for ex- the listing. Please note that are not Energy Star website.	x 5-1/16" «Ф (covered by US ing allows alignment: rotation) after housing ich ceiling installation, ich ceiling installation, icid steal with thru with sings for use with 9W s only are rated for dir ulation of H-42 or les ble with E1 light engin location option avails ulation of H-42 or les ble with E1 light engin location option avails atmodel #s. included the following options et 22KS, 27KH, and 31 hes: B-13, B-21, and A EM antione. EFC/TF
	FIELD REPLACEABLE UICHT ENCINE: Available in 6 lumen packages. Engine is field replaceable through the aperture without tools. See performance chart for precise lumen output information. COLOR: BeveLED 2.1 is available in 5 color temperatures (2200K, 270K, 300K, 350K, 400K). All color options are tightly binned for fitture-to-fitture color consistency within a 2-Step MacAdam Ellipse. 80+ color rendering index provided standard. 90+ CRI available for 2700K and 3000K CCTs. 2200K is not available with Ell light engine. RATED LIFE: Based on IESNA LM80-2008 50,000 hours at 70% lumen maintenance (1/20).	See emergency solutions chart I test switches and servicing. MOUNTING: Butterfly brackets with integral nails provided. Nail 14' to 24' centers. C-channel bar for acoustical celling application MAXIMUM CELLING THICKNESS ACCESSORY HOLDER: Snap in with ficture. 10° accepts TE size lens, maxin 25° accepts TE size lens, maxin	for more information on EM and adjustable nailer bars ler bars are extendible from rs are optionally available ns. SS: As per drawings above. scccssory holder shipped num 2. num 2.	trim styles: Frosted lens an 24 Compliant up to 16W me for exact models included. WARRANTY: 5 years NOTES: • Not for use in corrosive e • Use of pressure washer v PHOTOMETRICS: Consult files. Tested in accordance	d EM option.c CEC/TH ximum. See CEC web:

Lighting

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Revised 03/14/2018

Glighting design

lab

### **Specifications**

#### SPECIFICATIONS

**TRIM:** 4-1/2" square aperture with a 1" regressed bevel and 1/2" flange, retained by two mounting clips. Die cast aluminum bevel is self-flanged and is available in white, statuary bronze, black, and metalized grey finishes. Also available in black anodized or clear matte anodized bevel with self-finish or with contrasting painted flange. Custom color flanges available (provide RAL#).

**TRIM LENS:** 25° and 30° trim is shipped with integral solite lens. 10° does not come with a solite lens unless selected as an option. Frosted lens option available for both. 10° wet location is provided with a clear lens.

**REFLECTOR:** Interchangeable precision injection molded specular polycarbonate reflector optimized for 10°, 25° or 30° beam distribution. Note: 10° optic requires dedicated 10° light engine. 10° is not available with E1 light engine.

**ADJUSTMENT:** True hot aiming with center beam optics is adjustable, with a completely tool-less mechanism. 0°-40° lockable vertical tilt with 362° lockable rotation.

FIELD REPLACEABLE LIGHT ENGINE: Available in 6 lumen packages. Engine is field replaceable through the aperture without tools. See performance chart for precise lumen output information.

**COLOR:** BeveLED 2.1 is available in 5 color temperatures (2200K, 2700K, 3000K, 3500K, 4000K). All color options are tightly binned for fixture-to-fixture color consistency within a 2-Step MacAdam Ellipse. 80+ color rendering index provided standard. 90+ CRI available for 2700K and 3000K CCTs. 2200K is not available with E1 light engine.

**RATED LIFE:** Based on IESNA LM80-2008 50,000 hours at 70% lumen maintenance (L70).

**THERMAL MANAGEMENT:** Proprietary high performance aluminum die cast heatsink for maximum LED life. Ambient temperatures at fixture location should not exceed 40°C during normal operation.

FIELD REPLACEABLE DRIVER: 0-10V, 100%-10% solid state electronic constant current driver with a high power factor provided standard and sources 2mA. Specify 120V or 277V. Driver complies with IEEE C62.41 surge protection. Field state of 20 ga. galvanized steel with thru wi J-box, 4 in 4 out at min. 90°C, #12 AWG thru brand circuit wiring. IC-rated housings for use with 9W,

**DIMMING OPTIONS:** Multiple dimming drivers available. See compatibility chart attached. Some on-time delay may be experienced depending on control system used. Note: DIML6A and DIML6E logarithmic control are intended for use with Lutron control systems; DIML6B and DIML6F linear control are intended for use with non-Lutron controls. DIML15 and DIML6 dimming drivers source 2mA.

**EMERGENCY:** Fixtures provided with a remote test switch are provided with a 24" lead length for location of the test switch. Fixtures that have no USAI EM option may be connected to an inverter (by others) for emergency lighting. See emergency solutions chart for more information on EM test switches and servicing.

**MOUNTING:** Butterfly brackets and adjustable nailer bars with integral nails provided. Nailer bars are extendible from 14" to 24" centers. C-channel bars are optionally available for acoustical ceiling applications.

MAXIMUM CEILING THICKNESS: As per drawings above.

**ACCESSORY HOLDER:** Snap in accessory holder shipped with fixture.

10° accepts "E" size lens, maximum 2. 25° accepts "F" size lens, maximum 2. 30° accepts "F" size lens, maximum 2. CEILING CUT OUT: 5-1/16" x 5-1/16"

**HOUSING:** All-Ways Square® (covered by US Pat. No: US 7,832,889) housing allows alignment of square aperture (up to 20° rotation) after housing installation and prior to finish ceiling installation. Fabricated of 20 ga. galvanized steel with thru wire J-box, 4 in 4 out at min. 90°C, #12 AWG thru branch circuit wiring. IC-rated housings for use with 9W, 12W, and 16W light engines only are rated for direct contact with spray foam insulation of R-42 or less. IC rated housing is not available with E1 light engine.

LISTINGS: Dry/Damp. Wet location option available with B1 trim only. NRTL/CSA-US tested to UL standards. IBEW union made. Energy Star Qualified under Luminaires Specification V2.0. Please see Energy Star website for exact model #s included in the listing. Please note that the following options are not Energy Star qualified: 22KS, 27KH, and 30KH light engines; E1 light engines; B-13, B-21, and AB trim styles; Frosted lens and EM options. CEC/Title 24 Compliant up to 16W maximum. See CEC website for exact models included.

WARRANTY: 5 years NOTES:



Glighting design

Not for use in corrosive environment.
Use of pressure washer voids warranty.

**PHOTOMETRICS:** Consult factory or website for IES files. Tested in accordance with IESNA LM79-2008.

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#### HOW TO SPECIFY

Ordering Example: Specify trim code and housing code to order: Example : 3131W - B1- S - 10 - LSTA4 - 8412 - C3 - 27KS - 25 - NC - 277V - DIML2 - CB27 TRIM ORDERING INFORMATION OPTICAL ACCESSORIES

TRIM	OPT	ION			BEVE	L STYLE					LENS			FLANG	E FINISH			(Order	
3131				-					_				-				AI 10E	separately)	
3131 Square Adjustable 1" Regress	W <sup>1</sup> Wet trims (	Wet locatio only.	t location <sup>1</sup> n, use with B	B1 AB1 AC1	1" Regre Matche 1" Regre 1" Regre	ess Bevel, s Flange I ess Bevel, ess Bevel,	Painted inish Black A Clear M	Die Cast nodized atte Anodized	N No S So F Fro C Cle (use f	o Glass lite (us osted ear for 10°)	(use for 10' e for 25° an	') d 30°	01 0 02 E 10 V 13 S 21 E 28 M RAL 0	Clear Matt Black Ano White Statuary B Black Metalized Custom Co	e (AC Bevel only dized (AB Bevel ronze Grey lor (specify RAL	′) Only) #)	ALIOE ALISE AL30E AL20F AL20F AL30F AL40F AL55F AL80F AS61F	Refer to optic: accessories matrix on next page for resul beamspreads when access lens is combir with 10° and 25° optics	al Clearly specify quantity ting order ory ned
		RING	INFORM	ATION Engi	E	COL OP				uoi		s	ELECT ON	E C		R		ACCESSORIES	
LSTA	4	-	ATTAGE	-	: ] [	COLUN		-	]_			]	VULIAGE	-	UPTIONS	]	- [	AUGESSONIES	
LSTA	4	8409 8412 8416 8424 8433 8436	9W LED 12W LED 16W LED 24W LED 33W LED	C3 E1	22KS 27KS 30KS 35KS 40KS 27KH 30KH 27KS 30KS 35KS 40KS 27KH 30KH	<ul> <li>2200K, 8</li> <li>2700K, 8</li> <li>3000K, 8</li> <li>3500K, 8</li> <li>3500K, 8</li> <li>4000K, 8</li> <li>2700K, 8</li> <li>3000K, 8</li> <li>3000K, 8</li> <li>3000K, 8</li> <li>3000K, 8</li> <li>4000K, 8</li> </ul>	0+ CRI <sup>2</sup> 0+ CRI 0+ CRI	10 10° beam 25 25° beam 30 30° beam	CP IC	New ( all in o Chica Insula Rated	Constructio one go Plenum ition-Conta / Airtight <sup>3</sup>	n, ct	120V 277V 120V	For DIML2 DIML4H DIML6A DIML6B DIML6E DIML6F DIML6 DIML6 DIML7 DIML8 DIML7 DIML8	use with 120V or 10-10V dim, 10% (provided stand Lutron 5 ECO, 5% Lutron H ECO, 1% EdoLED 0-10V, 0.1% Iogarithmic / Lutro EdoLED 0-10V, 1% Inear controls EdoLED 0-10V, 1% controls EdoLED DALL, ( EdoLED DMX, ( r use with 120V or Source A controls Controls	277V dard) (5.6 % Fade <sup>4.6</sup> %, n controls near, 0.1%, 6, n controls %, linear 0.1% 0.1% 5 only e, 1%	CB27 CB52 EML EMLW	27" C-Channel E 52" C-Channel E Emergency bat Emergency bat wet location 7	Bars Bars tery,
		See perfo chart preci lume	ormance t for se n		2 Ste ellips for al	p MacAd se is stand II	am Iard		See solu opti hou	e emerg utions o ions wi isings	gency chart for EN th these	•	347V	DIML19 <u>Fo</u> DIML15	Phase 2-wire d 1% 120V only <sup>4,</sup> r use with 347V i 0-10V dim, 1% 3	imming, <sup>5, 6</sup> only 347 only	-		
		infor	mation.		<sup>2</sup> Not light e	available w engine	vith E1		<sup>3</sup> No light	ot availa t engine	ble with E1	4 5 6	N/A with 9 N/A with 33 N/A with E1	N, 3W I light engir	10		<sup>7</sup> See em for more Not avai	nergency solutions details on EM opt lable with 347V	chart ions.

# **Ordering Codes**

Light	+ Energy	<b>A</b> = 400 lm + 5 (	00w/ft		Descr	intio	n	Performance Summary			Light	t	Ener	gy	Effi	cacy		Co	lor A	ccur	acy			
LISIIC	· chergy	A 400 mm + 5.	0011,11		0050	iptio			Performance :	SUITIT	ary		(Im)		(W)	)	(Im	/W)	(C	RI)	(RS	3)	(SDCM)	
Versio	on	NT1-AA40		4	ft lur	nina	ire		CCT Color	400	10 K		1686	;	19.3	2	87	7.3	82	2.8	10.	1	< 2	
					100% A Lu	% Dn men	, 5		Temperature	350	οк	Г	1712		19.2	2	8	39	83	3.6	11.0	5	< 2	
Repor	rt	1248356		(	CCT 4	000	ĸ			300	)OK		1639		19.1	1	8	86	82	2.6	7.4	1	< 2	
	/		CANDLE	POW	/ER DIS	TRIBU	ITION			LUMEN	SUM	има	RY					L	UMIN	IANCE	DATA	(CD/)	v1²)	
			Vertical Angle	0.	Hor 22.5*	izontal A 45*	ngle 67.5*	50*	Zonal Lumens		z	one	Lumens	San Lam	ρ Fortú	e		v	ertical Angle	0*	45"	90	,	
			0.	393	393	393	393	393			0.	30*	377	NA	22				45*	5479	14960	1416	6	
		AV/	5*	396	405	410	415	417	37		0-	60*	1311	NA	78				55*	5456	14435	920	8	
		- V	75"	384	418	527	618	652	120		0-	901	1585	NA	100				651	5381	10850	513	1	
			25*	360	482	706	850	914	219		90-1	801	0	NA	0				75*	5228	6573	437	7	
		100% Dn	35*	325	548	817	911	911	301		0-1	80*	1586	NA	100				35*	5202	3007	268	9	
	LED	Punan	45'	279	580	763	740	722	332	Editerio - C														
	lightin	a facts <sup>.</sup>	55*	226	544	597	446	381	300															
		Arapatria to the	65*	164	441	331	178	156	220			inter d			71011									
	Light Output (Lun Watte	1616 19.12	75*	58	239	123	88	82	125	CO-EFF	ICIEN	1121	JF UH	LIZA	TION									
	Lunens per Watt	(Efficacy) 87.27	85*	33	45	19	17	17	31	Floor		_	_				2	0					_	
	Color Accuracy	120	30.	0	2	1	1	1		Celling Wall	70	50	0 30 10		70 70 50	10	50	10	50 30	10	50 <sup>10</sup>		1	
	Color Mandeling Index (CM		95"	0	0	0	0	0	0		110	110	110 110		112 112	116		111	106 1	0.5	102 103		0	
	Light Optor	4000 (Bright White)	105*	0	0	0	0	0	0	1	108	103	99 95		105 101	93	97	90	93	88	89 85	8	3	
			115*	0	0	0	0	0	0	z	98	89	82 76		95 88	75	84	74	81	72	78 70	6	8	
	North Dig	n min buigt	1/21	0	0	0	0	0	0	3	89	78	69 63	;	86 76	62	73	61	70	60	6B 59	5	7	
	23008 3000K	4600K 6000K	155	0	0	0	0	0	0	4	81	68	59 52		79 67	52	65	51	62	50	52 43	4	а п	
	All reachs are according to 400 km (Readownics, Teacher or Solid State	(A FACTOR Approved Reduction the Declarat and Laborations The E.S. Department of Energy 2002 resides	1957	0	0	0	0	0	0	6	68	54	45 38		66 53	38	57	38	50	37	48 37	3	5	
	and a second second in		100	0	0	0	0	0	0	7	63	49	40 33		61 48	33	46	33	45	33	44 32	3	0	
	that sees lighting hats	com for the Label Performance Guide.	136+					~	0	В	58	44	35 29	)	57 44	29	42	29	41	29	40 29	2	7	
	Repairies Randor U.M. May Volationale W11, 20104(311)	10-03030-804	100	0	0	0	0		0	9	54	40	32 26		53 40	26	39	26	37	26	36 26	2	4	
	Car Carrier Card		190.	0	U	0	0	0		10	51	37	19 11		ag ap	21	15	21	34 .	21	34 23		1	

Photometric Data

Integrating Sphere and Photometric results at 4000K B lumens, by an independent accredited testing laboratory per IES LM-79-2008 and ANSI C78.377-2011. Results for 3000K, 3500K scaled based on integrating sphere results of NB1-B. Candlepower Distribution scaled per total lumens of Integrating Sphere results.

### Candela Distribution

# Candela distribution curves are normally represented in polar form with the luminaire at the center.



100% Dis







# Industry testing equipment



### **Integrating Sphere- Lumens**

Goniophotometer - Distribution

# How much light will I get? What is the efficacy?

LED Damp Rated High Bay



# JCBL

9000, 12000, 15000, 18000, 24000, or 30000 lumens

C.E.C. TITLE **20** 

COMPLIANT







#### JCBL LED Damp Rated High Bay

**OPERATIONAL DATA** 

Lumen package	Input Watts	Ambient rating	Open Reflector	Delivered lumens 3000K CCT, 70CRI	Delivered lumens 3500K CCT, 70CRI	Delivered lumens 4000K CCT, 70CRI	Delivered lumens 5000K (CT, 70CR)	Delivered lumens 3000K (CT, 80CR)	Delivered Jumens 3500K (CCT, 80CRI	Delivered lumens 4000K (CT, 80CR)	Delivered lumens soooK CCT, soCRI	Delivered lumens 3000K (CCT, 90CR)	Delivered Jumens 3500K (CT, 90CR)	Delivered lumens 4000K CCT, 90CRI	Delivere Jumens Social (C 90CR)
_			DALR	25277	25933	26708	26708	23847	24562	25039	25516	19554	20270	20985	20985
			DALRN	24084	24766	25448	25448	22721	23403	23857	24312	18631	19313	19995	19995
			SAIR	25512	26234	26957	26957	24068	24790	25272	25753	19736	20458	21180	21180
		1 400 400	ACER	27763	28549	29334	29334	26192	26977	27501	28025	21477	22263	23049	23049
MJ0000	236	1229 (50%)	ACEEN	27483	28261	29038	29038	25927	26705	27224	27742	21260	22038	22816	22816
			ACCR	27853	28642	29430	29430	26277	27065	27591	28116	21547	22335	23124	2312
			ACCEN	26928	27691	28453	28453	25404	26166	26674	27183	20831	21594	22356	2235
			PLCR	25509	26231	26953	26953	24065	24787	25269	25750	19734	20456	21178	2117
			PLCRN	24684	25383	26081	26081	23287	23985	20051	24917	19095	19794	20492	2049
			DALR	20468	21047	21626	21262	19309	19888	20275	20661	15833	16413	16992	1689
			DALKN	19502	20053	20605	20605	18398	18950	19318	19686	15086	15638	16190	1619
			SALK	20658	21243	21827	21827	19489	20073	20463	20853	15981	16565	17150	1715
M Income	100	(-40°F-40°C)	ALTE	22980	23116	23/53	23/53	21208	21894	22268	22692	1/290	18027	18665	1866
NOOD	188	122°F (50°c)	ALHO	11253	22583	23513	23513	20996	21264	22043	22963	1/215	1/845	184/4	189/
			ACON	22303	23172	23030	23600	20277	21715	22391	22030	1/99/	12/00	10729	10/2
			8.00	21004	22922	23037	23657	10496	21107	21077	22010	10000	1/960	10102	1714
			PICEN	19987	20552	21112	21118	19956	19471	19798	20176	15462	1607	10093	1609
			DNIP	15606	16049	16490	16490	14723	15165	16459	16763	12073	13514	12956	1796
			DAIRN	14870	15290	15711	15711	14028	14449	14779	15010	115/8	11924	12345	1234
			SALE	15751	16797	16643	166453	14860	15306	15403	15900	17185	13631	13077	1307
			ACFR	17141	17626	18111	18111	16171	16656	16979	17303	13260	13745	14230	1423
M.Jocost	140	(-40°F-40°C)	ACERN	16968	17448	17928	17928	16007	16488	16808	17128	13126	13606	14086	1408
		135% (55%)	ACCR	17197	17683	18170	18170	16223	16710	17034	17359	13303	13790	14276	1427
			ACCRN	16626	17096	17567	17567	15684	16155	16489	16782	12861	13332	13802	1380
			PLCR	15749	16195	16641	16641	14858	15304	15601	15898	12184	12629	13075	1307
			PLORN	15240	15671	16102	16102	14377	14808	15096	15384	11789	12221	12652	1265
			DALR	13296	13672	14048	14048	12548	12919	13170	13421	10285	10662	11038	1103
			DALRN	12668	13027	13385	13385	11951	12310	12549	12788	9800	10158	10517	1051
			SALR	13419	13799	14179	14179	12660	13040	13293	13546	10381	10761	11141	1114
			ACIR	14603	15016	15430	15430	13777	14190	14465	14741	11297	11710	12123	1212
ISOCOLM	117	(-40%-40%) 135°E(55%)	ACEEN	14456	14865	15274	15274	13638	14047	14319	14592	11183	11592	12001	1200
		121020	ACCR	14651	15065	15480	15480	13821	14236	14513	14789	11334	11748	12163	1216
			ACCEN	14164	14565	14966	14966	13362	13763	14031	14298	10957	11358	11759	1175
			PLCR	13418	13798	14177	14077	12658	13088	13291	13544	10380	10760	11139	1113
			PLCRN	12984	13351	13719	13719	12249	12616	12861	13106	10044	10411	10779	1077
			DALR	10221	10510	10799	10799	9642	9932	10124	10317	7907	8196	8485	8485
			DALRN	9738	10014	10290	10290	9187	9463	9647	9830	7534	7809	8085	8085
			SALR	10316	10608	10900	10900	9732	10024	10219	10413	7980	8272	8564	8564
		( and with)	ACFR	11226	11544	11861	11861	10591	10908	11120	11332	8684	9002	9320	9320
12000LM	90	(-40%-40%) 135% (55%)	ACFRN	11113	11427	11742	11742	10484	10798	11008	11217	8597	8911	9226	9226
			ACCR	11263	11581	11900	11900	10625	10944	11156	11369	8713	9031	9350	9350
			ACCRN	10889	11197	11505	11505	10272	10580	10786	10991	8423	8731	9040	9040
			PLOR	10315	10607	10899	10899	9731	10023	10217	10412	7979	8271	863	8563
			PLCRN	9981	10263	10546	10546	9416	9698	9887	10075	7721	8004	8286	8286
			DALR	8007	8233	8460	8460	7553	7780	7931	8082	6194	6420	6647	6641
			DALRN	7629	7845	8061	8061	7197	7413	7557	7701	5901	6117	6333	6333
			SALR	8081	8310	8539	8539	7624	7852	8005	8157	6251	6480	6709	6705
		(40%-40%)	ACFR	8794	9043	9292	9292	8296	8545	8711	8877	6803	7052	7301	7301
9000LM	67	135¶ (55%)	ALHIN	8705	8952	9198	9198	8212	8459	8623	8787	6734	6981	7227	712
			ALCR	8823	9072	9322	9322	8323	8573	8739	8906	6825	7075	7324	732
			ACRN	8530	8771	9012	9012	8047	8288	8449	8610	6598	6840	7081	708
			PLOR	8080	8309	8538	8538	7623	7851	8004	8156	6251	6479	6708	6708
			PLERN	7819	8040	8261	8261	7376	7597	7745	7892	6048	6270	6491	649

b

## So many options so many variables

ORDERIN	G INFORMATION	d times will vary depending on opt	ions selected. Consult with your sales represe	ntative. Exa	mple: JCBL 24000	LM SALR MVOLT G	Z10 40K 70CRI SC6
JCBL					GZ10		
Series	Lumens	Reflector <sup>1</sup>	Lens <sup>1,2</sup>	Voltage	Driver	Color temperature	Color rendering index
JCBL	9000LM         9,000 lumens           12000LM         12,000 lumens           15000LM         15,000 lumens           18000LM         18,000 lumens           24000LM         24,000 lumens           30000LM         30,000 lumens	DALR       Diffuse aluminum         DALRN       Diffuse aluminum         narrow       SALR         SALR       Specular aluminum         ACFR       Frosted acrylic         ACCR       Clear acrylic         PLCR       Clear polycarbonate	(blank)Open bottomFor use with aluminum reflectorsALDRPDrop prismaticALCONConicalALFGLFlat prismaticFor use with acrylic and polycarbonate reflectorsACRDRPDrop prismaticACRCONConicalACRCONConicalACRFGLFlat prismatic	MVOLT         120-277V           HVOLT         347-480V           120         120V           208         208V           240         240V           277         277V           347         347V           480         480V	GZ10 0-10V dimming	30K 3000 K 35K 3500 K 40K 4000 K 50K 5000 K	70CRI 70 CRI 80CRI 80 CRI 90CRI 90 CRI

#### OPERATIONAL DATA

Lumen package	input Watts	Ambient rating	Open Reflector	Delivered Iumens 3000K CCT, 70CRI	Delivered lumens 3500K CCT, 70CRI	Delivered lumens 4000K CCT, 70CRI	Delivered Iumens 5000K CCT, 70CRI	Delivered Iumens 3000K CCT, 80CRI	Delivered lumens 3500K CCT, 80CRI	Delivered lumens 4000K CCT, 80CRI	Delivered lumens 5000K CCT, 80CRI	Delivered lumens 3000K CCT, 90CRI	Delivered lumens 3500K CCT, 90CRI	Delivered lumens 4000K CCT, 90CRI	Delivered lumens 5000K CCT, 90CRI	Comparab light sour
			DALR	25277	25933	26708	26708	23847	24562	25039	25516	19554	20270	20985	20985	
			DALRN	24084	24766	25448	25448	22721	23403	23857	24312	18631	19313	19995	19995	
			SALR	25512	26234	26957	26957	24068	24790	25272	25753	19736	20458	21180	21180	]
		1	ACFR	27763	28549	29334	29334	26192	26977	27501	28025	21477	22263	23049	23049	
30000LM	236	(-40°F-40°C) 122°F (50°c)	ACFRN	27483	28261	29038	29038	25927	26705	27224	27742	21260	22038	22816	22816	8-lamp 15H 400W HI
	1	1221 (50 0)	ACCR	27853	28642	29430	29430	26277	27065	27591	28116	21547	22335	23124	23124	
			ACCRN	26928	27691	28453	28453	25404	26166	26674	27183	20831	21594	22356	22356	]
			PLCR	25509	26231	26953	26953	24065	24787	25269	25750	19734	20456	21178	21178	]
			PLCRN	24684	25383	26081	26081	23287	23985	24451	24917	19095	19794	20492	20492	

Wattage Lumens Reflector Optics Lens CCT CRI

	4K, 70CRI	3K, 90CRI
30,000 nominal lumens. 236 watts.	125 l/w	80 l/w

### Luminaire Efficiency

The efficiency of a luminaire is expressed as the ratio of lumens emitted by the luminaire to those generated by lamp or lamps used therein.

	BeveLED 2.1	9 W	atts	12 W	/atts	16 W	/atts	24 W	/atts	33 Watts		36 Watts	
	ADJUSTABLE		90+		90+		90+		90+		90+		90+
		80+	HIGH	80+	HIGH	80+	HIGH	80+	HIGH	80+	HIGH	80+	HIGH
	Color Rendering Index	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI	CRI
25°/30°	Lumens per Watt	95	74	81	64	81	64	75	59	64	53	89	69
Performance	Source Lumens	1150	900	1300	1025	1725	1350	2400	1875	3025	2350	4150	3250
Data	Delivered Lumens	850	675	975	750	1300	1025	1800	1400	2250	1750	3000	2350
10°	Lumens per Watt	116	91	99	76	99	77	92	72	81	65		
Performance	Source Lumens	1150	900	1300	1025	1725	1350	2400	1875	3025	2350		
Data	Delivered Lumens	1050	825	1175	925	1575	1225	2200	1700	2750	2150		
	Color Consistency					2-Ste	ep Mac/	Adam El	lipse				

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### DELIVERED PERFORMANCE

Note: 25°/30° data includes solite glass lens. 10° data does not include lens.

CCT MULTIPLIER	2200K	270	OK	300	OK	3500K	4000K
Color Rendering Index	80+ CRI	80+ CRI	90+ HIGH CRI	80+ CRI	90+ HIGH CRI	80+ CRI	80+ CRI
Multiplier for Lumen Output	0.72	0.94	0.78	1.00	.78	1.00	1.06

90+ CRI is not available for 2200K, 3500K, or 4000K

## What is the LED equivalent in delivered lumens?







**CFL fixture**: 83-watt w/ 4-1800 lumen lamps= 7,200 total lumens. LED-A: 24-watt w/ 2558 lumens

LED-B: 22-watt w/ 1898 lumens



# CFL fixture efficiency – 37%

	General Label CM1732-4QF26	Defaults.	Pole or Pendant Mounted     Oynamic: Attach to Z=     O     Static: Length =
	Definition         Number Of Lamps         4           Luminaire Lumens         2660         Efficiency (%)         37           Luminaire Watts         83         S/P Ratio         1           Total LLF         1.000         Specify         1           Luminous Box:         LLHC         -0.705         -0.25         0.25	Arrangement	Symbols  CIRCLE DOWN LS  Fixel
	Photometric File           Description         Classification         LCS		Candela C LCS
After the luminaire efficiency of 37% is applied to the 7200 lamp lumens then the luminaire lumens= <b>2660</b>	Filename: C:\Users\strande\Desktop\Documents\class presentations\CFL [TEST] 08017 [TESTLAB] LUMINAIRE TESTING LABORATORY, INC. [ISSUEDATE] 04-12-2004 [MANUFAC] VISA LIGHTING [LUMCAT] CM1732 [LUMINAIRE] FORMED ALUMINUM HOUSING, FORMED WHITE ENAM [LAMPCAT] GE F26DBX/SPX35/4P [LAMP] FOUR HORIZONTAL 26 WATT DOUBLE TUBE COMPACT FLUC [BALLAST] TWO AC ELECTRONICS TP2/26RS UV [LESNA-1 M-63-2002		
		· ·	More

## What is the LED equivalent in delivered lumens?







**CFL fixture**: 83-watt w/ 4-1800 lumen lamps= <del>7,200</del> total lumens.

After the luminaire efficiency of 37% is applied to the 7200 lamp lumens then the luminaire lumens= **2660** 

LED-A: 24-watt w/ 2558 lumens

LED-B: 22-watt w/ 1898 lumens



# LED A lists "source lumens"



We don't know what the luminaire efficiency is.

#### LED PERFORMANCE - 3500K STANDARD

120-277V - 3500K, 82 CRI - L80 rating - 60,000 hrs - L70 rating (projected) - 100,000 hrs Amperage rated @ 110V input Operating ambient temperature: -20°C / -4°F - 40°C / 104°F

Standard 3500K source lumens noted. Consult Brownlee.com for performance of all CCTs. B6LED - 6W nominal, .05 A input - 698 lm - 114 lm/W B12LED - 12W nominal, .10 A input - 1422 lm - 120 lm/W C9LED - 9W nominal, .10 A input - 1072 lm - 122 lm/W C17LED - 17W nominal, .15 A input - 1829 lm - 111 lm/W C24LED - 24W nominal, .20 A input - 2558 lm - 107 lm/W C37LED - 37W nominal, .30 A input - 3837 lm - 104 lm/W C49LED - 49W nominal, .40 A input - 5116 lm - 107 lm/W

# LED B lists "delivered lumens"



Performanc	е
Input Wattage	21.8
Input Voltage Range (V)	120
Delivered Lumens (Im)	1898
Efficacy (Im/W)	87.0
Color Rendering Index (CRI)	80
Color Temperature (CCT)	3000
Equivalent Wattage	100W Inc.
Beam Angle	0
Power Factor	0.00
MAX THD (%)	0
Min. Ambient Temp (°F)	0
Max. Ambient Temp (°F)	104

# Luminaire lumens or Delivered lumens are derived from **absolute photometry**\*



# Poll- Luminaire efficiency is:

- A. Not always relevant with LED fixtures.
- B. Dependent on CCT.
- C. Varies depending on components.
- D. Is Measured in Foot-Candles
- E. The % of light out of the fixture relative to the light from the source.

# Is this an effective solution?



# Is this an effective solution?



- Will the distribution of the fixture put light where I want it?
- What light source does it take
- Will that source do what is intended
- Is the LED source replaceable
- Is the overall size compatible
- Will the controls be compatible
- Are there equivalent vendors
- Constructability issues?





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Is the frame durable enough

- steel, brass, aluminum, plastic, 'pot metal', cast, stamped
- Is the finish durable enough
- lacquered, painted, 'raw', UV stabilized

### Is the lens durable enough

- glass, styrene, acrylic, paper, mica, alabaster, UV stabilized





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Are there any special power requirements

Low voltage, 277-volt, remote transformer / driver

Does the fixture have any built-in electrical components

- driver, transformer, photo-cell, motion sensor, batteries, switch

Is the fixture on any recognized Lists

DLC, Energy Star

Are there any issues with driver compatibility







Is the fixture from a reputable manufacturer

• UL listed, factory address available, spare parts

Warranty

- Are you expecting a 5- or 10-year warranty to be honored by a 2-year-old company?
   Why is it priced the way it is
- Are there any hidden costs
- Expensive parts, hard to maintain



### WARRANTY LED ENGINES

TERRALUX warrants to the original buyer only each LED Module and Engine to be free from defects in materials and workmanship for the Warranty Period listed below, starting from the date of shipment to the original buyer. The LED arrays used in these products will only be considered defective when 10% or more of the LED's fail to illuminate. Upon any failure of a product to comply with this warranty, TERRALUX's sole obligation, and buyer's sole remedy, is to refund the purchase price or repair or replace the unit and return it to the original buyer, freight prepaid. This express limited warranty is subject to the terms and conditions outlined below.

TERRALUX product	Part Number	Warranty Period #
Low Voltage MR-16 Engine	TLM-R16B, TLM-16C, TLM-R16L	60 months / 5 years
Line Voltage Linear LED Engine	TLM-L04, TLM-L06, TLM-L08	60 months / 5 years
DLR7-H LED Downlight Retrofit	TLK-DLR7H	60 months / 5 years
DLR6-H LED Downlight Retrofit	TLK-DLR6H	60 months / 5 years
D <sub>R</sub> Downlight Retrofit Products	TLK-DR6A,DR8A,DR10A,DR88A,DRVA	120 months / 10 years
D Downlight Fixtures	TLF-D6A,D8A,DV6A,DV8A,D10A,D88A,DVA	120 months / 10 years
MR16 LED Trackhead	TRK-R16C1	60 months / 5 years
Decorative MR16 LED Lamp	TLL-R16A	36 months / 3 years
S <sub>R</sub> Surface Mount Engines	TLM-D08A, TLM-SR95A, TLM-D12A	84 months / 7 years
LED Recessed Downlight	TLF-DLSQ8	120 months / 10 years
LED Recessed Retrofit Kit	TLK-DLSQ8	120 months / 10 years
Line Voltage Spot Engine	TLM-R20A	60 months / 5 years
Wall Sconces	TLF-WSC118	60 months / 5 years
Flush Mount Ceiling Fixtures	TLF-CFA14, CFB14	60 months / 5 years
Stairwell Fixture	TLF-SL12, SL24, SL48	120 months / 10 years

### Are there environmental factors to consider

• Temperature sensitive components, proper ventilation, dirt, gasketing

### Is the fixture rated for the location it will be installed

• insulation contact, wet location, flammable vapors, local codes



Canyon Ranch Spa Club RTKL / HKS



Photo courtesy of BP.com



### Architectural Integration

- Integrated into the architecture
- Unobtrusive
- Visible but minimal in appearance so that they don't call attention to themselves
- Noticeable and responsive to the style of the space



Plymouth Church lighting de<sup>N</sup>sign lab

# Poll- The most effective luminaire:

- A. Is energy efficient.
- B. Has appropriate color qualities.
- C. Puts light where it is needed.
- D. Has low operating costs.
- E. Is controllable.
- F. All of the above.



# **Thank You!**



# And now – a few words from LDL



# Upcoming LDL Online Events

LDL Course	<b>Delivery Date</b>	Time
Cost-Effective Code Compliance: Building Envelope	Sept 14	10:00 - Noon
Heat Pump Water Heaters – Why and How – Part 1	Sept 15	10:00 - 11:00
Heat Pump Water Heaters – Why and How – Part 2	Sept 16	10:00 - 11:00
Cost-Effective Code Compliance: Lighting	Sept 21	10am – Noon
Cost-Effective Code Compliance: HVAC	Sept 28	10am - Noon

Today's slide deck and previous online courses can be found on our <u>website</u>

# **Click – Call – Connect**

- Eric Strandberg
  - ▶ 206-817-7142
  - eric.strandberg@seattle.gov





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# We'll SEE you on the next call... ©