



# Lighting Design Lab



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# Lighting Design Lab



**5**  
**MINUTES**  
**TILL CLASS BEGINS**

2



## Lighting Design Lab



# 3

**MINUTES  
TILL CLASS BEGINS**

3




## Lighting Design Lab




# 1

**MINUTE  
TILL CLASS BEGINS**

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# Lighting Design Lab



Basic Lamp Technologies

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WASHINGTON STATE  
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EXTENSION  
ENERGY PROGRAM



**South Seattle**  
Community College



BONNEVILLE  
POWER ADMINISTRATION



**BETTERBRICKS**  
Bottom line thinking on energy.



**BC Hydro**  
FOR GENERATIONS



## Our Goal

To Promote Energy Efficiency and Quality Design Thru:

Education

Consultations

Industry Alliances



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## Education

### Classes

*Variety of topics held throughout the Northwest (WA, OR, ID, MT)*

*Additional classes as requested*

### Tours

*Color Boxes*

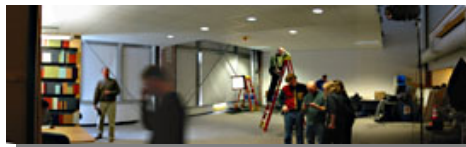
*Lamp Technologies*

*Lighting Vignettes: displays in a real world environment*




### Demonstrations

*Full scale Mock-up Facility*



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# Education



## Website and Newsletter

- *Commercial Lighting Guides (6 now available, 2 more soon)*
- *Downloads of previous lighting presentations*
- *Links to allied sites*
- *Lighting articles*
- *Codes and Standards downloads*


»

## Library

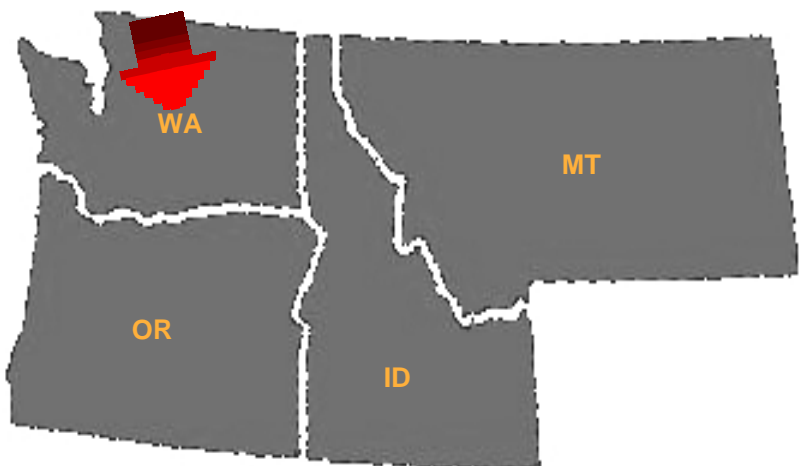
- *Manufacturers catalogs*
- *Full IES library*
- *Text and reference materials*

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# Consultations



Project or specifier must be in the region

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## LDL Outdoor Lighting Center

### Lighting Design Lab Outdoor Lighting Center at South Seattle Community College Seattle, WA

Three adjustable height towers spaced 150' apart with 3 fixture capability on each tower




## CONTENT OUTLINE

### Common Characteristics

- » *Color*
  - » Correlated Color Temperature (CCT)
  - » Color Rendering Index (CRI)
  - » Spectral Power Distribution (SPD)
- » *Metrics*
  - » Lumens
  - » Illuminance
  - » Light Distribution
  - » Shape and Size
  - » Maximum Overall Length (M.O.L.)
  - » Candelas
  - » Luminance
  - » Efficacy (LPW)
  - » Lamp Lumen Depreciation (LLD)
  - » Average Rated Life

### Lamp Families


- » *Incandescent*
- » *Fluorescent*
- » *High Intensity Discharge (HID)*
- » *L.E.D.*
- » *Neon*
- » *Cold Cathode*
- » *Electroluminescent*
- » *Fiber Optic*



# COMMON CHARACTERISTICS

Lumens  
 Correlated Color Temperature  
 Efficacy  
 Rated Life  
 Photometrics  
 Beam spread  
 Depreciation  
 Wattage  
 Illuminance  
 Exitance  
 Distribution  
 Spectral Power  
 Color Rendering Index  
 Spectral Power

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# COLOR

Electromagnetic Spectrum




Wavelength in Nanometers

$1 \times 10^8$   $1 \times 10^7$  0.1 10 1000  $1 \times 10^5$   $1 \times 10^7$   $1 \times 10^9$   $1 \times 10^{11}$   $1 \times 10^{13}$   $1 \times 10^{16}$

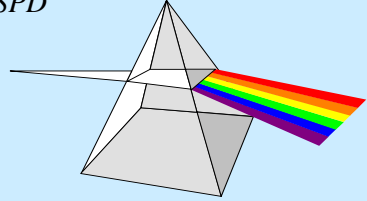
Cosmic Rays    Gamma Rays    X-Rays    Ultra Violet    Infrared    Radio    Microwave    Infrared Heating

Bactericidal Erythral    "Black Light"    Infrared Lamp    Incandescent Coil Heater    Steam Radiator

250 300 350 400 450 500 550 600 650 700 750 1,000 1,500 2,000 3,000 4,000 5,000 NM

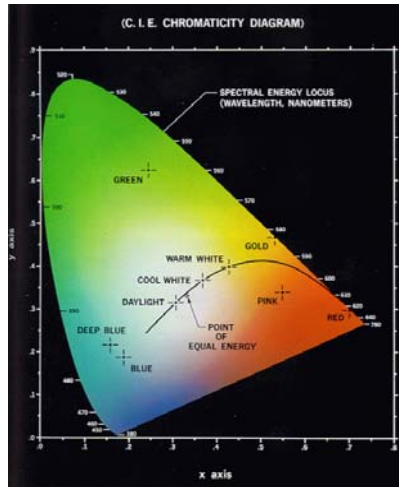
- » **Correlated Color Temperature**
  - » *CCT*
- » **Color Rendering Index**
  - » *CRI*
- » **Spectral Power Distribution**
  - » *SPD*



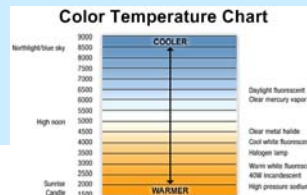
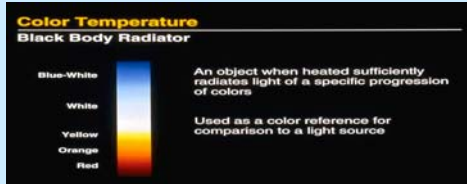
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# Correlated Color Temperature (CCT)



- » A way of measuring the 'Apparent' warmth or coolness of a source.
- » Expressed in degrees *Kelvin*, ( $^{\circ}\text{K}$ ).



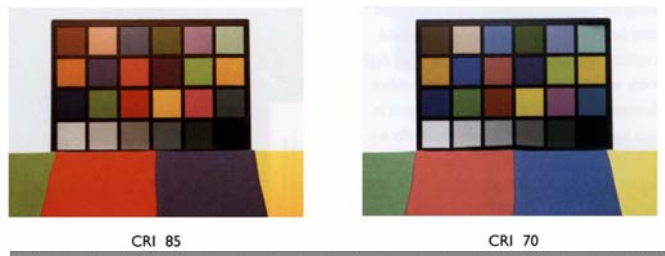
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# Color Rendering Index (CRI)



- » Ability of a source to accurately render surface colors relative to a reference source.
- » The scale ranges from 0 – 100
- » Color Temperature, (CCT), and Color Rendering, (CRI), are NOT related.

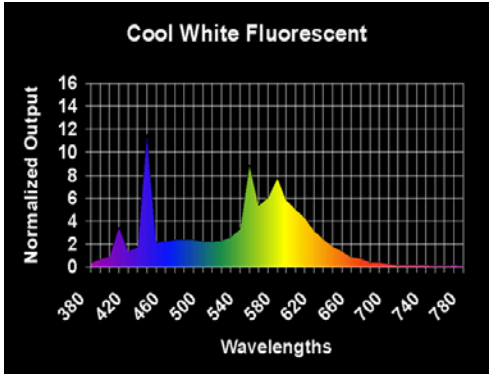


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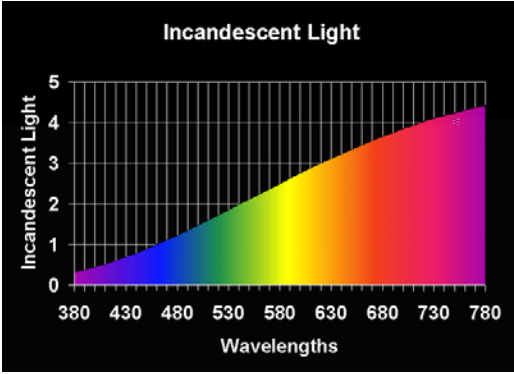


# Spectral Power (SPD)

Lighting Design Inc



NOTE: Eye most sensitive in yellow-green range.



NOTE: Continuous curve

# METRICS

Lighting Design Inc

- » Lumens
- » Illuminance (fc)
- » Candelas (cd)
- » Luminance
- » Exitance
- » Beam Spread
- » Shapes & Sizes
- » Maximum Overall Length (M.O.L.)
- » Efficacy (LPW)
- » Depreciation (LLD)
- » Average Rated Life

Total Luminaire Efficiency 56%  
 0% Uplight 100% Downlight  
 Spacing Criteria  
 Lateral Plane 0 90  
 1.1 1.2  
 TOTAL LAMP LUMENS = 29000  
 INPUT WATTS = 31

**Candela Distribution**

Vertical Angle	0	45	90	Zone Lumens
0	15001	10001	15001	0
15	994	1000	1012	85.7
30	627	1000	1028	282.9
45	335	939	971	426.8
60	198	778	802	464.9
75	110	470	410	588.4
90	66	39	21	51.2
105	0	0	0	0
120	0	0	0	0
135	0	0	0	0
150	0	0	0	0

**Luminance Data in Candela / Sq. Meter**

Angle in Vertical	Average 0	Average 45	Average 90
45	3847	3351	1375
60	981	580	212
75	27	34	62
90	11	11	11
105	0	0	33

**Coefficients of Utilization**

Effective Floor Cavity Reflectance = 20%	0.7	0.5	0.3	0.1
0	0.8	0.7	0.5	0.1
1	0.7	0.5	0.3	0.1
2	0.6	0.4	0.2	0.1
3	0.5	0.3	0.1	0.1
4	0.4	0.2	0.1	0.1
5	0.3	0.1	0.1	0.1
6	0.2	0.1	0.1	0.1
7	0.1	0.1	0.1	0.1
8	0.1	0.1	0.1	0.1
9	0.1	0.1	0.1	0.1

Figure 17. A typical photometric report showing the luminance summary table.



# Lumens

## Luminous Flux

- » The total light output from any source, in all directions.
- » Lumens don't diminish w/distance
- » Listed in catalogs two ways:
  - » *Initial: After 100 hrs. of lamp life*
  - » *Mean: At 40% of lamp life.*
- » Lumens are a property of the light source, **NOT** the surface/object being lit.



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# Illuminance

## Luminous Intensity

- » Measured in footcandles, (fc)
- » The amount of light striking a surface.
- » Expressed as Lumens per square foot, (or meters).
- » Illuminance is **NOT** a property of the source alone:
  - » *Lumens of the source*
  - » *Distance from the surface*
  - » *Relative darkness/lightness of the immediate surrounding surfaces*



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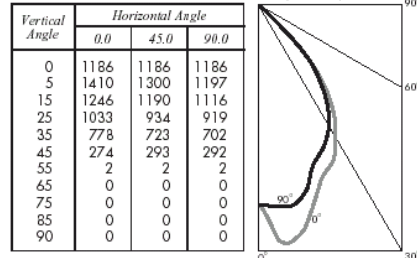
# Candelas

## Luminous Intensity

- » The intensity of a source in a particular direction.
- » Used primarily to quantify point sources, (CBCP\*).
- » Candelas also are a property of the source, *NOT* the surface/object being lit.

\* Center Beam Candle Power

**CANDLEPOWER DISTRIBUTION** (Candela)



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# Luminance

- » Amount of light directionally reflected from a surface.
- » Expressed in units of intensity per area, as candelas per sq. ft. (or meter).
- » Metric can be used on any surface.
- » Closest means of quantifying the idea of brightness.



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# Exitance

## Luminous Exitance

- » Expressed in Lumens per sq. ft. (or meter), the same as Illuminance.
- » Defines the amount of light per area 'emitted', by the lit surface/object.
- » This metric primarily used on matte, or diffuse surfaces.



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# Beam Spread (Distribution)

## Beam Angle

- » Angle at which light drops to 50% of CBCP value.

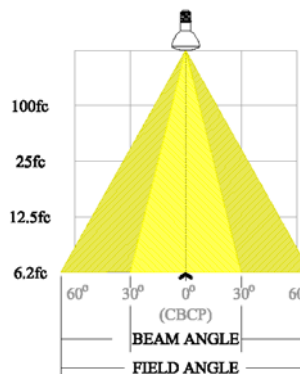
## Field Angle

- » Angle at which light drops to 10% of CBCP value.


## **CBCP**

- » Center Beam Candle Power

NOTE: Applies to 'Directional' lamps only.



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# Shapes & Sizes



A19 standard lamp

Inches, Eighths


PAR 38 medium side prong base lamp

## Nomenclature

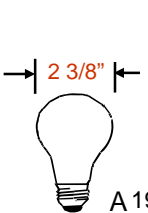
- » **A19: 'Arbitrary' Shape**  
(19) - 1/8<sup>th</sup>. inches in **Diameter**
- » **PAR38: Parabolic Aluminized Reflector**  
(38) - 1/8<sup>th</sup>. inches in **Diameter**

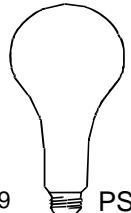
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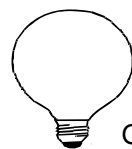
# Shapes & Sizes



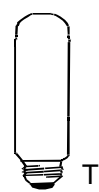
A19  
ARBITRARY



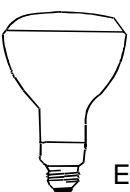
PS  
PEAR SHAPED



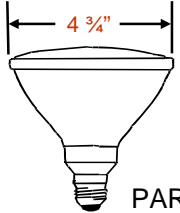
G  
GLOBULAR



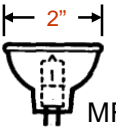
T  
TUBULAR




ER  
ELLIPTICAL REFLECTOR



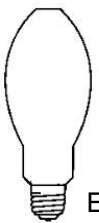
PAR 38  
PARABOLIC ALUMINIZED REFLECTOR



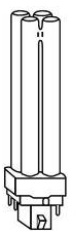
MR 16  
MULTI-FACETED REFLECTOR



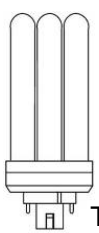
T



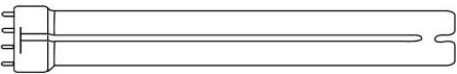
ED



Quad



Triple



Biax

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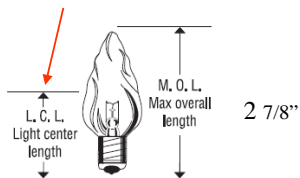


# Maximum Overall Length

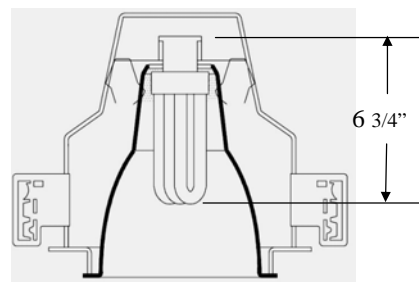
## Maximum Overall Length (M.O.L.)

- » Important when designing optical package
- » Reflectors engineered to take advantage of a lamp's shape and length
- » Any other size, shape, or M.O.L. would alter distribution for the worse

Also important in reflector design



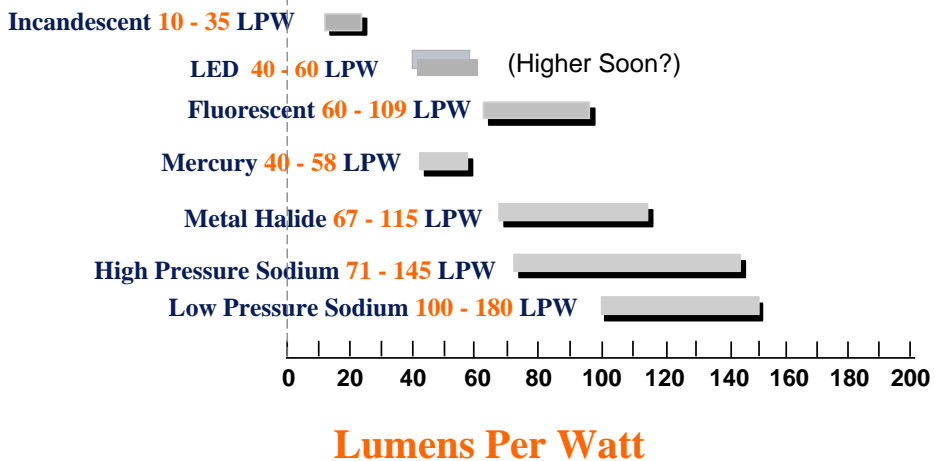
Is the fixture designed for this type of lamp, or this one?



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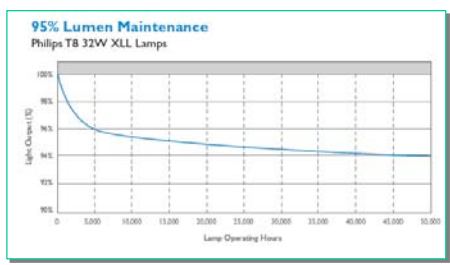
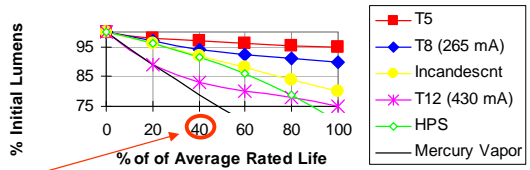
# Efficacy



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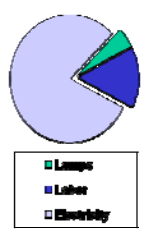
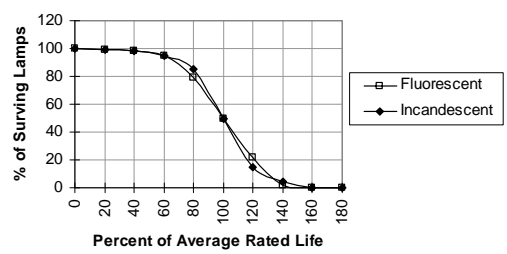
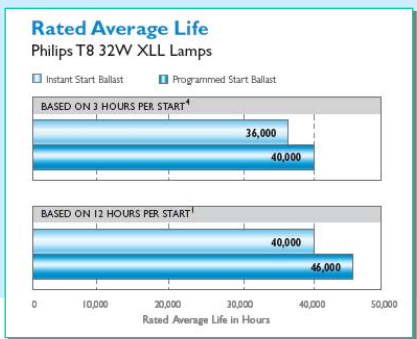
# Depreciation (LLD)

- Light Lumen Depreciation**
- » All lamps lose light with age
  - » **Initial Lumens**
    - » Rating after first 100 hrs.
  - » **Mean, (or Design) Lumens**
    - » Rating after 40% of lamp life
  - » **LLD =**
    - »  $\frac{\text{Mean lumens (T8 - 2800)}}{\text{Initial lumens (T8 - 2950)}}$
    - .95



# Average Rated Life

- » Large test batch of lamps
- » **Operating hours at 50% failure**
  - » Fluorescent depends on 'Start Times' (3 hr. vs. 12 hr.)



NOTE: It's the labor saved, **NOT** the cost of lamps that pays off



# LAMP FAMILIES


**LED'S** **FIBER OPTICS**

**E-I-S-I-Z** **INCANDESCENT**

**ElectroLuminescence**

**FLUORESCENT** **NEON**

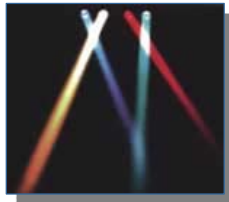



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# INCANDESCENT

**Characteristics**


- » **Point Source**
  - » *Filament*
  - » *Superior Optical Control*
  - » *Distinct Shadows*
- » **Dimmable**
  - » *Smooth Dimming Curve*
  - » *Magnetic Transformers*
  - » *Electronic Transformers*

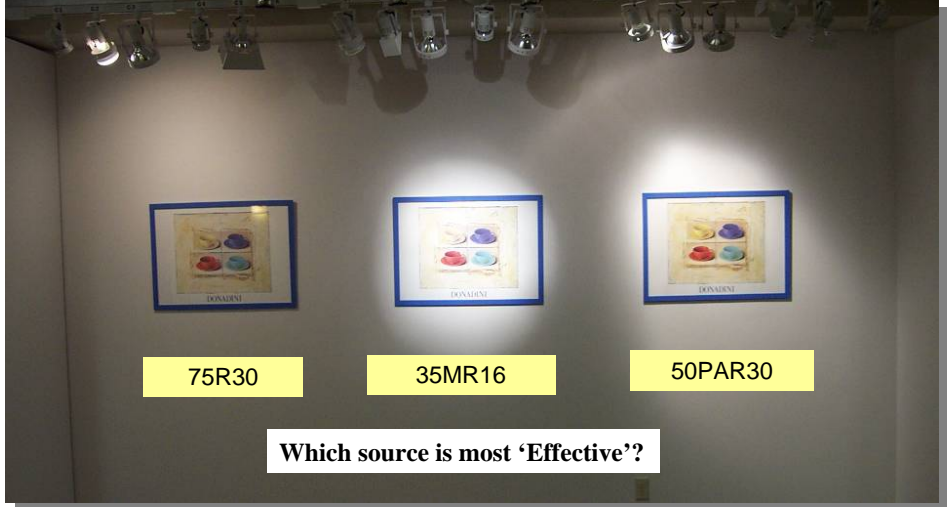
**NOTE:** EISA standards for 100w. 75w. 60w. 40w. GS lamps in place by 2014

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# Point Source Comparisons



**Which source is most 'Effective'?**


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# INCANDESCENT














## Bases / Sockets

**NOTE:** All Lamps have a proprietary socket for a reason!



**BASE IDENTIFICATION**

Typical bases are shown. One lead-in wire is soldered to the center contact and the other soldered or welded to the upper rim of the base shell. Base shells are typically made of brass or aluminum. ANSI designations are in parentheses.

 Mogul Screw	 3 Contact Mogul	 Double Contact Bayonet D.C. Bay (BA150)	 S14s	 Ext. Mogul End Prong GX16d	 Mogul End Prong	 Med Side Pr.	 Screw Terminal G53
 Candelabra cand. (E12)	 Intermediate Inter. (E17)	 Medium (E26) & Medium Brass (E26)	 3 Contact Medium 3 C Med (E260)	 Medium Skirted Med. Skirt (E26/50x39)			

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# Halogen Incandescent

- » **First major improvement to incandescent lamps since Edison**
- » **Halogen Cycle, coupled with tungsten filament and quartz envelope**
- » **IR technology doubles the efficacy**
  - » *Heat in the IR region is reflected back onto the filament*

## Halogen

Halogen Gasses:

Iodine  
Chlorine  
Fluorine  
Bromine

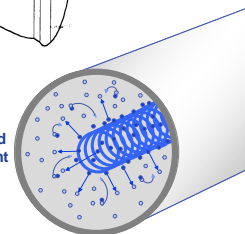
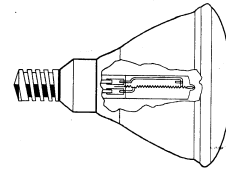
Materials - Strength  
Pure quartz or hard  
glass bulb is strong and  
has a high melting point

Regenerative  
cycle puts the  
tungsten back  
onto the filament

The filament is affected by the halogen cycle



"Tungsten Spikes"



# Halogen Infrared





# Low Voltage

## » Characteristics

- » *Transformers needed*
- » *Transformer losses*
- » *Line voltage to 12v. or 24v.*

## » Advantages

- » *Reduced filament size*
- » *Greater optical control*



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# FLUORESCENT

## Characteristics

- » *Phosphors*
- » *Starting Modes*
  - » Instant Start
  - » Rapid Start
  - » Programmed Start
- » *Bases / Sockets*
- » *Ballasts*
  - » Magnetic
  - » Electronic
    - » *Dimming*
    - » *Bi-Level Switching*
  - » Ballast Factor
  - » Power Factor



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# Characteristics

## Advantages

- » High efficacy
- » Long life
- » Good CRI
- » Variety of Color Temperatures
- » Low cost per lumen
- » Wide array of fixture types
- » Low glare source
- » Dimmable

## Disadvantages

- » Requires a ballast
- » Difficult to focus – not a point source
- » System cost (lamp and ballast) higher than filament sources
- » Fixtures are large
- » Temperature sensitivity
- » Life affected by starting cycles



# Characteristics

## **Phosphors**

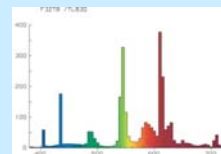
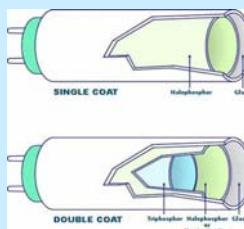
- » Coating that converts UV to another wavelength
- » Inorganic compounds that “fluoresce” when exposed to Ultraviolet radiation
- » Blends produce various colors, or versions of ‘white’

## **Halophosphors**

- » Calcium *halophosphate* compounds
- » Relatively inexpensive

## **“Tri” Phosphors**

- » AKA ‘rare earth’ phosphors
- » 90% comes from China
- » Inexpensive no more!

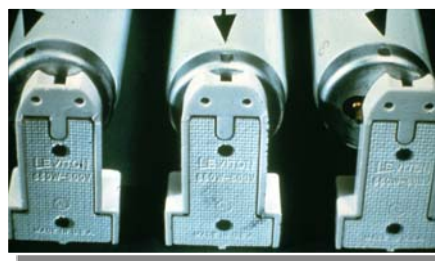




# Characteristics

## Bases / Sockets

- » T12 / T8 share
- » T5 is proprietary
- » Shunted sockets now used for Instant Start T8 lamps



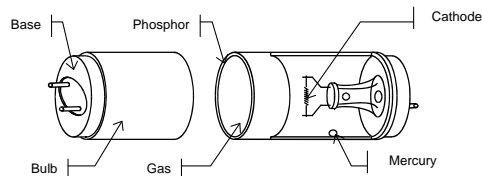
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# Characteristics

## Starting Modes

- » **Instant Start (IS)**
  - » Hard on Cathodes
  - » Cheaper
  - » Consumes ~2w. less
- » **Rapid Start (RS)**
  - » Easy on Cathodes
- » **Programmed Start (PS)**
  - » Easiest on Cathodes



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Take a 5 Minute ...



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## Ballasts

### Magnetic


- » *Simple construction*
- » *Large, heavy, hot*
- » *~20% less efficient*
- » *1 or 2 lamp versions only*
- » *Can cause flicker*
- » *Can be noisy*
- » *Difficult to dim*
- » *Banned and being phased out*



**Prior to 1979 all ballasts contained PCB's**

**Now unless the label says,  
"Contains No PCB's" . . . .**



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# Ballasts

**Electronic**

- » *Complex electronic device*
- » *Smaller, lighter*
- » *~20% more efficient*
- » *No flicker*
- » *No noise*
- » *Variety of operational modes*
- » *Can handle up to 4 lamps*
- » *Parallel wiring*
- » *Easily dimmed*
  - » *Full Range or Bi-Level*
- » *Available in different ballast factors*
- » *Universal input voltage*




**NEMA Premium Ballasts\***

**Extra efficient ballasts consume 3-6 watts less than generic electronic ballasts (GEB)**

**Cost \$1-\$4 more**  
*Save \$20-\$40 in electric cost over ballast life*

**Most new fixtures come with GEB (lowest cost)**

\*NOTE: Most utilities only rebating NEMA Premiums 45



# Characteristics

**Ballast Factor\***

- » Ratio of lamp lumens of a commercial ballast, to that of a reference ballast rated at 1.0
- » 
$$BF = \frac{\text{lumens on a commercial ballast}}{\text{lumens on a reference ballast}}$$
- » The range of ballast factors goes from a low of 0.60 to as high as 1.3
  - » *BF of 0.78 is considered 'Low'*
  - » *BF of 0.88 is considered 'Normal'*
  - » *BF of 1.10 is considered 'High'*

**Application**

- » In a retro-fit, the BF can be used to 'tune' the light levels in the space, especially if the levels are determined to be high relative to the tasks performed.
- » In new construction, a high BF can drive a 2-lamp system high enough to deliver the same lumens as a 3-lamp system at a lower BF.
  - » *Lamp life is not affected by either low or high ballast factors.*

\*NOTE: As opposed to **Power Factor**, a measure of how a ballast converts current into power. Utilities charge for watts consumed **NOT** for volt-amps. Low PF goes uncharged.

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# Linear Fluorescent

## T12 'Cool White'

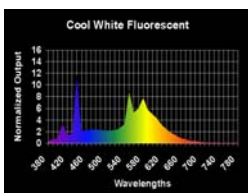
- » 70 LPW / 60-70% LLD
- » 62 CRI
- » Flicker (with magnetic ballast)
- » 24,000 hour rated life
- » 34w. & 40w.
- » Legal versions still available!



500,000,000 still burning in the US!

Supposed to be illegal as of July 15, or not!!

EISA non-compliant



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# Linear Fluorescent

## T8 Standard Output

- Lumens:** 2915 @77°F
- Efficacy:** 90+ l/w
- No flicker w/ electronic ballast**
- Wattage:** 32 (30w. 28w. 25w. also available) (Retro-fit opportunity)
- Life:** 42,000+ hrs. (12 hr. Start)
- LLD:** 90%



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## Linear Fluorescent

### High Performance T8

**Lumens:** 3100 @77°F  
**Efficacy:** 97+ l/w  
**Wattage:** 32  
**Life:** 60,000 hrs. (12 hr. Start)  
(w/PS Ballast)  
**LLD:** >90%



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## Linear Fluorescent

### T5 Standard Output

**Lumens:** 2835 @95°F  
**Efficacy:** 100+ l/w  
**Wattage:** 28  
**Life:** 36,000 hrs. (12 hr. Start)  
**LLD:** 95%



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## Linear Fluorescent

### T5 High Output

**Lumens:** 4650 @95°F

**Efficacy:** 86+ l/w

**Wattage:** 54 (49w. 45w. also available) (Retro-fit opportunity)

**Life:** 60,000 hrs. (12 hr. Start)

**LLD:** 95%



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## Compact Fluorescent (CFL)

### Pin-Base

- » 2-Pin Magnetic Ballast
- » 4-Pin Electronic Ballast



### Screw Base – (Self-Ballasted)

- » Tries to behave like an A23
- » Functioning ballast tossed away with dead lamp



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# Compact Fluorescent



- » Triple tubes most popular in new construction
- » 26w. 32w. 42w. use same ballast



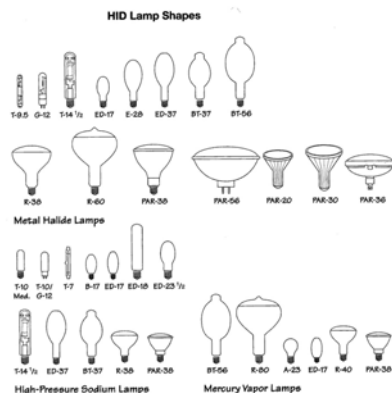
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# HIGH INTENSITY DISCHARGE (H.I.D.)

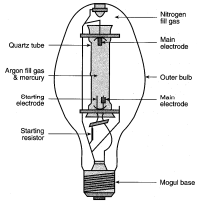

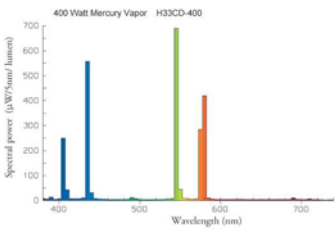
## Characteristics

- » *Strike / Re-Strike time*
  - » An issue with Metal Halide
- » *Orientation*
  - » Horizontal Mount
  - » Vertical Mount
- » *Ballasts*
  - » Magnetic Probe Start
  - » Electronic Pulse Start



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# Mercury Vapor

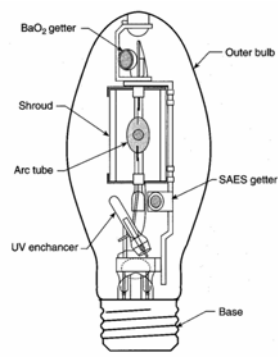
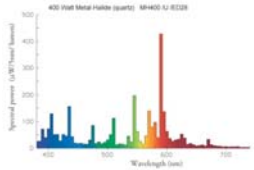




- » Oldest HID source
- » Street Lighting source until recently
- » Lowest 'Efficacy' (~40 LPW)
- » Poor CRI rating (~15–35)
- » High CCT's (~4500° to 5500°)
- » Poor LLD (less than 60%)
- » Color shift by \*L<sub>70</sub> (becomes green)
- » Legislation has banned mercury ballasts, technology now obsolete

\* Useful Life

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# Metal Halide

- » Improved version of Mercury Vapor
- » More 'complex' than other HID sources
- » Increased variety of:
  - » *Types:*
    - » Standard / Ceramic / Self-Ballasted
  - » *Ballast options:*
    - » Magnetic Probe Start
    - » Electronic Pulse Start
  - » *Wattages:*
    - » 20w. – 1500w.
  - » *Color Temperatures:*
    - » 3000°K - 4200°K (typical)
  - » *Color Rendering:*
    - » 60 CRI – 95 CRI

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## Characteristics

### Advantages

- » *High Efficacy (up to 120 LPW)*
- » *Long life (up to 24,000 hrs.)*
- » *Point source – good optical control*
- » *Available in high LLD (~20%)*
- » *Can be dimmed*
  - » *Difficult but possible*

### Disadvantages

- » *Some color shift over time*
- » *Color inconsistency lamp to lamp*
- » *Sensitive to burning position*
- » *High system cost*
  - » *Strike/re-Strike time*
- » *Few electronic ballasts available*
  - » *Costly though coming down*

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## Standard Metal Halide

- » **Magnetic Ballast**
  - » *Probe Start, 50w. – 1500w.*
- » **Newer types for Pulse Start**
  - » *Requires remote ignitor*
- » **Available in a variety of types:**
  - » *Exterior applications*
  - » *Remote mounting*
  - » *Inside poles*

- » **Electronic Ballast**
  - » *Pulse Start, 20w. – 400w.*
  - » *Integral ignitor*
- » **Components / Construction**



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## Self-Ballasted Metal Halide

- » **25w. Philips / 24w. Sylvania / 23w. GE**
- » **10,000 hrs.+ Ave. Rated Life**
- » **Easy, instant upgrade / retrofit from halogen PAR38**
- » **80 plus CRI**
- » **Available in variety of beam angles**

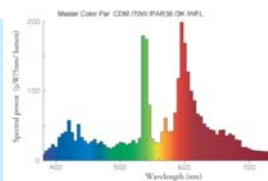


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## Ceramic Metal Halide


- » **Ceramic materials used for inner envelope**
- » **Improved efficacy and life**
- » **Good 'point source' distribution**
- » **Applications**
  - » *Retail - Low wattages*
  - » *More high wattages being developed*



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# Ceramic Metal Halide



320fc  
150WPAR

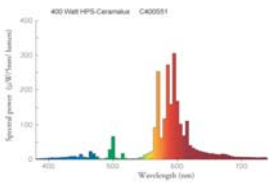
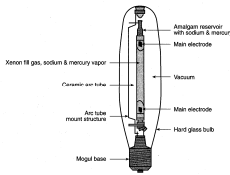

460fc  
90WPAR/H

640fc  
45W/MH



# High Pressure Sodium

- » **Very high Efficacy (~140 LPW)**
- » **Poor Color performance**
  - » 21 CRI typical
  - » 2200°K typical
- » **Mostly Sodium**
  - » Some mercury and xenon
- » **Almost exclusively used outdoors**
  - » Still the Street Lighting source of choice
  - » Some High Bay applications
- » **Many types available**
  - » 35w. – 1000w.
  - » 'Eco' variety: low mercury / lead free

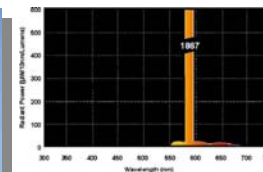




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## Low Pressure Sodium

- » **Highest Efficacy (up to 200 LPW)**
- » **Monochromatic yellow output**
  - »  $1700^{\circ}K$
  - »  $0$  CRI (*that's right, zero!*)
- » **Used only where color recognition is NOT important**
  - » *Roadway*
  - » *Tunnels*
  - » *Some security applications*
  - » *Near observatories*

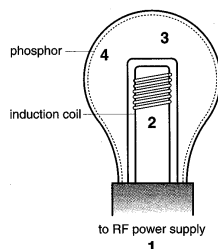


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## Induction Electrodeless Fluorescent

- » **Fluorescent technology uses RF signal to energize lamp**
- » **Soft instant start / longer life**
  - »  $60,000$  hrs. @  $L_{70}$
- » **Wattages: 40 - 200**
- » **80 CRI @**
  - »  $3100^{\circ}K$
  - »  $4100^{\circ}K$
  - »  $5000^{\circ}K$



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# Induction



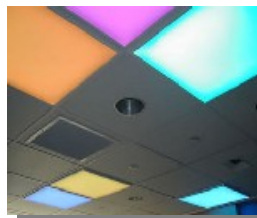
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# L.E.D. Solid State Lighting

## » Light Emitting Diode

- » *Semiconductor Device that emits visible light*
- » *Fundamentally different from conventional light sources*
- » *Uses no gas or filament*
- » *Has no fragile glass bulb*
- » *Has no failure prone moving parts*
- » *Contains no mercury*



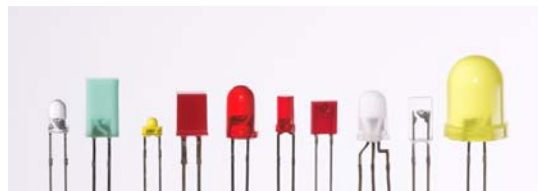
66



## L.E.D.

### Characteristics

- » Can perform in small clusters and large arrays
- » Can also emit UV and IR
- » Many are dimmable
- » Chips and luminaires available from numerous sources, not just from traditional sources
- » Improvements almost daily



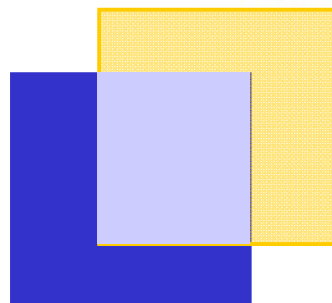
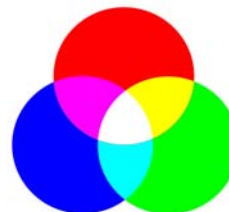
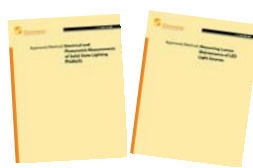
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## L.E.D.

### Issues

- » Life rating based on  $L_{70}$  **NOT** true mortality
- » IES LM 79 & LM80 define life & lumen maintenance
- » Proper heat sinking required to achieve rated life
- » Secondary optics needed for different beam spreads
- » Scotopic / photopic lumens debate
- » Acceptable 'warm' white needs remote phosphors.



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# L.E.D.



**Philips' Result  
w/ LUXEON Rebel**

---

910 lm

---

9.7 W

---

93.4 lm/W

---

2727 K

---

93 CRI



*Glows white  
when illuminated*



Beats performance of a 60w. A19



**NOTE: Form factor match**

DOE L-Prize Winner!

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# L.E.D.





## Applications





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# LDL Approved LED Products



**Quick Links**

- [LED Product List](#)
- [How to Qualify your LED Product](#)
- [Check the Status of your LED Product](#)
- [LED Specifications](#)
- [NEWS Spring 2012 Newsletter](#)




**The List itself**  
(Good for only 1 year)

**How to Qualify**  
(Lamp or Fixture)

**Where you are . . .**  
. . . in the process

**The Specs.**


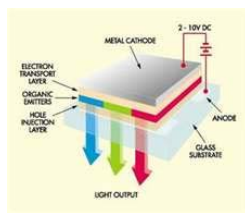

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# OLED (Organic L.E.D.)

- » **An LED in which the emissive electroluminescent layer is a film of organic compounds which emit light in response to electric current.**
- » **Used in small devices such as TV screens, (*better than LCD*), and in large-area light-emitting elements for general illumination.**
- » **Still very expensive**
- » **Very short lived, (14,000 hrs.  $L_{50}$ )\***

\*Lumens at 50% of Ave. Rated Life

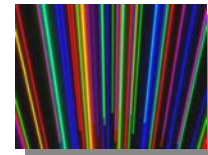




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# NEON

- » Inert gases combine w/rare earth oxides in discharge tube at very high voltage
- » Being replaced by lower cost options

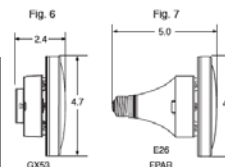
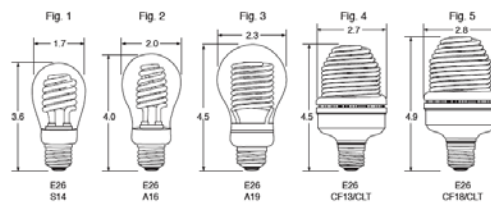


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# COLD CATHODE

- » Bendable fluorescent
- » Many colors available
- » Linear product costly, short lived
- » Coiled lamps down to 3w. and 25,000 hrs. w/dimming



LAMP CONTAINS MERCURY  
 Handle in Accord with Disposal Laws  
 See: www.lamprecycle.org

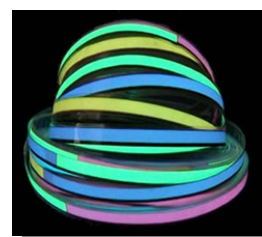
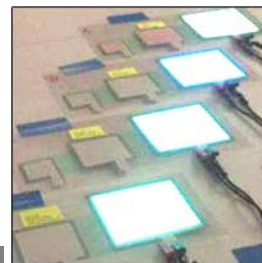
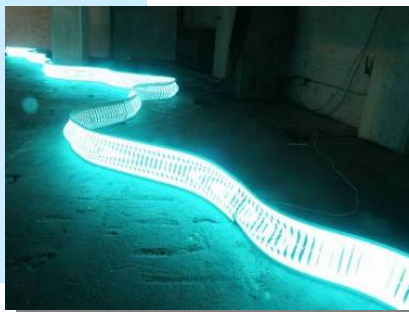


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# Electroluminescence

- » **Low AC current converted to light by phosphors**
- » **No discharge involved**
- » **Applications**
  - » *Exit signs*
  - » *Low level clearance*



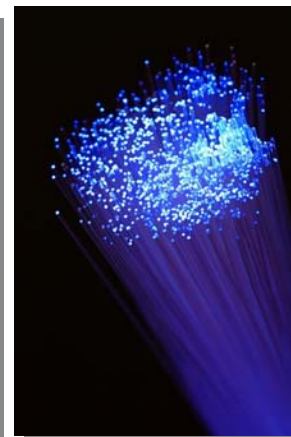
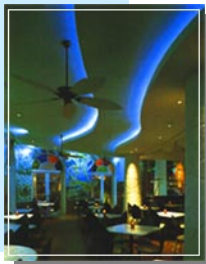
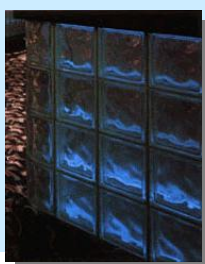
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# FIBER OPTICS

## Characteristics

- » *End Emitting*
- » *Side Emitting*
- » *No Uv or IR*



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# FIBER OPTICS

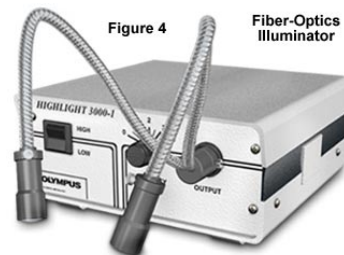
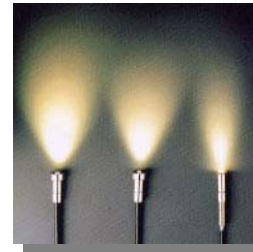
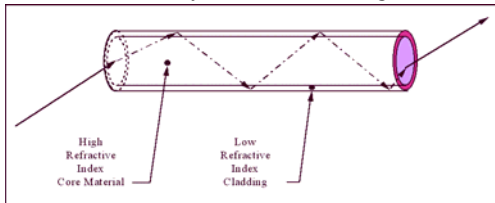
**Total Internal Reflection**, the basis of operation of fiber optic systems

**Fiber Interior:**

Thin cylindrical fibers of glass or plastic of high transmissivity and high index of refraction  
Usually called the “core”

**Fiber Exterior:**

Fiber is coated with a material of lower index of refraction  
Usually call the “cladding”



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# Bibliography & Resources:

- » **IESNA Lighting Handbook**
  - » *Reference and Application*
  - » 10<sup>th</sup>. Edition
- » **IESNA Lighting Education**
  - » *The Fundamentals of Lighting (FOL-IM-09)*
  - » *Intermediate Level Lighting Course (ED-150)*
  - » *Seminars – (7) Topics, (4) more soon*
- » **Lighting Controls Association**
  - » [www.aboutlightingcontrols.org](http://www.aboutlightingcontrols.org)
- » **Advanced Energy Design Guides (USGBC FREE downloads)**
  - » [www.ashrae.org/aedg](http://www.ashrae.org/aedg)
- » **US EPA Energy Star**
  - » [www.energystar.gov](http://www.energystar.gov)
- » **Northwest Energy Efficiency Alliance**
  - » [www.northwestalliance.org](http://www.northwestalliance.org)

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## Contact

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» **EMAIL:**

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» **WEBSITE:**

» *www.lightingdesignlab.com*

» **COME IN: (call first for appt.)**

» *2915 4th Avenue S.*

» *Seattle, WA 98134*

