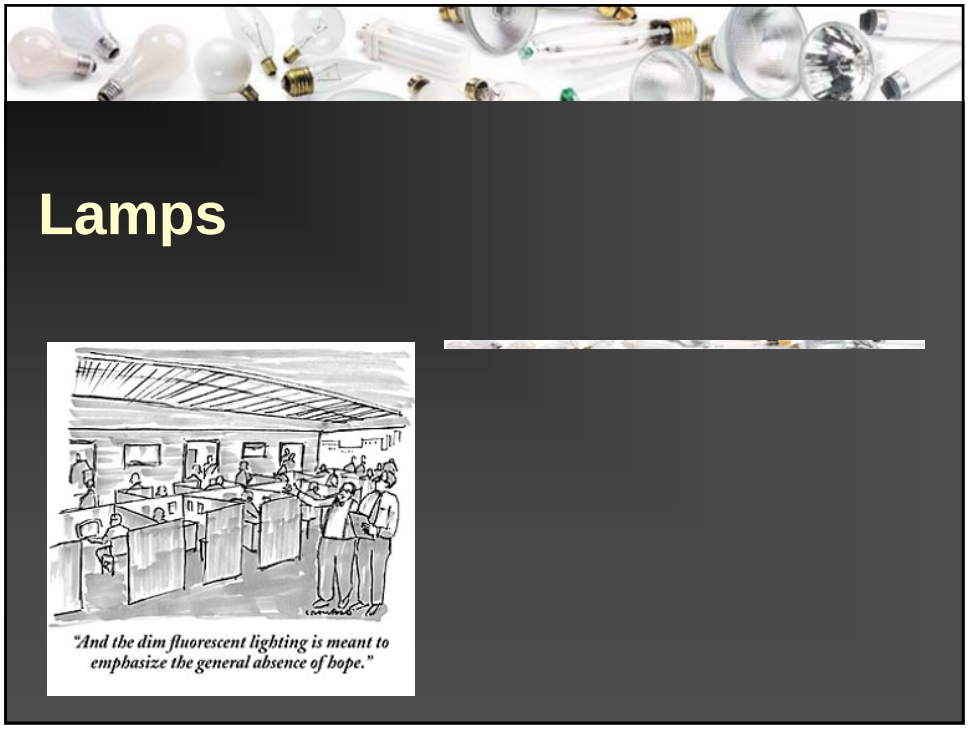
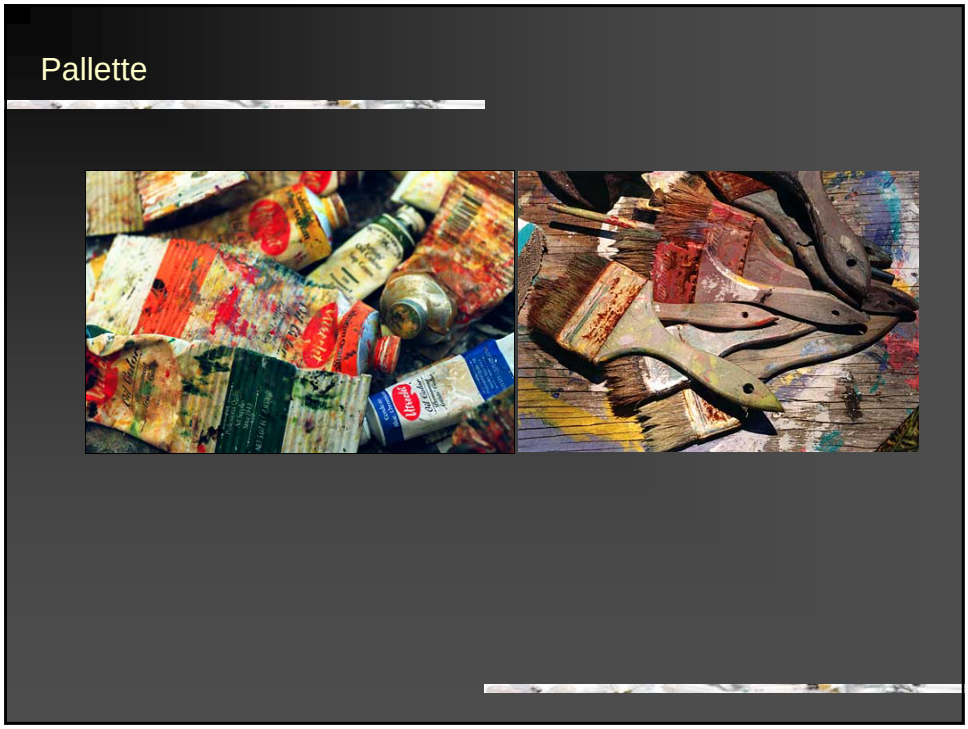
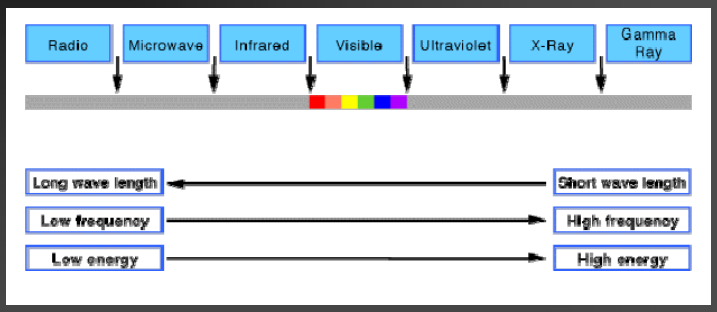

Lamps
"And the dim fluorescent lighting is meant to emphasize the general absence of hope."


Pallette

Frequency of Visible Light



The Color of Light Sources

- **Correlated Color Temperature (CCT)**

  color appearance of various light sources

- **Color Rendering Index (CRI)**

  how a light source renders the color of objects

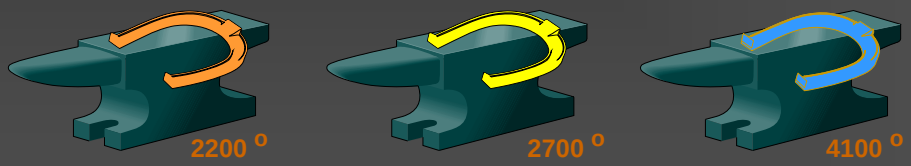
Lamps

Burning Temperature

The higher the color temperature (CCT), the
"cooler"
the color of the lamp is in appearance.

The lower the color temperature (CCT) the
"warmer"
the color the lamp is in appearance.

This color temperature is measured in Kelvin.



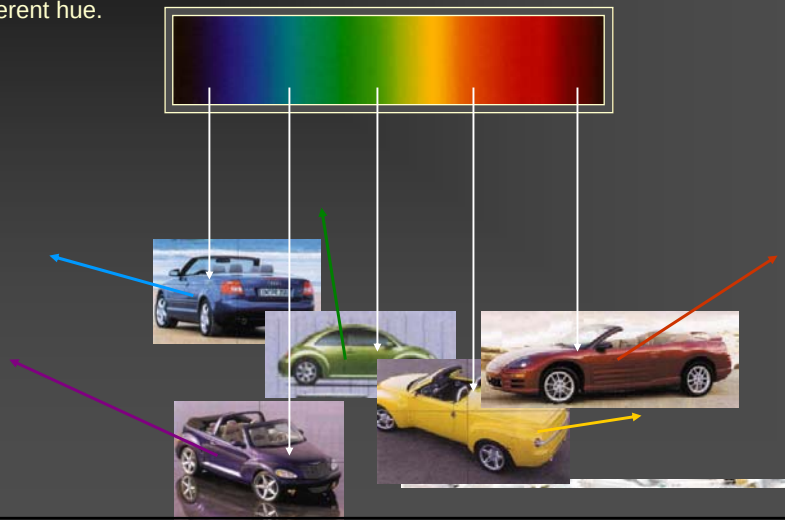
Correlated Color Temperature

COLOR TEMPERATURE	WARM	NEUTRAL	COOL	DAYLIGHT
Kelvin Range	3000K	3500K	4100K	5000K
Associated Effects and Moods	Friendly Intimate Personal Exclusive	Friendly Inviting Non-threatening	Neat Clean Efficient	Bright Alert Exacting coloration
Appropriate Applications	Restaurants Hotels Lobbies Boutiques Libraries Office areas Retail stores	Public reception areas Showrooms Bookstores Office areas	Office areas Conference rooms Classrooms Mass merchandisers Hospitals	Galleries Museums Jewelry stores Medical examination areas Printing companies

Correlated Color Temperature

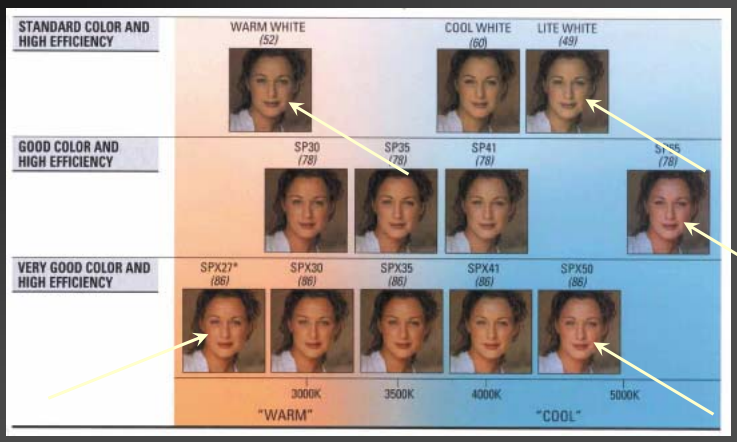
Color Rendering Index

Measures the effect of a light source on the perceived object and its surface.
High CRI light makes virtually all colors look natural and vibrant.
Low CRI causes some colors to appear washed out or even take on a completely different hue.



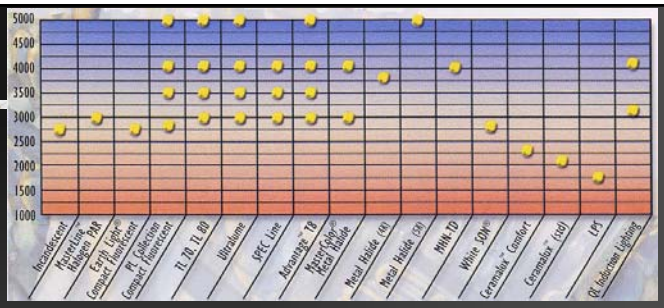
Lamps

Color Rendering Index



	COOL	MIDRANGE	WARM
CCT:	4100°k	3000°k	2700°k
CRI:	80CRI	80CRI	80CRI

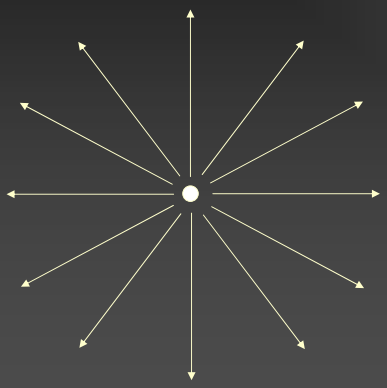
Lamps



		CCT	CRI
Incandescent		2850 º	100
Fluorescent		2700º-5000 º	51-90
HID-	MH (master color)	3000 º -4000 º	92
	MH (standard)	3700 º -5000 º	65-70
	HPS (color corrected)	2700 º	85
	HPS	2100 º-2700 º	low 20's
	LPS	1700 º	N/A
	MV	4000 º	20-45

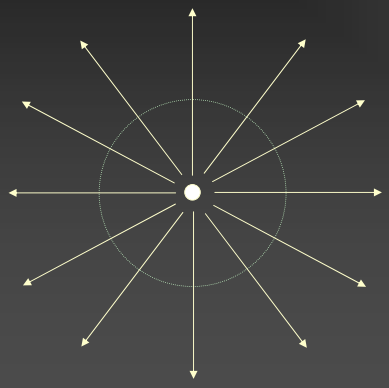
Light Direction

Light travels in a straight line…radiates out from the source



Light Direction of Clear Lamps

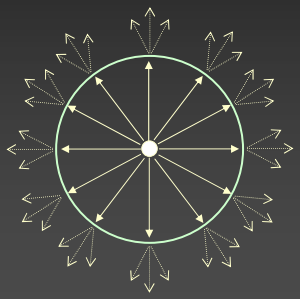
Light travels in a straight line…radiates out from the source



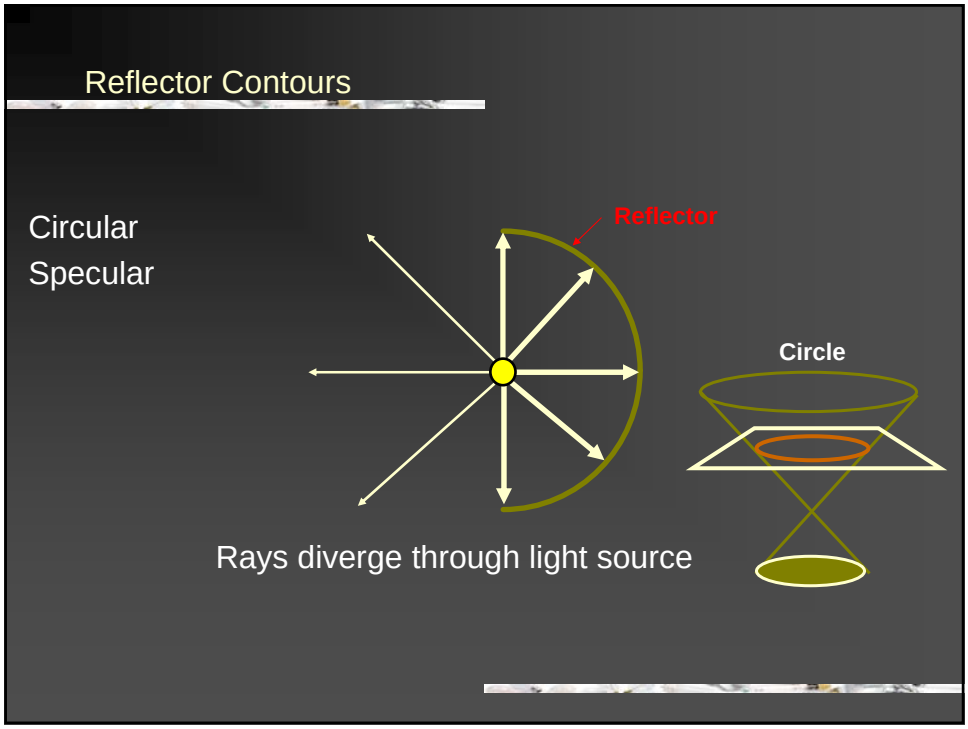
…. add a clear enclosure or envelope around the source, the light will still travel in a straight line.

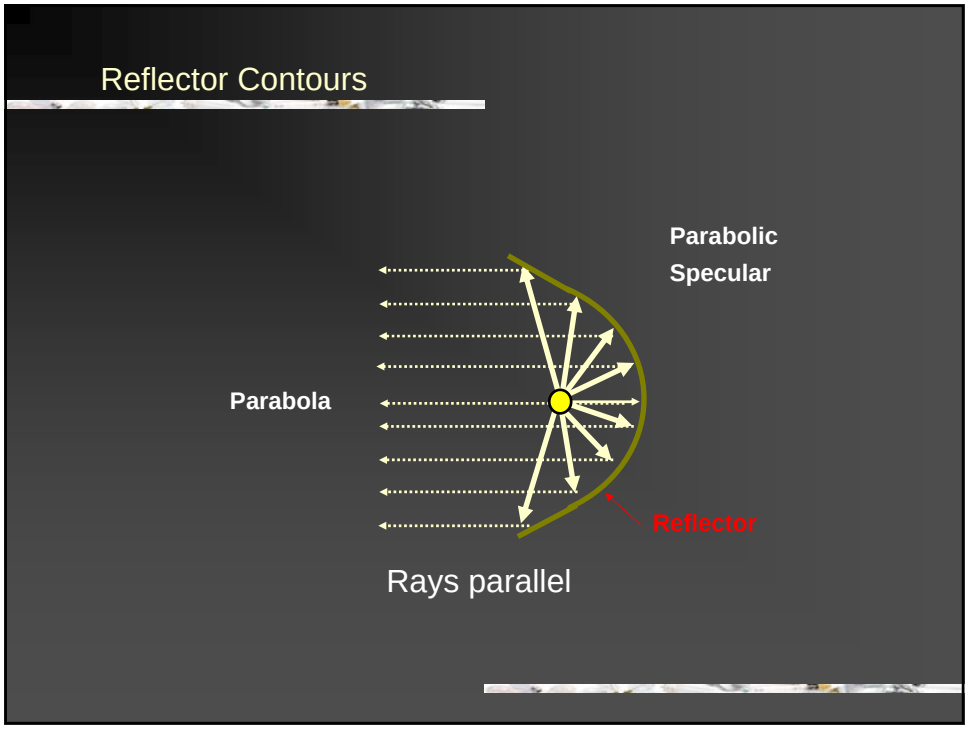
Light Direction of Frosted Lamps

Light travels in a straight line…radiates out from the source

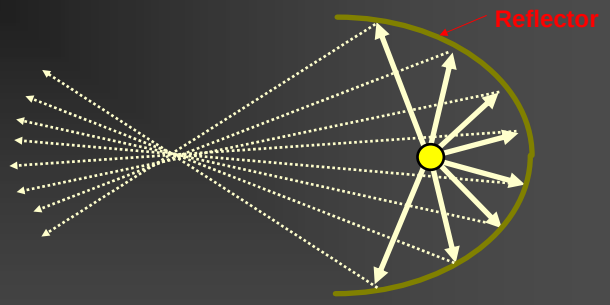


…. add a coated or frosted enclosure or envelope around the source, the direction of light will bend and radiate from the surface of the enclosure


Reflector Contours
Circular
Specular
Reflector
Circle
Rays diverge through light source


Reflector Contours
Parabolic
Specular
Parabola
Reflector
Rays parallel

Reflector Contours



Rays converge

2 foci

Ellipsoidal

Specular

General Definitions

Intensity:

The light emitted in a specific direction by a source. Properly called “luminous intensity” or “flux per solid angle in a given direction”, it is measured in candelas (cd). Intensity in a succession of directions is plotted on a distribution curve or polar graph.

General Definitions

Flux:

The light emitted in all directions by a source. Properly called luminous flux or “time rate flow of light”, it is measured in lumens (lm).

General Definitions

Illuminance:

The density of light on a surface. Properly defined as “density of flux incident on a surface measured perpendicular to the surface”, it is measured in footcandles (fc).

Note, metric unit is lux (lx) aproximately 1/10 of a footcandle.

General Definitions

Luminance:

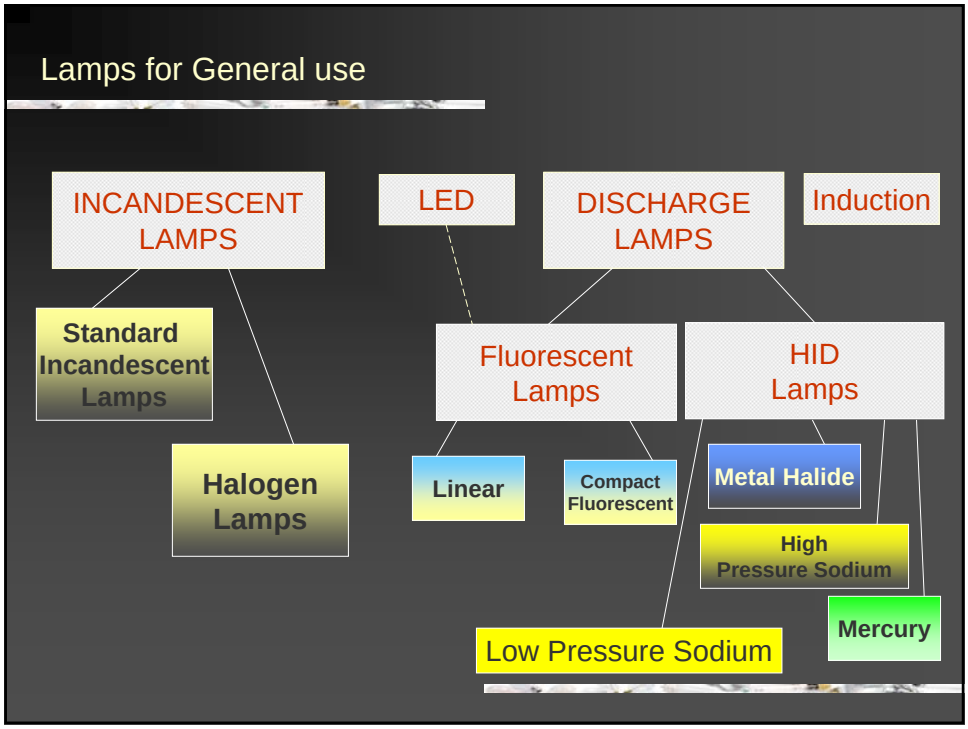
The accepted term for light that us reflected from a surface in a given direction (back towards the eyes). Properly defined as “intensity of flux leaving a surface in a given direction”, it is measured in candelas per square foot (cd/sqft).

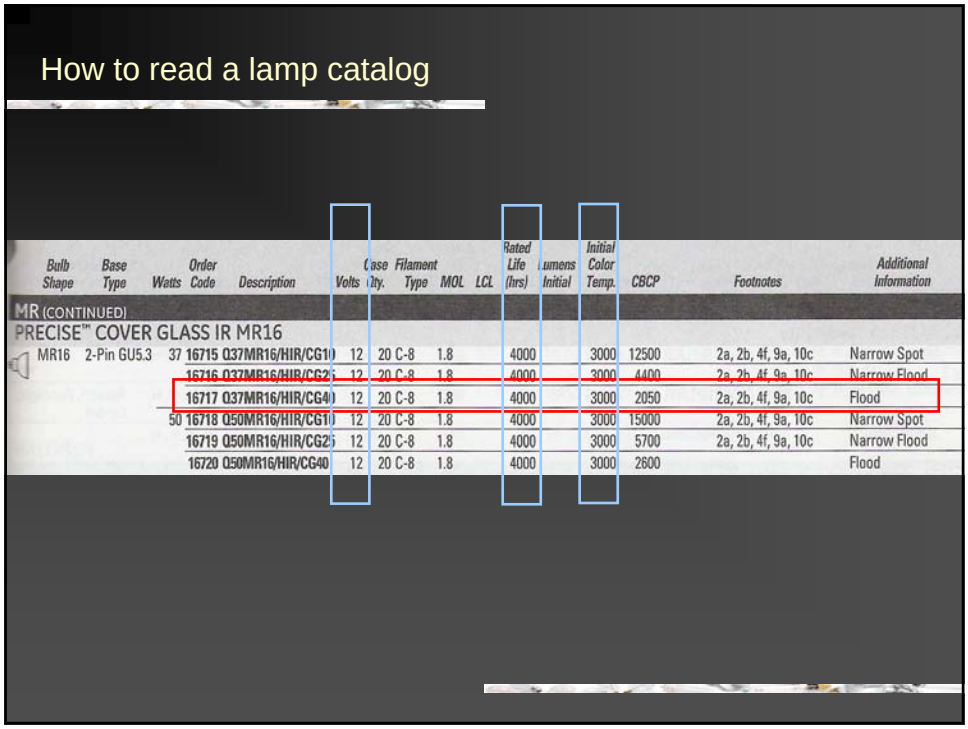
General Definitions

Exitance:

The total quantity of light emitted, reflected, or transmitted in all directions from a surface. Properly defined as “density of flux leaving a surface”, it is measured in lumens per square foor (lm/sqft).

Lamps


Lamps for General use
INCANDESCENT LAMPS
LED
DISCHARGE LAMPS
Induction
Standard Incandescent Lamps
Halogen Lamps
Fluorescent Lamps
HID Lamps
Linear
Compact Fluorescent
Metal Halide
High Pressure Sodium
Mercury
Low Pressure Sodium


How to read a lamp catalog
Bulb Shape
Base Type
Watts
Order Code
Description
Volts
Case Qty.
Filament Type
MOL
LCL
Rated Life (hrs)
Lumens Initial
Initial Color Temp.
CBCP
Footnotes
Additional Information
MR (CONTINUED)
PRECISE™ COVER GLASS IR MR16
MR16 2-Pin GU5.3 37 16715 Q37MR16/HIR/CG10 12 20 C-8 1.8 4000 3000 12500 2a, 2b, 4f, 9a, 10c Narrow Spot
16716 Q37MR16/HIR/CG25 12 20 C-8 1.8 4000 3000 4400 2a, 2b, 4f, 9a, 10c Narrow Flood
16717 Q37MR16/HIR/CG40 12 20 C-8 1.8 4000 3000 2050 2a, 2b, 4f, 9a, 10c Flood
50 16718 Q50MR16/HIR/CG10 12 20 C-8 1.8 4000 3000 15000 2a, 2b, 4f, 9a, 10c Narrow Spot
16719 Q50MR16/HIR/CG25 12 20 C-8 1.8 4000 3000 5700 2a, 2b, 4f, 9a, 10c Narrow Flood
16720 Q50MR16/HIR/CG40 12 20 C-8 1.8 4000 3000 2600 Flood

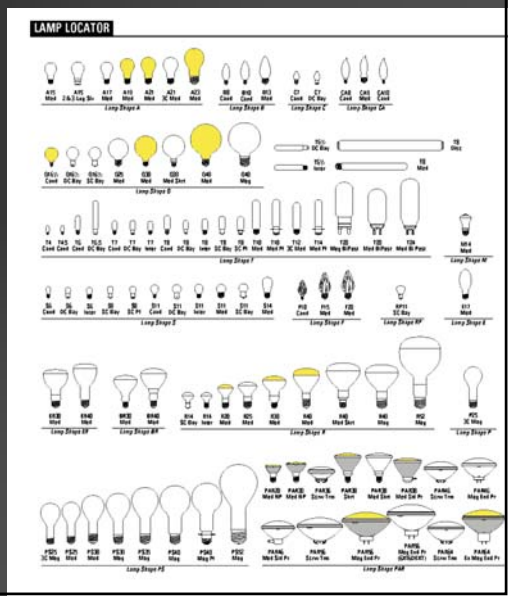
Lamps

How to read a lamp catalog

Bulb	Base	Watts	Nominal Length in.	Order Code	Description	Case Qty.	Rated Life 3hr/ Start	Rated Life 12hr/ Start	Lumens Initial	Lumens Mean	Color Temp. K	CRI	Foot-notes	Warning and Cautions	Additional Information
T5 STARCOAT ECO LUX® LAMPS															
HIGH EFFICIENCY															
T5	Miniature BiPin (G5)	14	21.6	31590	F14W/T5/830/ECO	40	30000	36000	1350	1240	3000	85		19	101
				46671	F14W/T5/835/ECO	40	30000	36000	1350	1240	3500	85		19	101
				46673	F14W/T5/841/ECO	40	30000	36000	1350	1240	4100	85		19	101
				46674	F14W/T5/850/ECO	40	30000	36000	1300	1190	5000	85		19	101
				46676	F14W/T5/865/ECO	40	30000	36000	1250	1150	6500	85		19	101
		21	33.4	46677	F21W/T5/830/ECO	40	30000	36000	2100	1930	3000	85		19	101
				46684	F21W/T5/835/ECO	40	30000	36000	2100	1930	3500	85		19	101
				46687	F21W/T5/841/ECO	40	30000	36000	2100	1930	4100	85		19	101
				46688	F21W/T5/850/ECO	40	30000	36000	2000	1840	5000	85		19	101
				46689	F21W/T5/865/ECO	40	30000	36000	1950	1790	6500	85		19	101

Incandescent

Incandescent



Attributes and Options - Incandescent

- Varied wattages, sizes, shapes, and bases
- Finishes
  - Clear
  - Inside Frosted
  - Coated (Softwhite)
- Economical
- Short lamp life
- Warm Light
- Dimming
  - Yes

Color Spectrum – Daylight & Incandescent

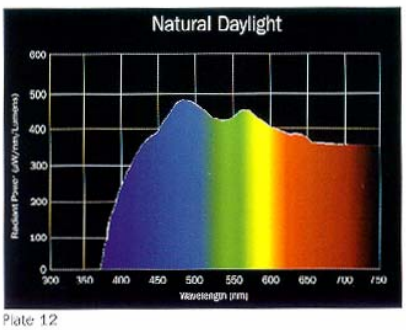


Plate 12

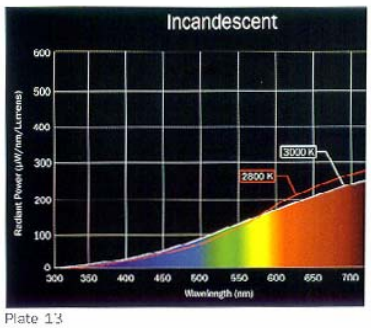


Plate 13

Color Spectrum – Daylight & Incandescent

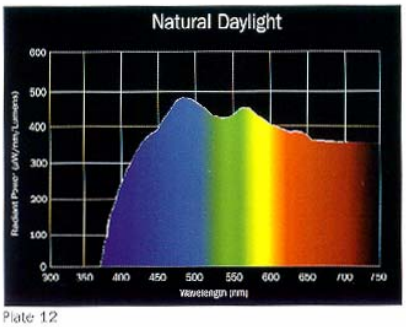


Plate 12

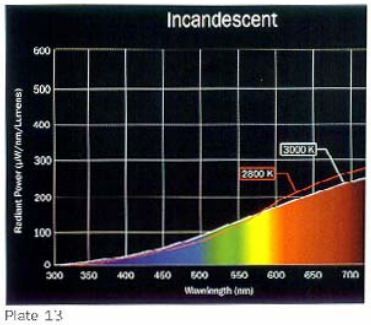


Plate 13

Halogen (Incandescent)

Attributes and Options - Halogen

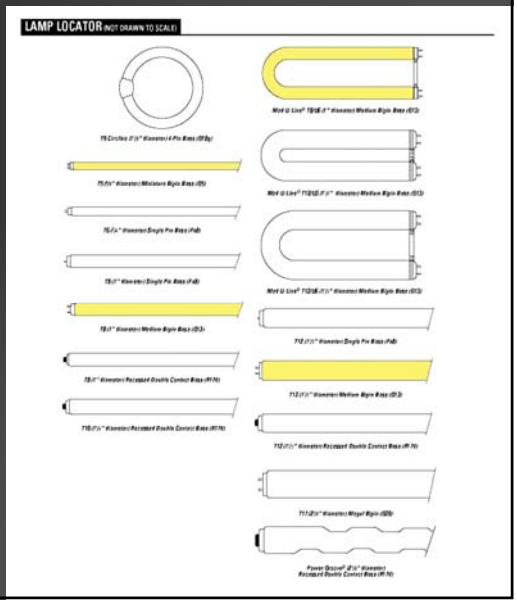
- Varied wattages, sizes, shapes, and bases
- Finishes
  - Clear
  - Inside Frosted
  - Coated (Softwhite)
- Small Sources – Ideal for controlled optics
- Often low voltage and require transformers
- White Light
- Dimming
  - Yes

How Halogen Lamps Work

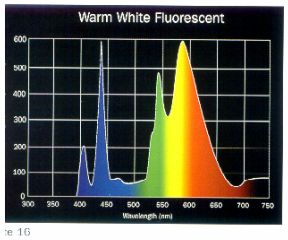
Halogen Cycle

Fluorescent

Fluorescent



Color Spectrum - Fluorescent



te 16

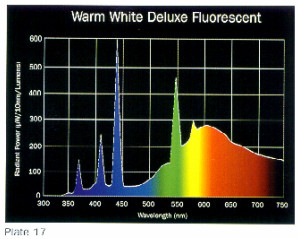


Plate 17

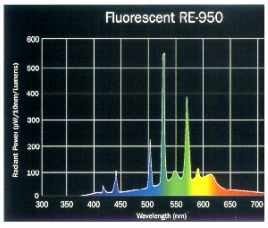


Plate 23

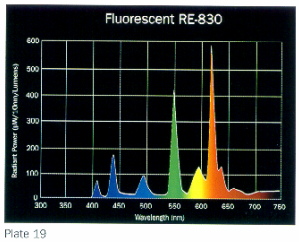


Plate 19

Attributes and Options - Fluorescent

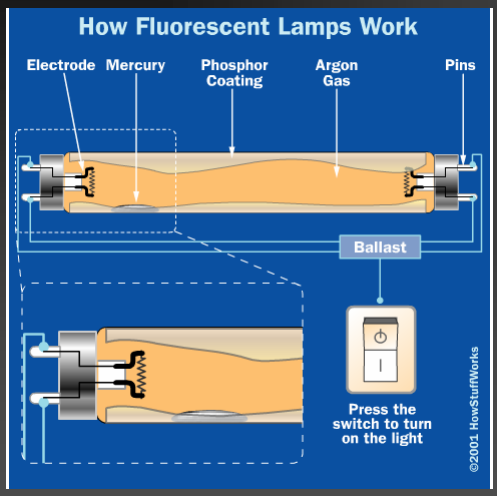
- Varied wattages, sizes, shapes, and bases
- Finishes
  - Coated only – coating determines color
- Operates with specific Ballast
- Long Life
- Cool Burning
- Dimming
  - Yes, with dimming ballast and specific dimmers

Ballast

Ballasts perform three main functions

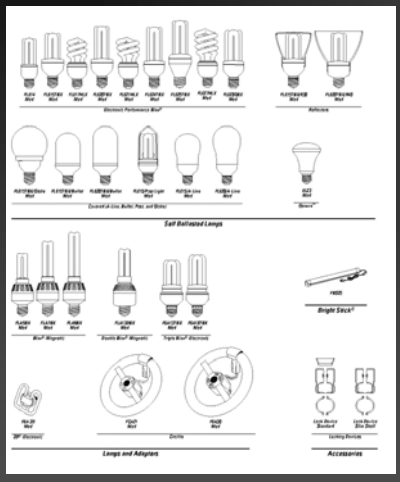
- ✓ They start the lamp.
- ✓ They take the line voltage (120/240/277/480) and step it up or down as required by the lamp.
- ✓ They make sure the lamp operates in a stable mode by regulating the current

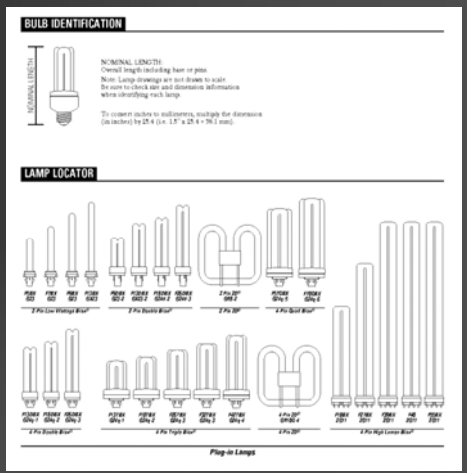
Fluorescent Lamp Design



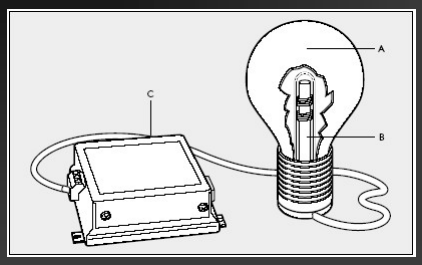
Rapid start and starter switch fluorescent bulbs have two pins that slide against two contact points in an electrical circuit.

Compact Fluorescent





Induction Lamps



A Discharge Vessel
B Tube with Power Coupler
C Electronic Ballast

Icetron (Osram)

QL (Philips)

Similar in technology to Fluorescent:

1 – Ballast produces a regulated voltage

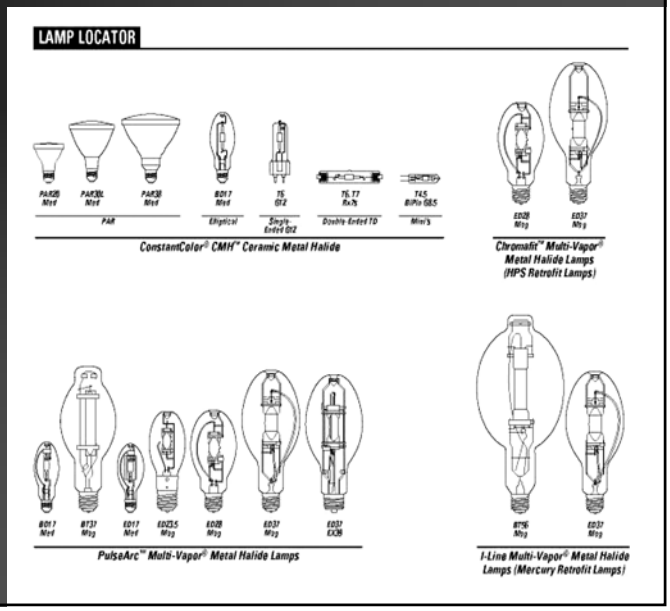
2 – The power coupler acts an antenna, producing a high frequency electromagnetic field

3 – Mercury vapour in the discharge vessel produces UV light which is then shifted into the visual spectrum by phosphors

-Up to 400W
-3500K-4100K, 80CRI
-May last up to 10 yrs (100 000hrs)

High Intensity Discharge

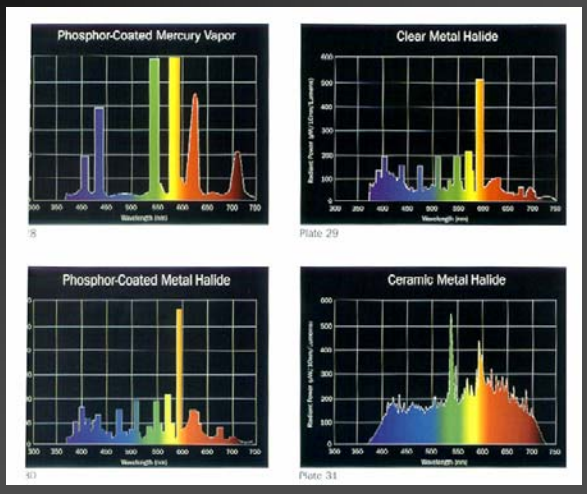
HID



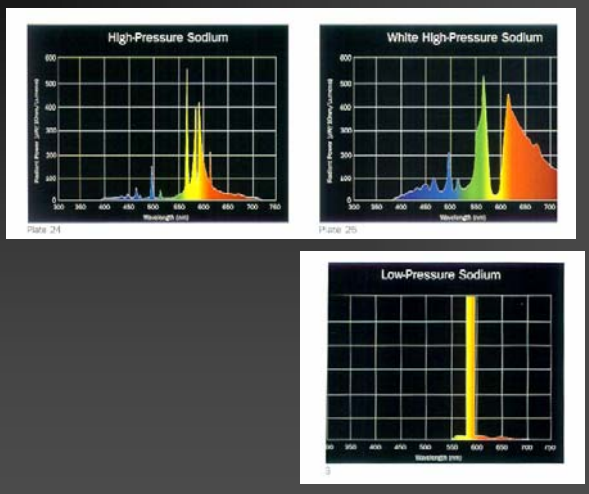
Attributes and Options - HID

- Varied wattages, sizes, shapes, and bases
- Finishes
  - Clear
  - Coated
  - Colored
- Operates with Ballast
- Burning Position Critical
- Dimming
  - No
  - Multi-level Switching possible

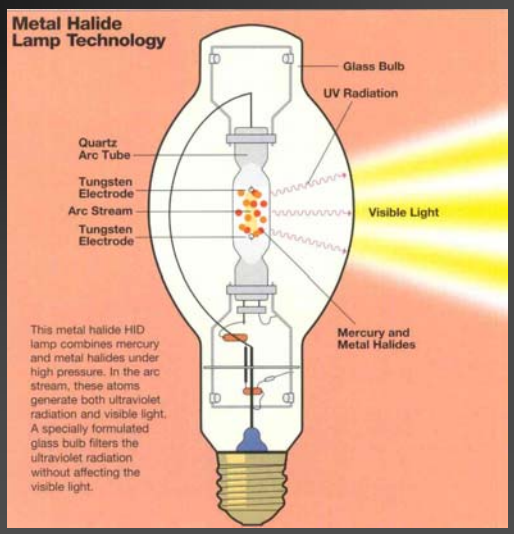
Color Spectrum – Metal Halide



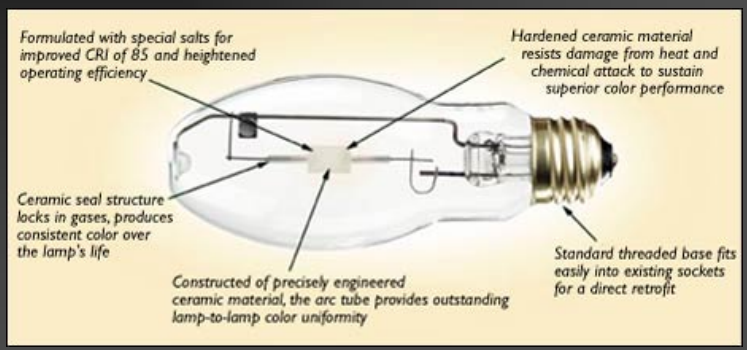
Color Spectrum – High Pressure Sodium



High Intensity Discharge



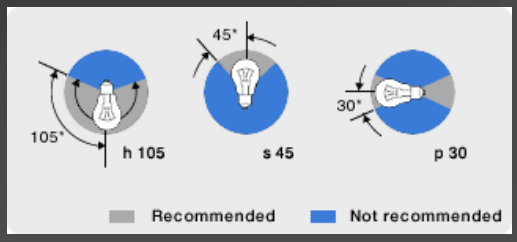
High Intensity Discharge



Burning Position

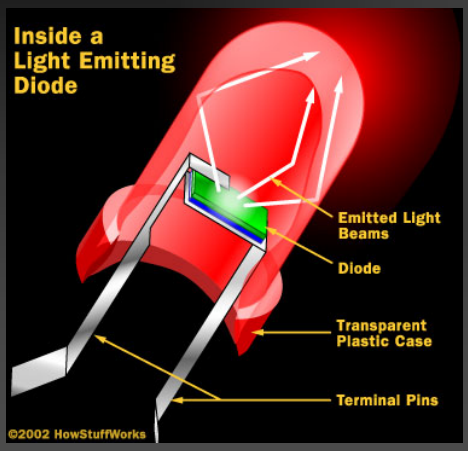
The burning position defines the position in which lamps may or may not be operated. A combination of a letter and a number is used in which the letter indicates the datum alignment and the number is the half-angle of the recommended range.

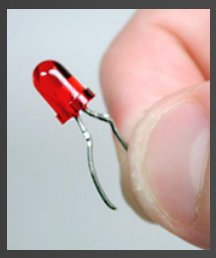
There are three basic datum positions:

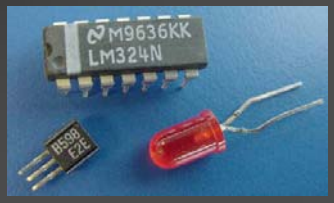


vertical, base up vertical, base down horizontal

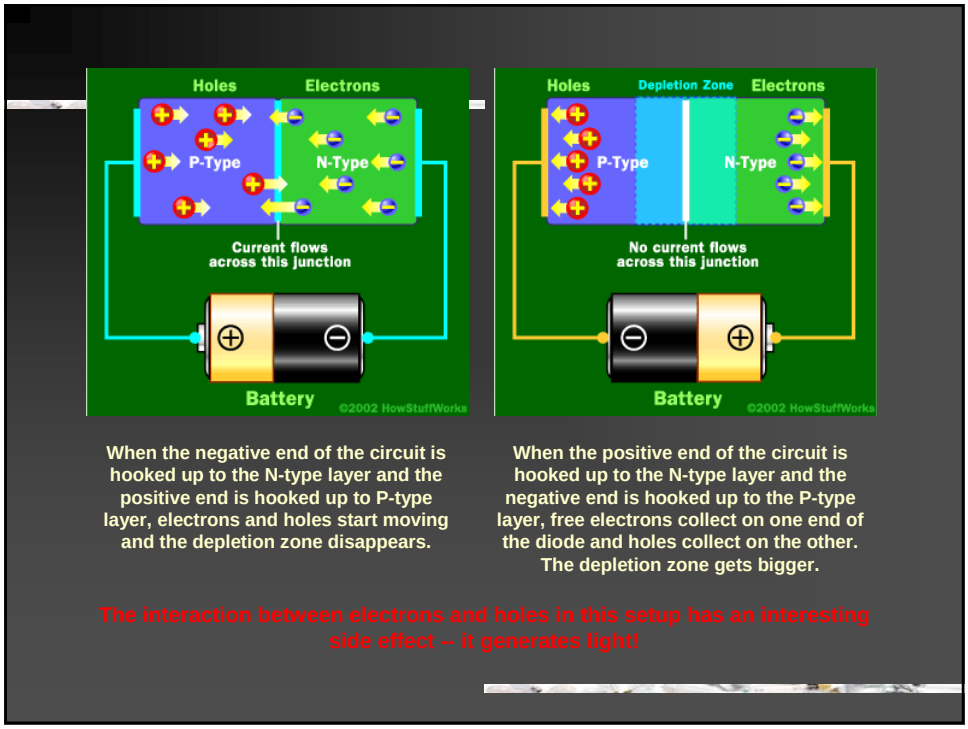
How LED's Work







Lamps

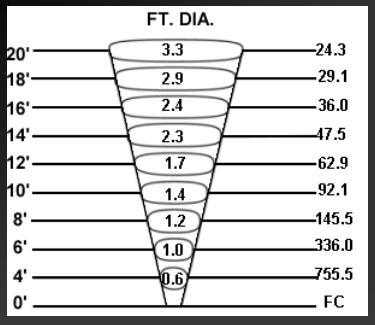


When the negative end of the circuit is hooked up to the N-type layer and the positive end is hooked up to P-type layer, electrons and holes start moving and the depletion zone disappears.

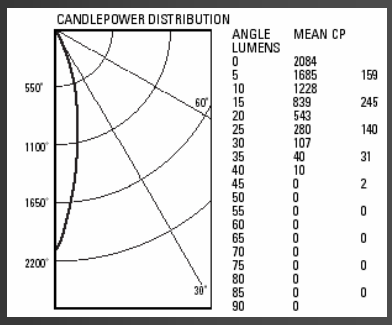
When the positive end of the circuit is hooked up to the N-type layer and the negative end is hooked up to the P-type layer, free electrons collect on one end of the diode and holes collect on the other. The depletion zone gets bigger.

The interaction between electrons and holes in this setup has an interesting side effect -- it generates light!

Lamps



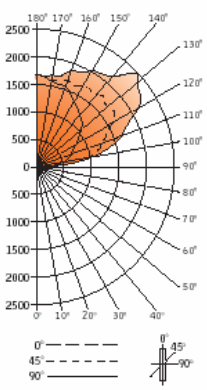
MR16 Illuminance diagram



MR16 downlight Polar Plot

Lamps

CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	0	0	0	0	0	
5°	0	0	0	0	0	0
15°	0	0	0	0	0	0
25°	0	0	0	0	0	0
35°	0	0	0	0	0	0
45°	0	0	0	0	0	0
55°	0	0	0	0	0	0
65°	0	0	0	0	0	0
75°	0	0	0	0	0	0
85°	0	0	0	0	0	0
90°	0	0	0	0	0	
95°	49	217	216	213	210	212
105°	262	727	1041	1109	1116	943
115°	540	947	1577	1849	1942	1393
125°	828	1122	1813	2245	2366	1520
135°	1124	1314	1784	2290	2491	1393
145°	1317	1412	1684	1931	2033	1053
155°	1532	1566	1705	1849	1912	792
165°	1661	1684	1708	1756	1778	485
175°	1711	1708	1706	1703	1703	163
180°	1732	1732	1732	1732	1732	

Linear fluorescent uplight