

A spiral-bound notebook with a textured, light brown cover. The spiral binding is on the left side. The text is centered on the cover.

Lighting Basics

Joe Siedler

Overview

- ☞ What defines good lighting?
- ☞ How do we measure it?
- ☞ Basics of lighting we would use in our shops and homes
- ☞ Future of lighting

The Color of Light

There are many quality differences in white light

Depends on:

- Fluorescent lamp phosphor
- Incandescent Filament temperature
- High Intensity Discharge arc & chemistry

Part 1: Correlated Color Temperature “CCT”

- “warm” - 2700K or 3000K
- “neutral” - 3500K
- “cool” - 4100
- “daylight” - 5000K or 6500K

Part 2: Color Rendering Index (CRI)

Color Temperature (CCT)

Definition:

Describes the appearance, atmosphere, ambiance, or mood created by the light

Measured in Kelvins (K)






CCT is how WARM or COOL the light source appears to your eye.

The correlated color temperature (CCT) is a specification of the color appearance of the light emitted by a lamp, measured in degrees Kelvin (K). The CCT rating for a lamp is a general "warmth" or "coolness" measure of its appearance. However, opposite to the temperature scale, lamps with a CCT rating below 3200 K are usually considered "warm" sources, while those with a CCT above 4000 K are usually considered "cool" in appearance.



COLOR TEMPERATURE	WARM WHITE	SOFT WHITE	NEUTRAL	COOL	SOFT DAYLIGHT	DAYLIGHT
KELVIN	2700K	3000K	3500K	4100K	5000K	6500K
MOOD & EFFECTS	FRIENDLY, PERSONAL, INTIMATE	SOFT, WARM, PLEASING LIGHT	FRIENDLY, INVITING, NON-THREATENING	NEAT, CLEAN, EFFICIENT	BRIGHT, ALERT	BRIGHT, COOL
APPLICATIONS	HOMES, LIBRARIES, RESTAURANTS	HOMES, HOTEL ROOMS, LOBBIES, RESTAURANTS, RETAIL STORES	EXECUTIVE OFFICES, PUBLIC RECEPTION AREAS, SUPERMARKETS	OFFICES, CLASSROOMS, MASS MERCHANDISERS, SHOWROOMS	GRAPHICS INDUSTRY, HOSPITALS	JEWELRY STORES, BEAUTY SALONS, GALLERIES, MUSEUMS, PRINTING

Common Color Temperatures

 Approx Temp.	Light Source
 8500K	Blue Sky
6500K	Daylight Fluorescent Lamp
 6000K	Clear Mercury Lamp
 <u>5000K</u>	Normal high end of Fluorescent Lamps
 <u>4500K</u>	Clear Metal Halide Lamp
 <u>4000K</u>	Cool White Fluorescent Lamp
 3000K	Halogen Lamp, WW Fluorescent
 2500K	40 Watt Incandescent Lamp
 2000K	Candle, HP Sodium

Color Temperature (CCT)

Kelvin Scale (K)

Black Body Locus

Color temperature:
Sources occurring on
the black body locus

Sky &
Sun

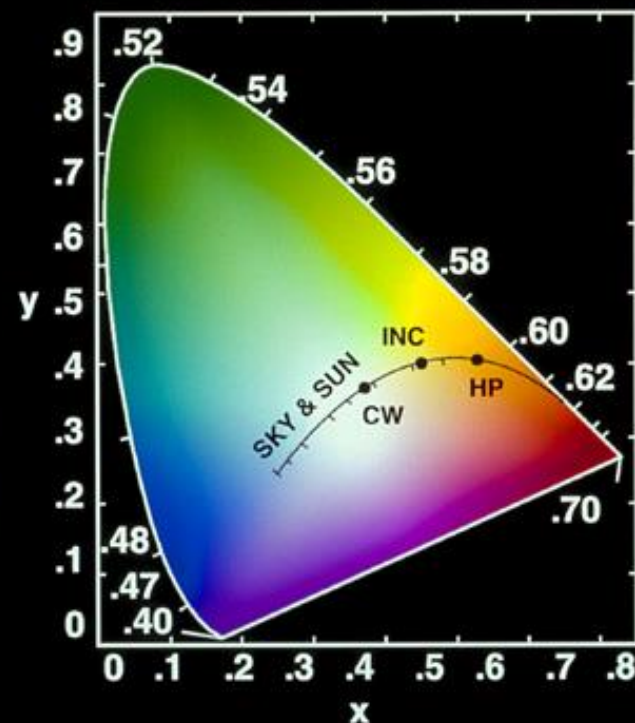
CW

INC

HPS

Correlated color
temperature:

Sources adjacent to
black body locus
(Closest match)



Color Rendering Index (CRI)

Definition:

The ability of a light source to produce natural colors in objects

The higher the CRI the more natural people and objects will appear

Measured on a scale of 0 – 100 where 100 is equal to natural sunlight

CRI or COLOR RENDERING INDEX is a quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.

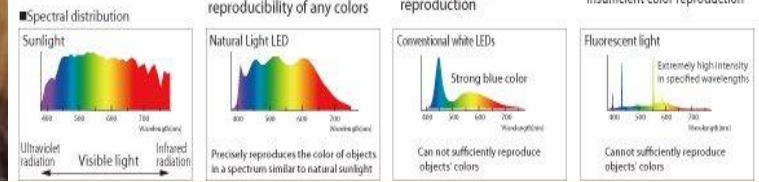
<p>Fair 50–60 CRI Standard Warm White Fluorescent Standard Cool White Fluorescent 60–70 CRI Premium High Pressure Sodium Conventional Metal Halide</p>	
<p>Better 70–80 CRI Thin Coat Tri-Phosphor Fluorescent</p>	
<p>Best 80–90 White High Pressure Sodium Warm Metal Halide Thick Coat Tri-Phosphor Fluorescent 90–100 High CRI Fluorescents Incandescent and Tungsten-Halogen</p>	



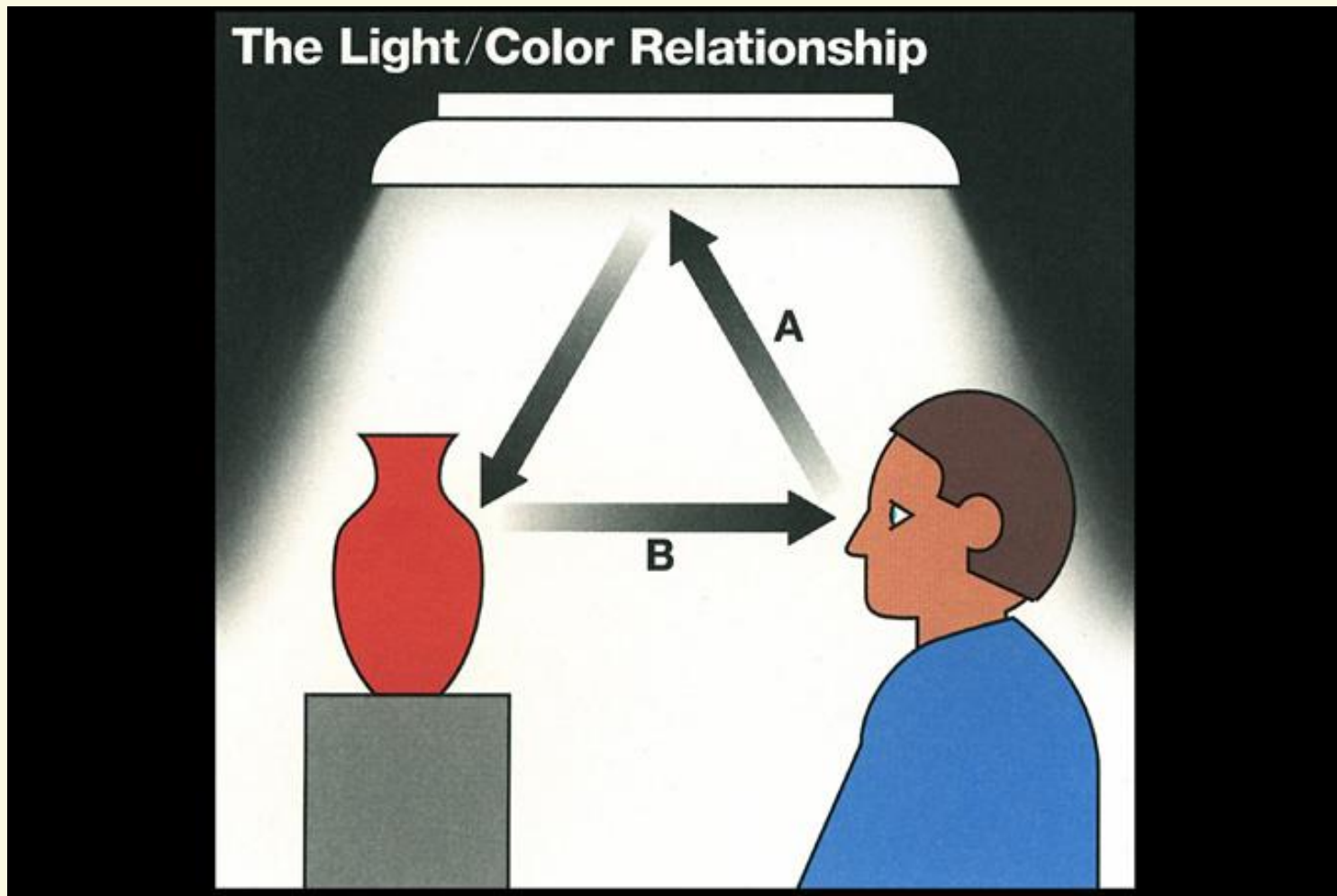
Close to natural sunlight; offers outstanding reproducibility of any colors

Strong bluish tint overall; insufficient color reproduction

Emphasizes specified colors (e.g., green and violet); insufficient color reproduction



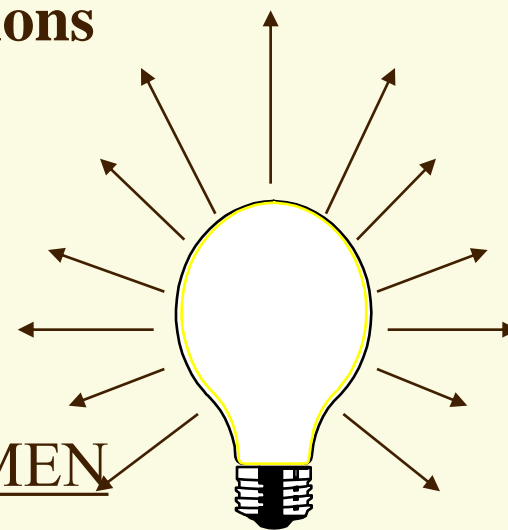
Color Temperature (K) and CRI together



Lamp Light Output

Luminous Flux

Total lamp light output in all directions
metric is the “Lumen”



Equations you'll use with the LUMEN

Source efficacy = (lumens/input wattage)

Illumination in fc=(lumens/area) x losses

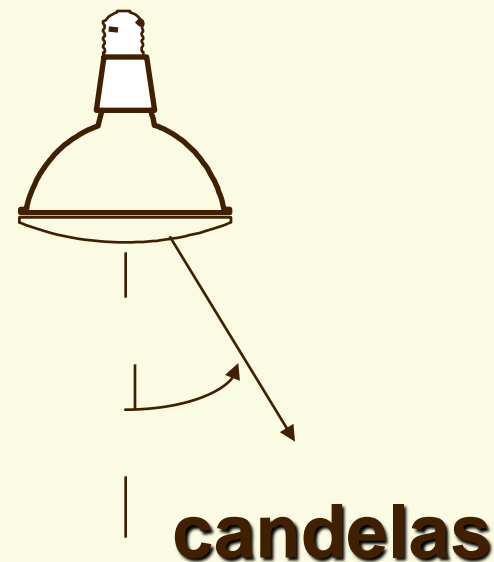
fc (foot Candle) is the standard measurement of usable light

Lamp Light Output

Luminous Intensity

The intensity of light in a given direction:

(candlepower [candelas], cp)



Illumination straight beneath a lamp: = "fc"

ILLUMINATION RECOMMENDATIONS FOR GENERAL LIGHTING

**TABLE 4
Current Illuminance Recommendations for General Lighting and Specific Visual Tasks***

For Specific Visual Tasks

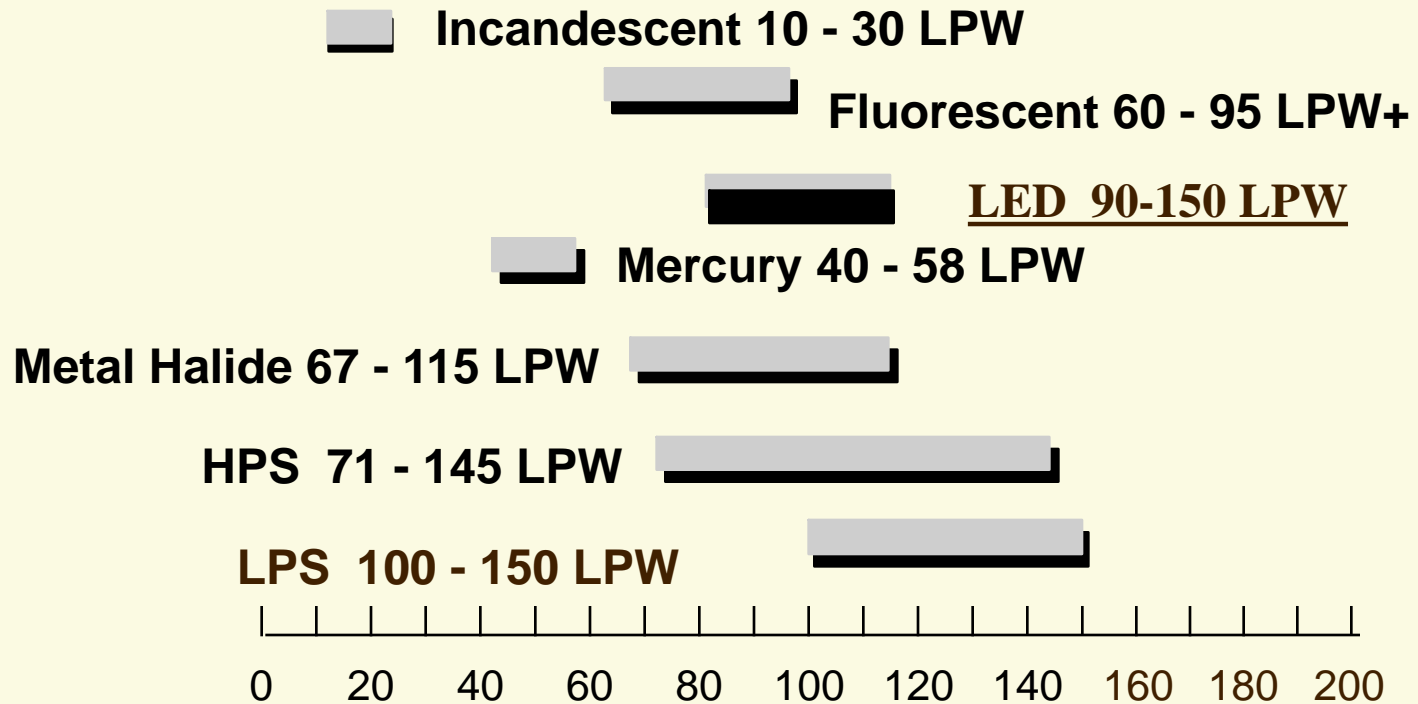
Category C Dining	100, 150, or 200 lux (10, 15, or 20 fc)
Category D Reading—casual, normal, books, magazines, papers Kitchen counter, range, sink—noncritical Laundry—preparation at tubs, washer and dryer Ironing Grooming Full-length mirror Multi-purpose tables Hand and machine sewing—occasional, high contrast Music study—simple scores Workbench hobbies—ordinary tasks	200, 300, or 500 lux (20, 30, or 50 fc)
Category E Reading—handwriting, reproductions, poor copies, study; prolonged, serious or critical Kitchen counter, range, sink—difficult seeing Hand and machine sewing—light to medium fabrics Music study—advanced scores Workbench hobbies—difficult tasks Easel hobbies	500, 750, or 1000 lux (50, 75, or 100 fc)
Category F Hand or machine sewing—dark fabrics, low contrast Music study—substandard size scores Workbench hobbies—critical tasks	1000, 1500, or 2000 lux (100, 150, or 200 fc)
For General Lighting Category B General lighting Conversation, relaxation and entertainment Passageways	50, 75, or 100 lux (5, 7.5, or 10 fc)

Areas involving Visual Tasks— $\frac{1}{3}$ of Visual Task Illuminance but not less than 200 lux (20 fc).

*Maintained in service

Lamp Efficacy

Lumens Per Watt



Lumens Per Watt - Including Ballast

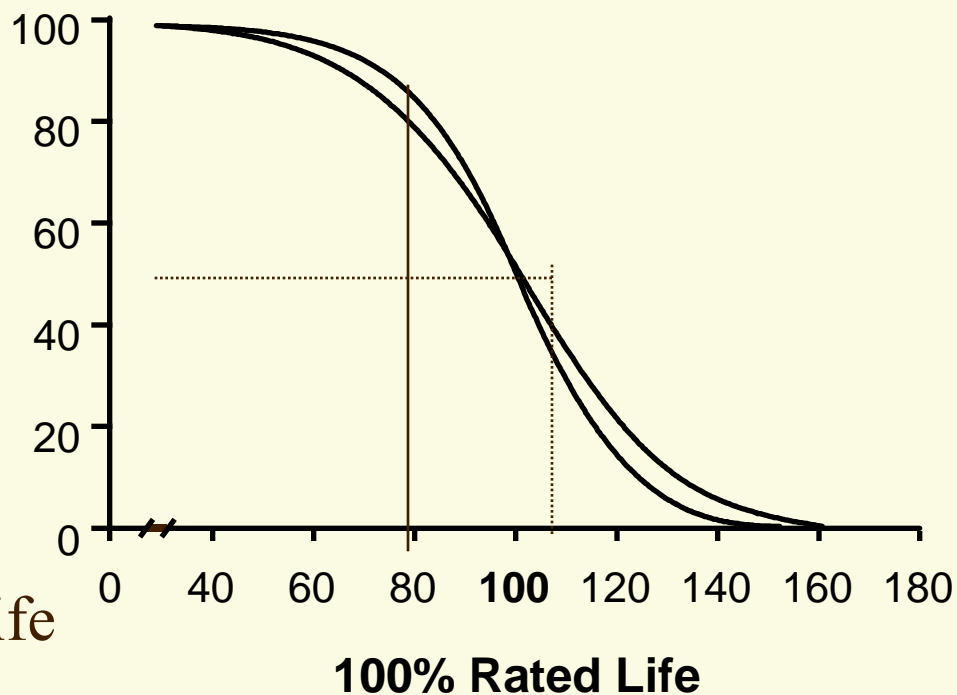
All watts not producing light are expended as heat**

Average Rated Lamp Life

Mortality Curves--

- varies by lamp type *and* by burn-hours-per-start

50% Survivors



Note: it's
not the same
as “useful” life

Lamp Lumen Depreciation

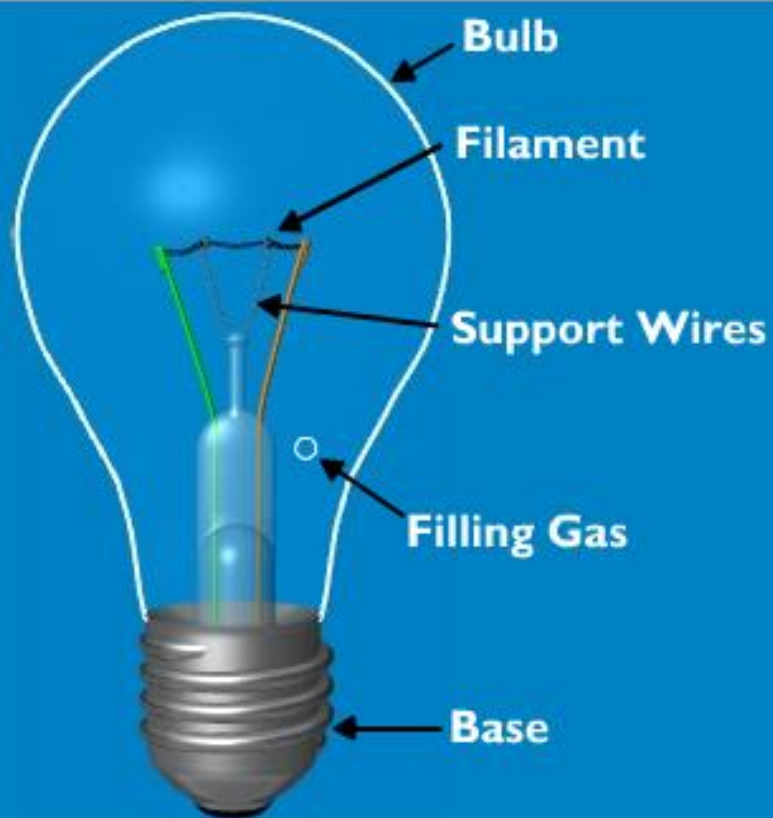
% Initial Lumens-

- important factor in lighting calculations
- Called “**design**” or “**mean**” lumens
- T8 Energy Saving (97%)
- T8 Standard (95%)
- T5 (95%)
- T12 (87%)
- Standard Quartz Arc Metal Halide (65%)
- Pulse Start Quartz Arc Metal Halide (70%)
- Ceramic Metal Halide (75 - 80%)
- 2nd Generation Ceramic Metal Halide (90%)
- High Pressure Sodium (90%)

Incandescent Lamps

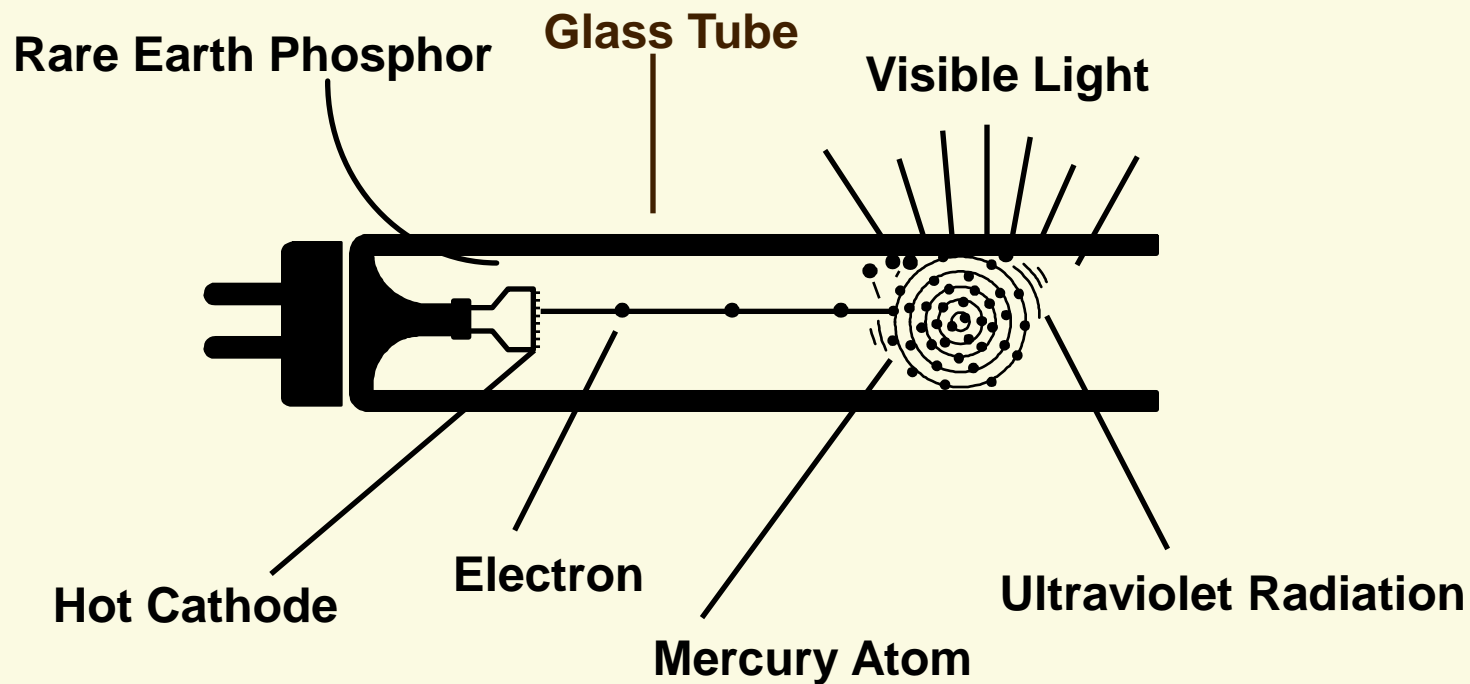
Incandescent Lamps

Lamp Elements





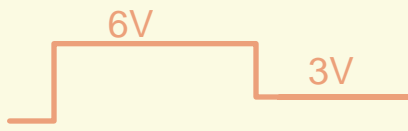
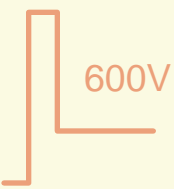
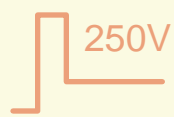

Fluorescent

Construction & Operation



Fluorescent

Lamp starting circuits (Ballasts)

	GOOD Instant Start	GOOD Rapid Start	BEST Programmed Start
Cathode Voltage			
Starting Voltage			
Start Cycles	15 - 20k	15 - 20k	50k+(100K)
Start Temp	0 deg F	50 deg F	0 deg F
Input Power(2x32)	59W (51)	63W	60W(48)
Wiring	//	Series	Series
Rated Life(3hr/start)	24k	30k	30k

Fluorescent Color Description

3-digits to classify lamps

- CRI listed first (7, 8 or 9)
- Color Temperature listed next (27, 30, 35, 41, 50 or 65)
- “835” stands for a CRI of 80+ and Color Temperature 3500.



Good/Better/Best offerings

- Lumen Output
- Lumen maintenance (LLD)
- CRI
- Rated Lamp Life

Example:

F32T8/735

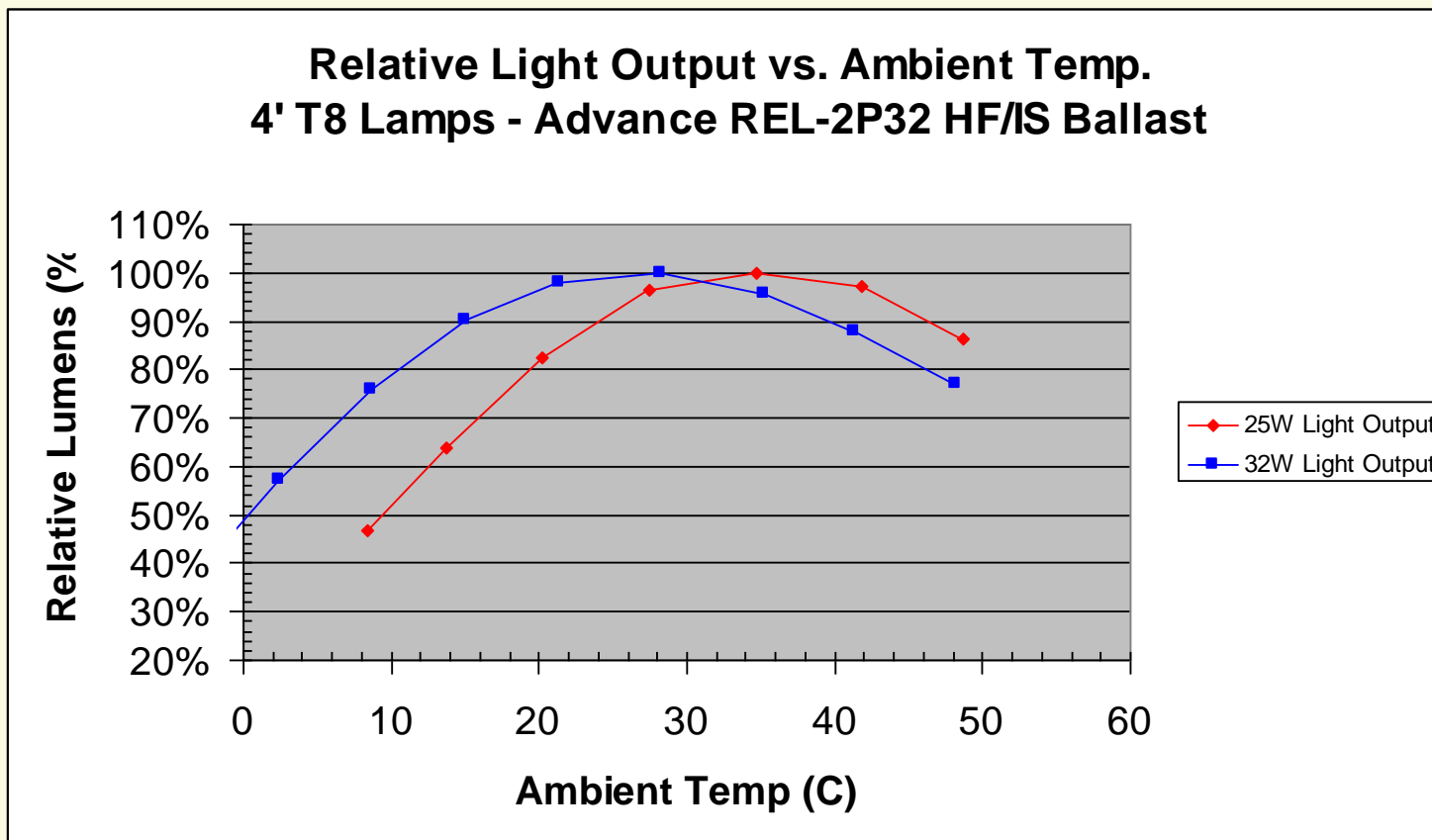
F32T8/835

F32T8/835PLUS / XLL

Energy Saving T8 Options

T8 Product	Wattage	Initial Lumens	Design Lumens
32 Watt Universal TL70	32	2800	2660
32 Watt Universal TL80	32	2950	2800
28 Watt Energy Advantage	28	2725	2645
25 Watt Energy Advantage	25	2500	2425

25W vs. 32W – Light Output vs. Temperature



New Federal Energy Legislation

Calls for phase out of many incandescent lamps starting in 2012

Calls for phase out of many T12 Fluorescent lamps starting in 2012

Options?

Energy saving T8 Fluorescent Lamps: 28 & 25w

Energy Saving Halogen Lamps

LED's : New T8 style LED replacement Lamps

What is the Future in Lighting?

LED

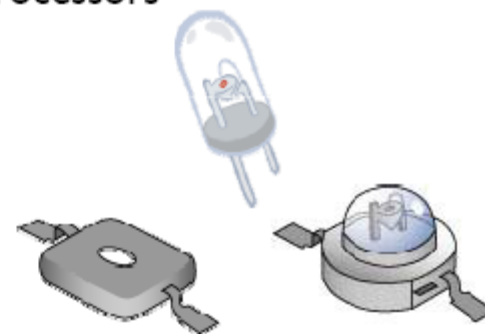
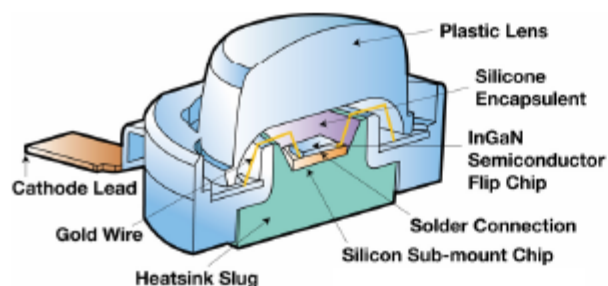
Light Emitting Diodes



LED

WHAT IS AN LED?

- Light Emitting Diode
- An LED is a tiny semiconductor diode device that converts electrical energy directly into a discrete color of light
- The diode is made from different materials and substrates
 - Compounds produce unique colors
 - Gallium Nitride = blues & greens
 - Aluminum Indium Gallium Phosphide = reds & yellows
- LEDs are made in chip 'fabs', just like microprocessors



Advantages of LED's

Size

Efficiency

Life expectancy

Dimmable

Low temperatures

Toxin free

LED life ratings

The life of an LED lamp is generally rated at “L” which is the point when the LED output has decreased to 70% of its initial Lumen output. In contrast a Fluorescent lamp is rated at a point when 50% of the lamps installed on the same date have failed.

Most commercial LED lamp are rated at 25,000 to 45,000 Hours

Not all LED lamps are the same. Offshore manufactures do not use the same standards as major manufactures: GE, Phillips, Sylvania.

Types of T8 LED replacements



GE Recommends - Easiest Installation

Not Recommended

GE Recommends - Best Performance

UL TYPE A

UL TYPE B

UL TYPE C

LED Tube with Integrated Driver Wired to Existing LFL Ballast

LED Tube with Integrated Driver Wired to Mains

LED Tube with Remote Driver



Delivers lowest installation cost. No rewiring required for installation



Medium installation cost. Requires rewiring for installation



Medium installation cost. Requires rewiring for installation



Limited dimming capabilities



Limited dimming capabilities



Controllable dimming system



Reduced system efficacy



Higher system efficacy than UL Type A



Best system efficacy



System compatibility dependent upon LFL ballast



Good system compatibility between LED tube and driver



Optimal system compatibility between GE LED tube and GE Lightech driver



Life dependent on LED tube and LFL ballast



Additional safety processes required due to high-voltage wires



Low-voltage connection to sockets minimizes shock hazard

GE Lighting's Solution

GE Lighting's Solution

QUESTIONS??
