

ART 2640, Building Systems of Interior Environments  
Fall Semester 2020  
Tuesdays & Thursdays 10:30-11:50  
Online

# Lighting for Interiors

# Lighting:

## Light Type

- ❑ Sun/Day light – light/heat from the sun.
- ❑ Combustion – light/heat from combustion (fire).
- ❑ Electrical (human made) – light/heat from human made sources.

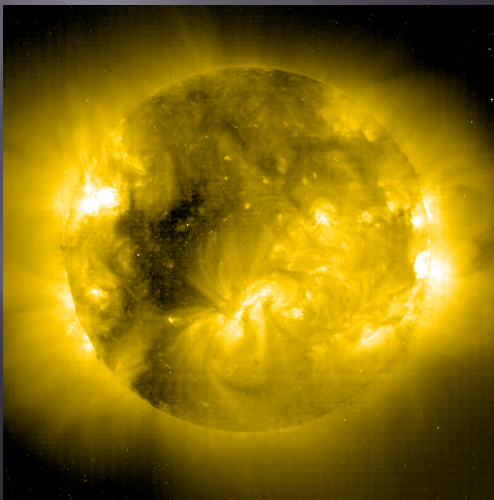
# Sources of Light - Natural

Sunlight

Moonlight

Bioluminescence

Lightning



# Lighting:

## Electrical Light Sources

- ❑ Lamp = Light bulb – the housing producing the source
- ❑ Luminaries – the lighting fixture that includes the lamp
- ❑ Light source properties
  - ❑ Initial Cost
  - ❑ Operating Cost
  - ❑ Color Rendering Index (CRI)
  - ❑ Color Temperature
  - ❑ Ballast / Transformer requirements
  - ❑ Instant on / off
  - ❑ Directionality
  - ❑ Efficacy
  - ❑ Lamp Life
  - ❑ Temperature requirements
  - ❑ Heat generated
  - ❑ Noise generated

# Electric Light Sources

## Incandescent lamps

- ▣ Incandescent
- ▣ Halogen

## Discharge lamps

### Fluorescent

- ▣ Cold Cathode 'Neon'
  - ▣ (HID) High Intensity Discharge
- (LED) Light Emitting Diode

# Lighting:

## The Color Science of Light Sources

### ❑ Color Rendering Index

- ❑ The complexity or completeness of the spectral output of a light source.
- ❑ 0 – 100: 100 = contains all/full spectral energy
  - ❑ 80 – 100 Good/Great
  - ❑ 70 – Ok
  - ❑ 60 – 30 AVOID
  - ❑ 30 – 0 POOR

### ❑ Color Temperature

- ❑ The color that a light source appears to the eye due to an imbalanced spectral output.
- ❑ Expressed in Degrees Kelvins
- ❑ 2500 Kelvins warm
- ❑ 3000 Kelvins neutral
- ❑ 4100 Kelvins cool

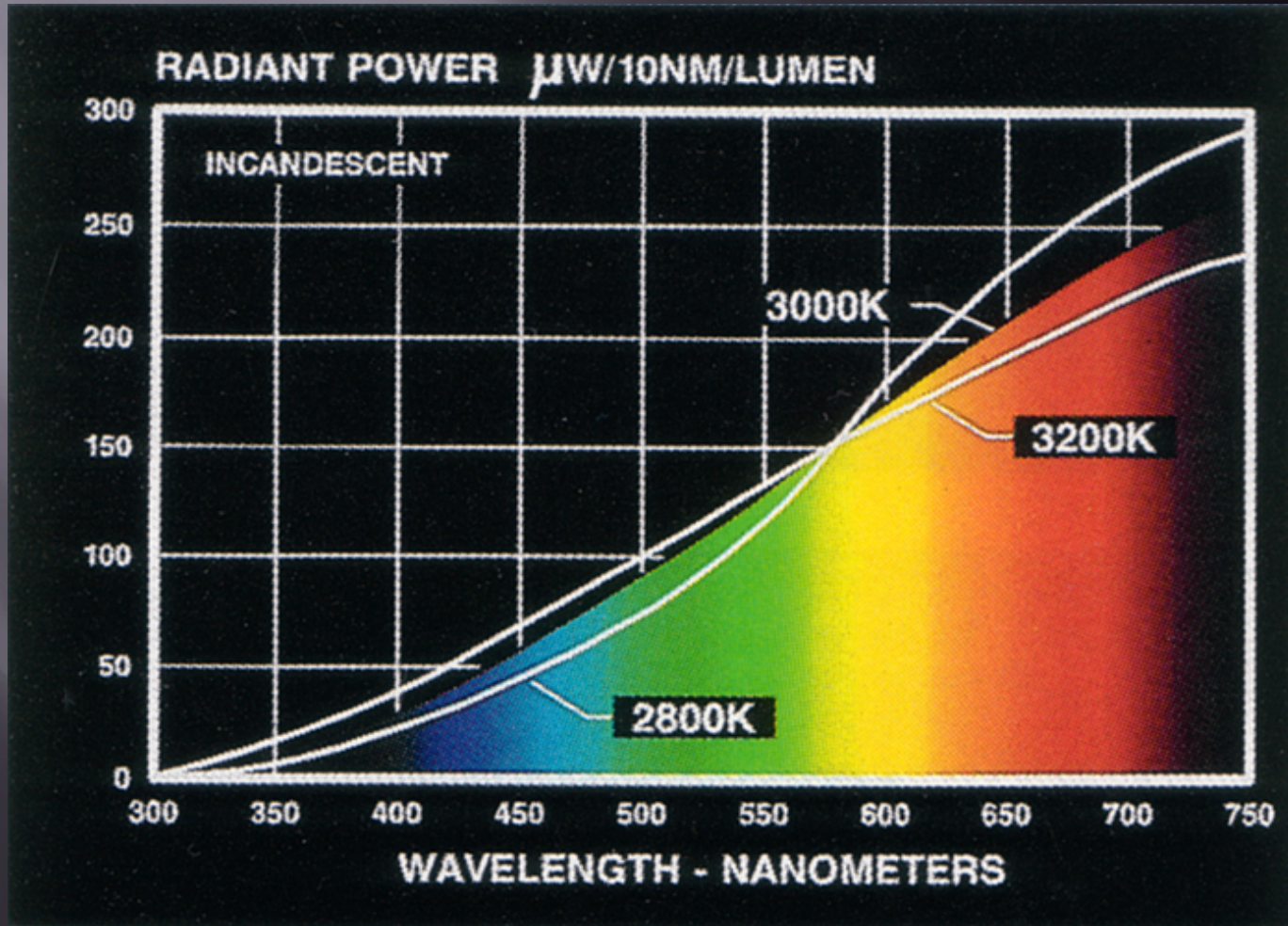
# Lighting:

## Standard Incandescent Sources

- ❑ Standard “light blubs” - 1879
- ❑ How it works – A metal (tungsten) filament that glows when electricity passes through it. Housed in a glass bulb that is vacuum sealed.
- ❑ Properties
  - ❑ Cheap initial cost
  - ❑ Inefficient – high operating cost
  - ❑ Great CRI (100)
  - ❑ Warm color temperature
  - ❑ No Ballast/transformer required
  - ❑ Easily dimmed
  - ❑ Has instant on
  - ❑ Provides diffuse light, poorly directional
  - ❑ Efficacy is poor with 10 lumens per watt (lpw)
  - ❑ Short lamp life
  - ❑ No temperature requirements
  - ❑ Hot = 2/3 energy is heat. 1/3 energy is light.
  - ❑ Some noise when dimming

# INCANDESCENT LAMPS

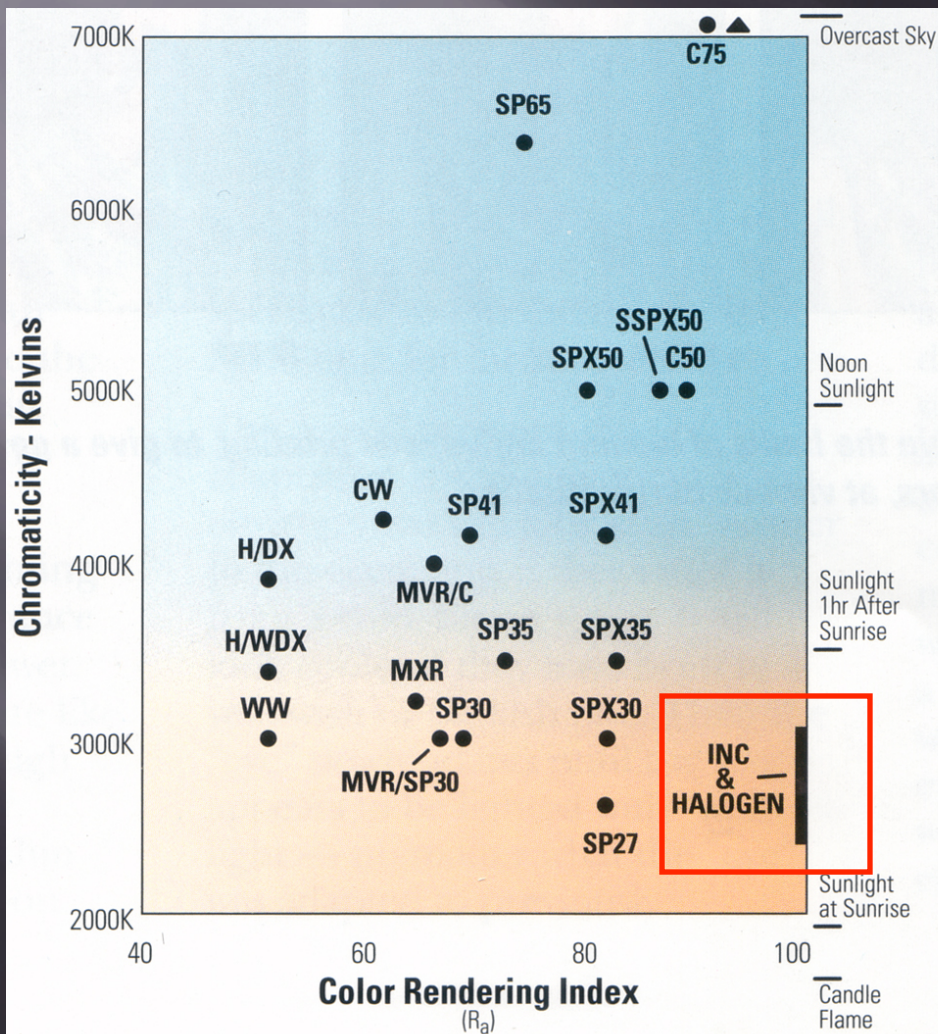
Color Warm 2700-3200 deg. K 99 CRI





# INCANDESCENT LAMPS

Color Warm 2700-3200 deg. K 99 CRI



## The designations are for these lamps:

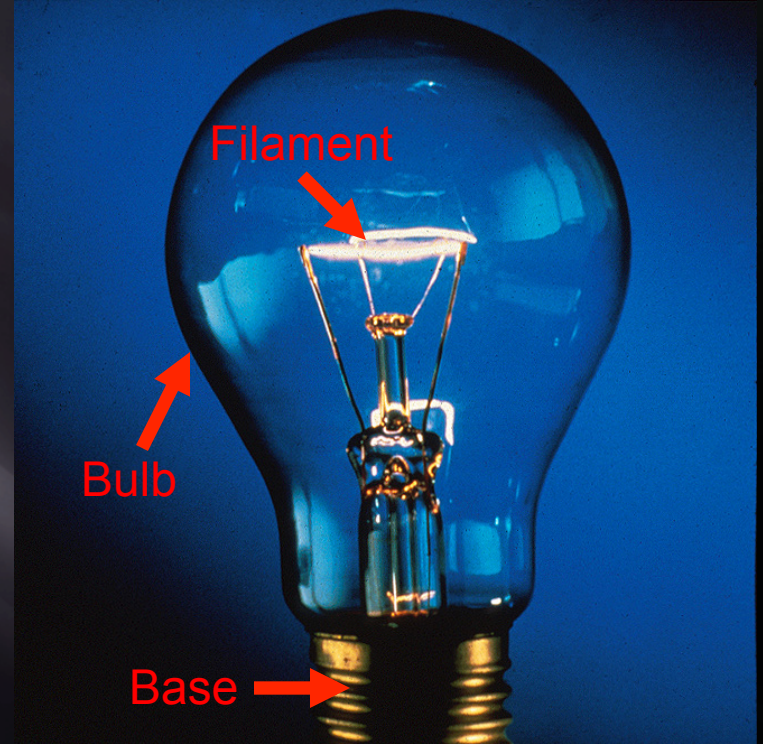
<b>SP30</b>	Specification Series 3000K Fluorescent
<b>SP35</b>	Specification Series 3500K Fluorescent
<b>SP41</b>	Specification Series 4100K Fluorescent
<b>SP65</b>	Specification Series 6500K Fluorescent
<b>SPX30</b>	Deluxe Specification Series 3000K Fluorescent
<b>SPX35</b>	Deluxe Specification Series 3500K Fluorescent
<b>SPX41</b>	Deluxe Specification Series 4100K Fluorescent
<b>SPX50</b>	Deluxe Specification Series 5000K Fluorescent
<b>SSPX50</b>	Super Deluxe Specification Series 5000K Fluorescent
<b>CW</b>	Cool White, Fluorescent
<b>WW</b>	Warm White, Fluorescent
<b>C50</b>	Chroma 50, Fluorescent
<b>INC</b>	Incandescent
<b>H/DX</b>	Mercury Deluxe
<b>H/WDX</b>	Mercury Warm Deluxe
<b>MVR</b>	Multi-Vapor
<b>MVR/SP30</b>	Multi-Vapor, Phosphor Coated
<b>MXR</b>	Halarc®
<b>LU/DX</b>	Deluxe Lucalox

# INCANDESCENT LAMPS

## Operation

Varied shapes and sizes lamps but the process of operation is the same.

Electricity passes through a wire in a glass bulb with filled with a gas such as argon, nitrogen, halogen or a vacuum. The resistance to the electricity in the wire causes the wire or filament to heat to the point of incandescence. When a material incandesces it produces visible light.

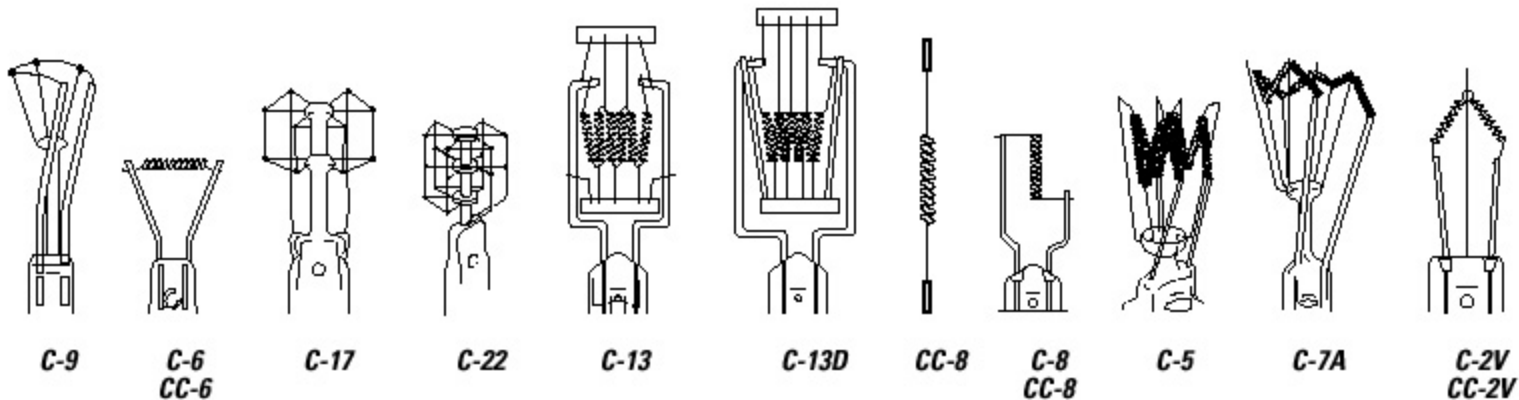


# INCANDESCENT LAMPS

## Filaments

- The first filament was made of carbon in Edison's lamp.
- Contemporary lamps have tungsten filaments. They are coiled to increase efficacy (lumens per watt) and reduce heat loss.
- The filament is .0018" dia.- 21" long in 60w A-lamp
- Failure of lamps occur when the tungsten evaporates and breaks.
- During the life of the lamp the tungsten deposits itself on the bulb decreasing the effectiveness of the lamp (up to 80%).

## FILAMENT IDENTIFICATION



# INCANDESCENT LAMPS

## Gas Fill

Lamps 40 watts and less have vacuums in the bulb.

## **What is a vacuum?**

Gas in other lamps are argon and nitrogen (mixture varies according to wattage).

Other lamps may contain krypton increase efficacy 10% but expensive.

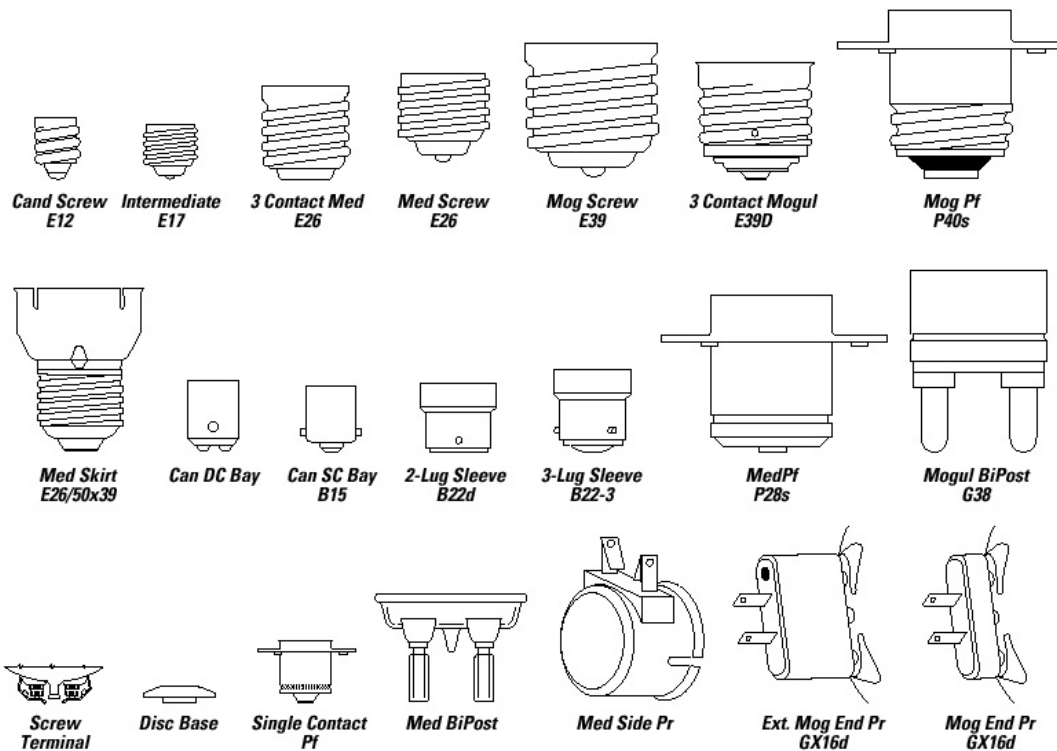
All lamps contain inert gasses (do not react with other atoms)

# INCANDESCENT LAMPS

## Bases

Base-- two purposes- mechanically holds the lamp in place and allows for the electrical connection. You need to know the base type to match the correct fixture.

### BASE IDENTIFICATION



# INCANDESCENT LAMPS

## Bulbs

**Bulb** The glass case that encloses the filament.  
Used to determine lamp measurement. The lamp number refers to the number of 1/8" in the diameter of the bulb.

**An A-19 lamp would have a diameter of how many inches?**

**A par 38 lamp would have a diameter of how many inches?**

Most bulbs are composed two types of glass:

Soft-- Soda lime glass-- general service lamps - interior applications.

Hard (quartz)--Resistant to water and for exterior use.

# INCANDESCENT LAMPS

## Lamp Types/Shapes

General service-- A, S, P, PS, and T bulb

Decorative-- F,G,CA,B

Reflector -- R (Reflector)

PAR (Parabolic Aluminized Reflector)

Tungsten Halogen

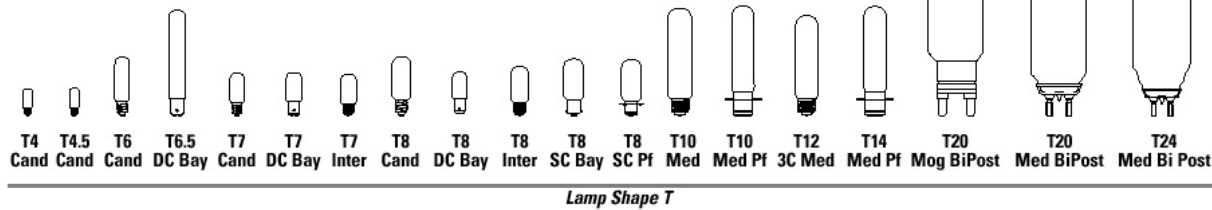
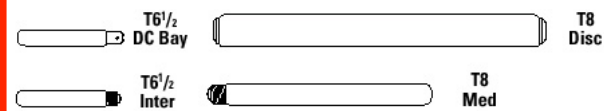
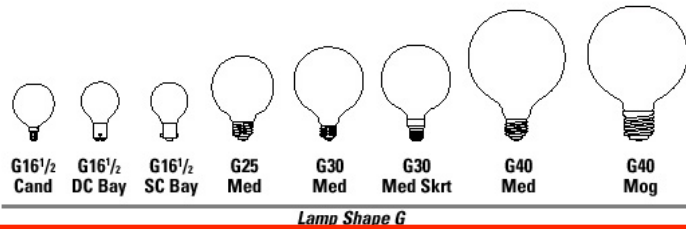
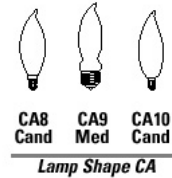
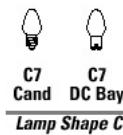
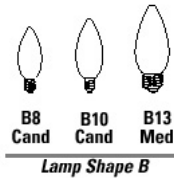
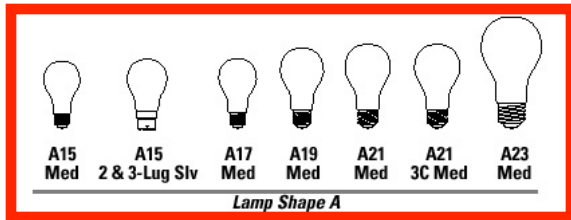
Low Voltage Lamp - MR

# INCANDESCENT LAMPS

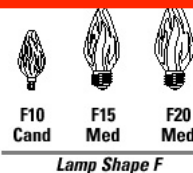
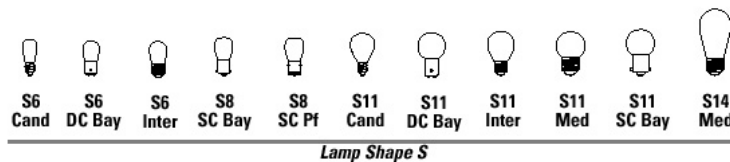
## General service -- A, S, P, PS, and T bulb

- radiates light in all directions
- home and table lamp fixtures

### LAMP LOCATOR



*Lamp Shape M*



*Lamp Shape E*



# INCANDESCENT LAMPS

## Decorative-- F,G,CA,B

--radiate light in all directions

--used for accent lighting

--low wattages

-- sparkle

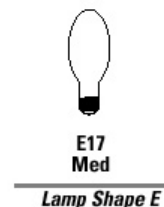
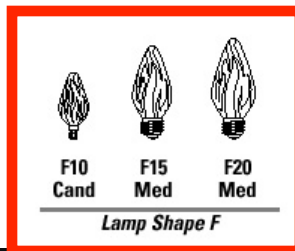
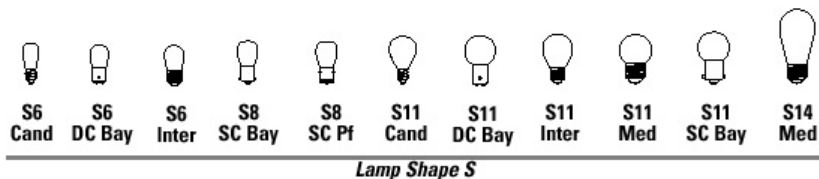
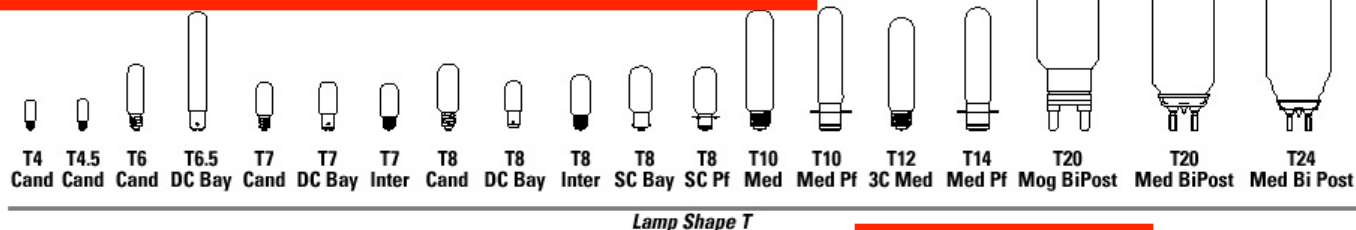
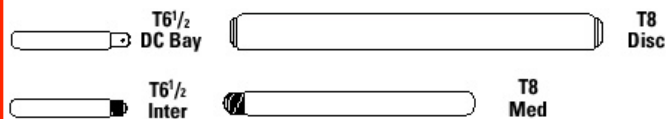
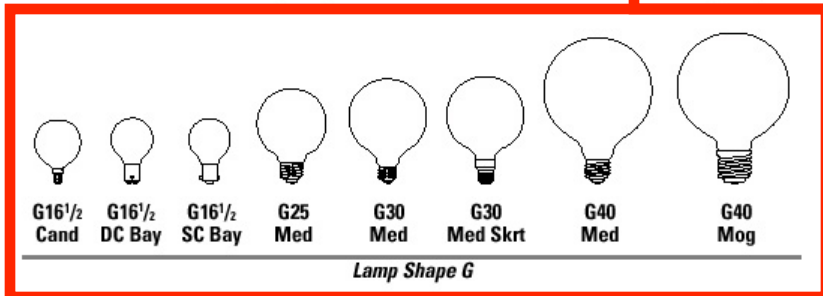
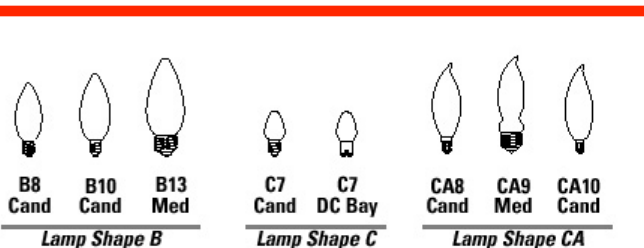
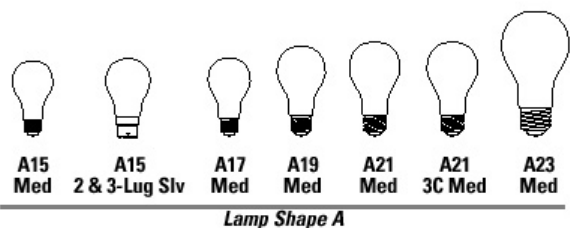
--often you will see churches use decorative lights to illuminate a space.

**What would be the problems in using decorative lamps for ambient light?**

# INCANDESCENT LAMPS

## Decorative-- F,G,CA,B

### LAMP LOCATOR

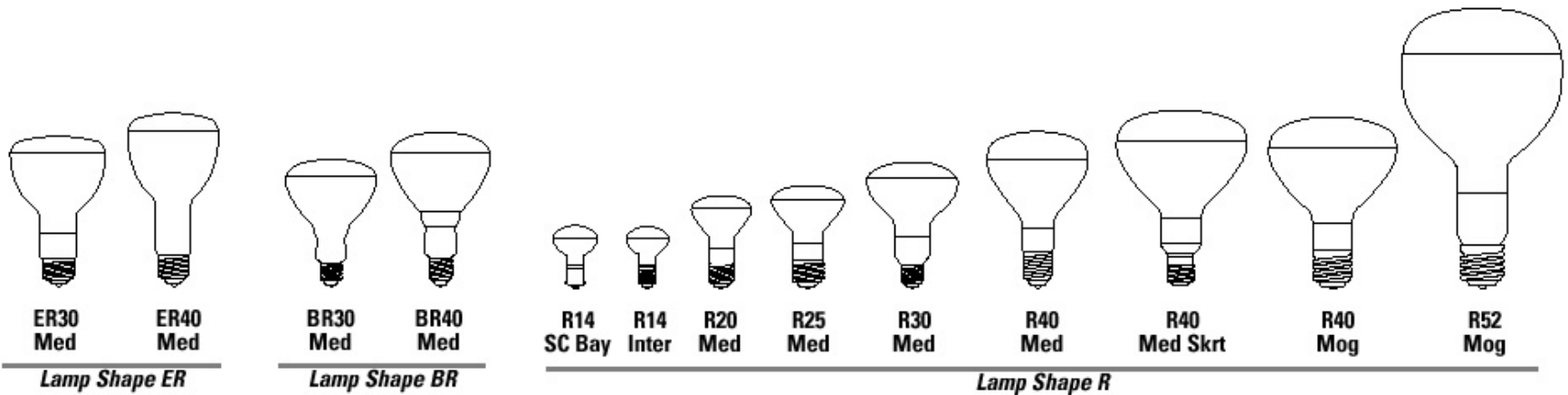


# INCANDESCENT LAMPS

## Reflector -- R (Reflector)

- Designed with built in reflectors
- Inside of glass is coated with aluminum or silver
- Directs light in a particular direction

It is important to use a candle power distribution chart to understand how a particular lamp directs its light



# INCANDESCENT LAMPS

## Reflector -- R (Reflector)

- One piece glass bulb
- Made of soda- lime glass
- Produces some stray light. (soft edges)
- 20/30/40 produce round beam patterns
- ER (Elliptical Reflector) lamps produce a elliptical beam pattern
- Typically used in deep recessed lighting and track lighting
- Can only be used for interior applications

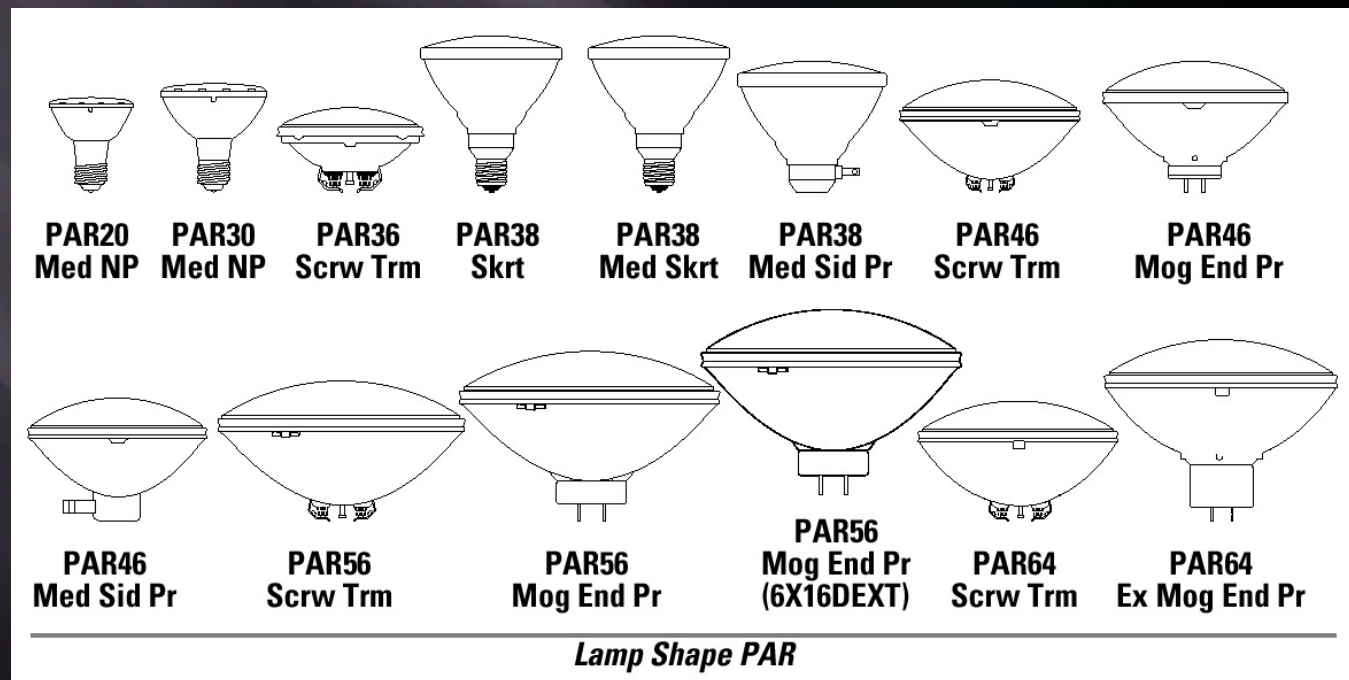


# INCANDESCENT LAMPS

## PAR (Parabolic Aluminized Reflector)

- Similar to R lamps but more accurate direction of light.
- Designed with built in reflectors
- Inside of glass is coated with aluminum or silver
- Directs light in a particular direction

It is important to use a candle power distribution chart to understand how a particular lamp directs its light



# INCANDESCENT LAMPS

## PAR (Parabolic Aluminized Reflector)

- Two piece construction (parabolic reflector and lens)
- Greater control of light and sharp edges
- Used for interiors and outdoors
- Typically used for retail, hospitality, residential,
- Cost more than R-Lamps



# Lighting:

## Halogen Incandescent Sources

- ❑ Halogen, Quartz Halogen, Tungsten Halogen
- ❑ How it works - same as standard incandescent housed in a quartz bulb filled with halogen gas.
- ❑ Properties:
  - ❑ Moderate initial cost
  - ❑ Expensive operation cost
  - ❑ Great CRI (100)
  - ❑ Color temperature is warm to neutral
  - ❑ Some require a ballast / transformer
  - ❑ Easily dimmed
  - ❑ Has an instant on
  - ❑ Easily can be directional light
  - ❑ Poor efficacy at 15 lumens per watt (lpw)
  - ❑ Medium to good lamp life
  - ❑ No temperature requirements
  - ❑ Generates a lot of heat
  - ❑ Generates some noise

# INCANDESCENT LAMPS

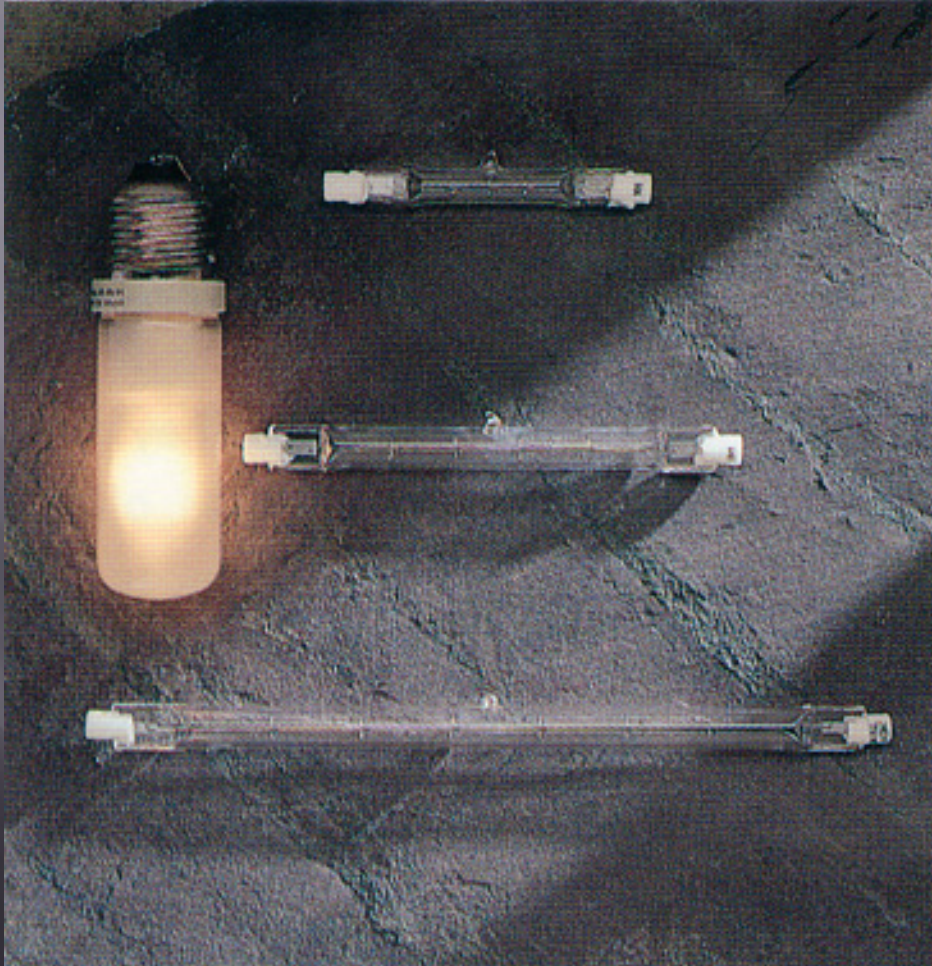
## Tungsten Halogen

- Bulb filled with halogen gasses
- As the tungsten evaporates the halogen combines with the tungsten to keep particles off the bulb.
- The lamp remains 98% of maintenance throughout life. (Little tungsten is deposited on the lamp surface)
- Lamp Life is between 1000-5000 hours (greater than typical incandescent lamp)
- Color temperature is around 3000-3200deg K (2700 typical incan)
- Saves energy (More lumens per watt)
- Can serve many different applications decorative, washes, spots



# INCANDESCENT LAMPS

## Tungsten Halogen



# INCANDESCENT LAMPS

## Tungsten Halogen PAR Lamps

-- Similar operation to tungsten halogen but with parabolic configuration

-- Whiter light compared to PAR and R

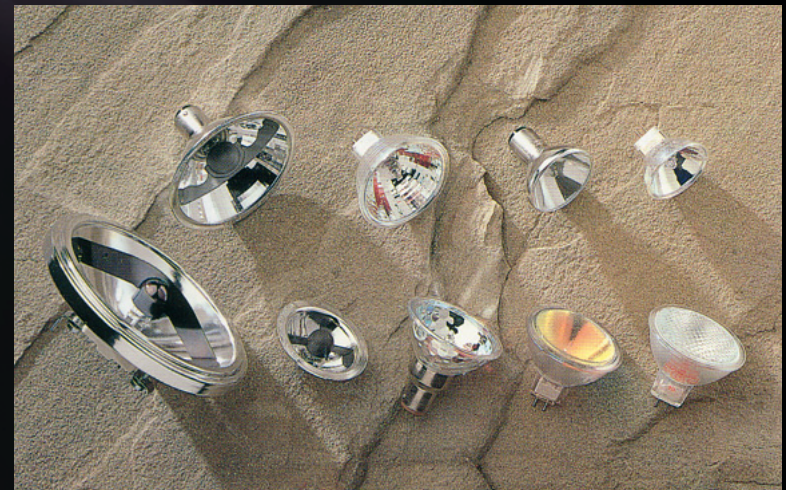
-- Better Efficacy compared to a typical par lamp



# INCANDESCENT LAMPS

## Low Voltage Lamps

- 12 volt energy system (step down transformer required for operation)
- Designed to precisely control the direction of light
- Small facets on the inside of light
- Tungsten halogen source
- Low color shift
- 90% of the maintained lumens over life.

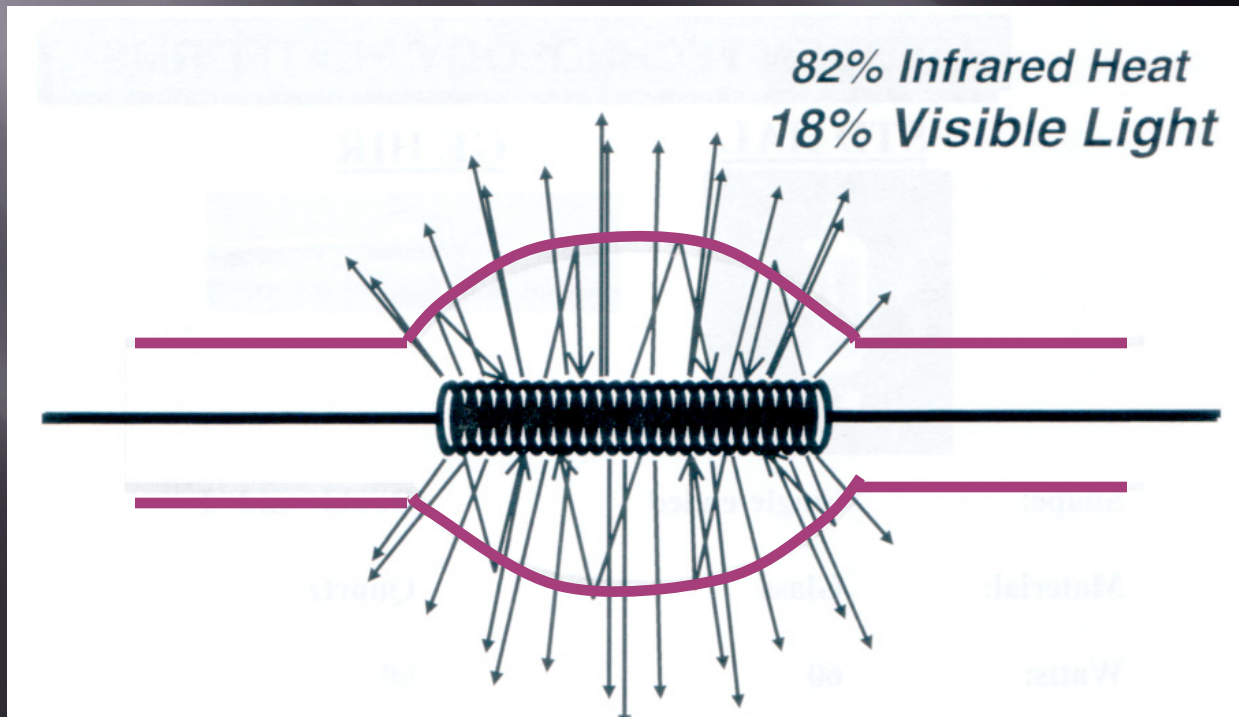


# INCANDESCENT LAMPS

## IR PAR/Halogen Lamps

-- Infrared coating on the inside of the bulb directs heat back to filament increasing efficiency

-- 60 w IR provides the light of a 90 w lamp



# INCANDESCENT LAMPS

## IR PAR/Halogen Lamps

- The coating redirects wasted heat to heat the filament.
- Lowers the UV Emissions
- 50% Cooler than PAR Halogen lamps
- Cuts energy costs
- Good for displays with perishable materials.
- Long life (Up to 6000 hours.)

# INCANDESCENT LAMPS

## Incandescent Considerations

- Inefficiency (most energy used produces heat) Up to 90% of the energy used to produce Incandescent light is lost as heat.
- Short lamp life (you must pay a person to change the lamps) 700-1000 hrs (better for halogen, but not comparable to fluorescent and HID).
- Very good CRI (99/100)
- Pleasing color temperatures (warm 2400-3200 deg.)
- Easily Dimmable (Color becomes visually warm when dimmed)
- Excellent light control (small source)
- Typically used for accent and task lighting.

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# INCANDESCENT LAMPS - SPECIFICATION

**MOL in.:**  
Maximum Overall Length in inches.

**LCL in.:**  
Distance between the center of the filament and the Light Center Length reference plane, in inches.

**Filament Design:**

Filaments are designated by a letter combination in which C is a coiled wire filament, CC is a coiled wire that is itself wound into a larger coil, and SR is a straight ribbon filament. Numbers represent the type of filament-support arrangement.

**Energy Used - Nominal Watts:**

Energy Used (as defined by FTC Lamp Label Rules). To estimate energy consumption (kWh), multiply watts x hours of use and divide by 1000.

**Case Quantity:**

Number of product units packed in a case.

**Life - Hours:**

Life (as defined by FTC Lamp Label Rules) is rated average life in hours.

**Light Output - Lumens:**

Light output (as defined by FTC Lamp Label Rules) is rated average lumens.

**Reference Color Temperature Kelvins (K):**

"Warmth" or "Coolness" of the lamp, measured in Kelvins (K). The higher the temperature, the cooler the appearance of the light.

**Bulb Shape:**

Bulb shape followed by its size (the maximum diameter of the bulb expressed in eighths of an inch).

**Order Code:**

It is important to use this five-digit code when ordering to ensure that you receive the exact product you require.

**Base:**

The type of base.

**Lamp Description:**

The lamp's identification code.

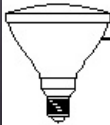
**Approximate CBCP (Center Beam Candlepower):**

For reflector type lamps. Center Beam Candlepower is the intensity (candelas) at the center or maximum intensity of the beam.

**Additional Information**

Typical application and/or other important information.

Shape	Base	Order Watts	Order Code	Description	Case Volts	Filament Qty.	Design	MOL	LCL	Rated Avg. Life Hours	Color Lumens	Temp. K	CBCP	Footnote	Additional Information
<b>HALOGEN PAR38 LAMPS</b>															
<b>HIR™</b>															
PAR38	Med Skirt	50	12396	50PAR/HIR/SP9	120	12	CC-8	5.31		3000	850	2810	14000	⚡ 15, 23, 56, 80, 88, 96	Spotlight



**50 PAR / HIR / SP 9**

Identifies the lamp's wattage.

Identifies the lamp shape and the bulb diameter in eighths of inches.

Identifies the lamp type.

Identifies beam angle, code may also include packaging information.

Identifies as Spotlight.

# INCANDESCENT LAMPS - SPECIFICATION

## Light Control / Beam Spread

VNSP--very narrow spot 5 deg - 13deg

NSP-- Narrow Spot

SP-- Spot

NFL-- Narrow Flood



FL -- Flood



GE WEB SITE FOR CATALOGS:

<http://www.gelighting.com/na/contactus/literature.html>





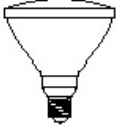
# INCANDESCENT LAMPS - SPECIFICATION

Shape	Base	Watts	Order Code	Description	Volts	Case Qty.	Filament Design	MOL	LCL	Rated Avg. Life Hours	Lumens Initial	Color Temp. K	CBCP	Approx. Beam Spread	Footnotes	Additional Information
<b>INCANDESCENT LAMPS (CONTINUED)</b>																
	R20	Med	50	16542	50 PAR 36 VWFL	12	12	C-6	2.75	2000	330		600	55	15	Very Wide Flood, Filament Shield
				14885	50R20/SW/1-6PK	120	30	CC-6	3.93		2000	380			4, 35, 56	Indoor Floodlight, Soft White
				14888	50R20/PL/1-6PK	120	30	CC-6	3.93		2000				4, 35, 56	Indoor Floodlight, House Garden™, Plant Light
				14896	50R20/1-6PK	120	30	CC-6	3.93		2000	410		510	4, 35, 56	Indoor Spotlight
	A19	Med	60	14052	60A/SSW-24PK	120	120	CC-8	4.43	3.12	1000	840				Super Soft, Soft White
				14414	60A/CVG 24PK	120	24	CC-6	4.43	3.12	1000	850			23, 47, 83	Inside Frost, covRguard™, Teflon® Coated

Shape	Base	Watts	Order Code	Description	Volts	Case Qty.	Filament Design	MOL	LCL	Rated Avg. Life Hours	Lumens	Color Temp. K	CBCP	Footnote	Additional Information
<b>HALOGEN COMPACT PAR LAMPS (CONTINUED)</b>															
<b>COMPACT PAR20</b>															
	PAR20	Med NP	50	14927	50PAR20/H/SP10	120	6	CC-8	3.12	2500	570	2800	6000	☞ ↗ 15, 55, 56, 80, 88	Spotlight
				14928	50PAR20H/FL25	120	6	CC-8	3.12	2500	570	2800	1500	☞ ↗ 15, 55, 56, 80, 88	Floodlight
				50 17866	50PAR20/H/SP10	130	15	CC-8	3.12	2500	570	2800	6000	☞ ↗ 15, 55, 56, 80, 88	Spotlight
				46		120				5000	498				
			50 17868	50PAR20/H/FL25	130	15	CC-8	3.12	2500	570	2800	1500	☞ ↗ 15, 55, 80, 88	Floodlight	
			46		120				5000	498					
<b>HALOGEN COMPACT PAR16</b>															
	PAR16	Med NP	60	41623	60PAR16/H/FL30	120	6	CC-8	2.87	2000	650		1550	☞	Floodlight
				41624	60PAR16/H/SP10	120	6	CC-8	2.87	2000	650		5400	☞	Spotlight
				75 41629	75PAR16/H/FL30	120	6	CC-8	2.87	2000	900		1600	☞	Floodlight
				41630	75PAR16/H/SP10	120	6	CC-8	2.87	2000	900		6200	☞	Spotlight

# INCANDESCENT LAMPS - SPECIFICATION

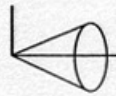
Shape	Base	Watts	Order Code	Description	Volts	Case Qty.	Filament Design	MOL	LCL	Rated Avg. Life Hours	Lumens	Color Temp. K	CBCP	Footnote	Additional Information
<b>MR</b>															
<b>TURN &amp; LOCK CONSTANTCOLOR®</b>															
	MR16	TAL	50 30899	<b>50MR16/Q/40/TL</b>	12	10	C-6	2		3500		3000	1395	132	Floodlight
			30900	50MR16/Q/20/TL	12	10	C-6	2		3500		3000	3330	132	Narrow Floodlight
			30901	50MR16/Q/10/TL	12	10	C-6	2		3500		3000	10800	132	Narrow Spotlight
<b>CONSTANTCOLOR® PRECISE™ COVER GLASS MR16</b>															
	MR16	2-Pin GU5.3	20 20857	<b>Q20MR16C/CG40</b>	12	20	C-6	1.87		5000		2900	475	132	Floodlight, Clear Glass Protective Lens, Suitable for Use in Open Fixtures

Shape	Base	Watts	Order Code	Description	Volts	Case Qty.	Filament Design	MOL	LCL	Rated Avg. Life Hours	Lumens	Color Temp. K	CBCP	Footnote	Additional Information	
<b>HALOGEN PAR38 LAMPS (CONTINUED)</b>																
<b>LONG LIFE</b>																
	PAR38	Med Skirt	45 17470	45PAR/H/SP10	120	6	CC-8	5.31		2500	510	2750	7000	15, 23, 56, 88, 96	Spotlight	
			17471	45PAR/H/FL25 6PK	120	6	CC-8	5.31		2500	510	2750	1800	15, 23, 56, 88, 96	Floodlight	
			25947	45PAR/H/FL-TWIN	120	3	CC-8	5.31		2500			1800		Floodlight	
			45 16229	45PAR/H/SP10 130V	130	12	CC-8	5.31		2500	510	2750	7000	15, 23, 56, 88, 96	Spotlight	
			40		120					5000	385					
			45 16231	45PAR/H/FL25	130	12	CC-8	5.31		2500	510	2750	1800	15, 23, 56, 88, 96	Floodlight	
			40		120					5000	385					
			60 25266	<b>60PAR/H/SP10</b>	120	12	CC-8	5.31		2500	810	2800	13000	15, 23, 46, 56, 83, 88	Spotlight	
			25269	60PAR/H/FL25	120	12	CC-8	5.31		3000	800	2800	2800	15, 23, 56, 83, 88, 96	Floodlight	
			25270	60 PAR/H/SP10	130	12	CC-8	5.31		3000	800	2800	13000	15, 23, 46, 56, 83, 88	Spotlight	
		120					6000	608								
25271	60PAR/H/FL25	130	12	CC-8	5.31		3000	800	2800	2800	15, 23, 56, 83, 88, 96	Floodlight				
		120					6000	608								

# INCANDESCENT LAMPS - SPECIFICATION

Lamp	Hours	Watts	Lumens	Efficacy	Color Temp.	Beam	Shape Size
50R20/FL	2000	50	380	7.6 L/W*	2800	FLOOD	Reflector 2"
60A19	1000	60	840	14 L/W	2800	N/A	A 2 3/8"
50PAR20H/ FL25	2500	50	570	11.4 L/W	2800	FLOOD	PAR 2"
60PAR16/ H/SP10	3500	60	N/A	N/A	3000	SPOT	PAR 2"
50MR16/Q/ 40	5000	20@12 Volts	N/A	N/A	3000	FLOOD	MR 2"
Q20MR16/ C/CG40	5000	20@12 Volts	N/A	N/A	2900	FLOOD	MR 2"
60PAR38/ H/ SP10	2500	60	810	13.5 L/W	2800	SPOOT	PAR 4"

# INCANDESCENT LAMPS - SPECIFICATION











Lamp	Rated Life	Beam Spread	0° Aiming Angle					30° Aiming Angle					45° Aiming Angle					60° Aiming Angle				
			D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S
<b>Q20 MR16/VSNP</b> (Halo Z32)	3,000	7°x 5°	7	183	1	1	1	6	163	1	1	1	4	198	1	1	1	2	291	1	1	1
			10	90	1	2	2	9	73	1	2	2	6	88	1	1	1	3	129	1	1	1
			13	53	2	2	2	12	41	2	2	2	8	50	2	2	2	4	73	2	1	1
			16	35	2	3	3	15	26	2	3	3	10	32	2	2	2	5	47	2	2	2
<b>Q20 MR16/NSP</b> (Halo Z30) 12V ESX	2,000	15.7°x 13.3°	6	97	2	1	1	3	270	1	1	1	4	89	2	1	1	3	65	3	1	1
			8	55	2	1	2	5	97	2	1	1	6	39	3	2	2	5	24	5	2	2
			10	35	3	2	2	8	38	3	2	2	8	22	4	2	2	7	12	7	3	3
			12	24	3	3	3	11	20	4	3	2	10	14	5	3	3	9	7	9	4	4
<b>Q20 MR16/FL</b> (Halo Z35) 12V BAB	2,000	37.6°x 37.0°	4	31	3	3	3	3	47	3	2	2	2	68	2	2	2	1	144	2	1	1
			6	14	4	4	4	5	17	4	4	4	3	30	4	3	2	2	36	3	2	2
			8	8	5	5	5	7	9	6	5	5	4	17	5	4	3	3	16	5	3	3
			10	5	7	7	6	9	5	8	7	6	5	11	6	5	4	4	9	6	4	4
<b>25W R14</b> (Halo Z11)	1,500	73.7°x 73.7°	3	15	4	4	4	3	14	5	4	4	2	25	3	2	3	1	58	2	2	2
			4	9	6	6	6	4	8	7	6	5	3	11	5	3	4	2	14	3	3	3
			5	5	7	7	7	5	5	8	7	6	4	6	7	6	6	3	6	6	5	5

[Link to Entire Lamp Reference](#)

What lamp would you specify if you want to illuminate a display case of diamonds at 200fc at a distance of 7ft? What will be the beam spread?

# INCANDESCENT LAMPS - SPECIFICATION











Lamp	Rated Life	Beam Spread	0° Aiming Angle					30° Aiming Angle					45° Aiming Angle					60° Aiming Angle				
			D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S
75 PAR30/ CAP/NSP 	2,000	12°x 12° 	7	217	3	3	2	6	192	3	3	2	4	239	3	2	2	2	363	3	1	1
			10	106	4	4	3	9	85	4	4	3	6	106	4	3	3	3	161	4	2	2
			13	63	5	5	4	12	48	6	5	5	8	60	6	4	4	4	91	5	3	3
			16	42	6	6	5	15	31	7	6	6	10	38	7	5	5	5	58	7	4	3
75 PAR30/ CAP/NFL 	2,000	32°x 32° 	4	194	3	3	3	3	226	3	3	2	2	320	3	2	2	2	154	4	2	2
			6	86	5	5	4	5	81	5	4	4	3	142	4	3	3	3	68	6	3	3
			8	48	6	6	6	7	42	7	6	5	4	80	6	4	4	4	39	8	4	4
			10	31	8	8	7	9	25	9	8	7	5	51	7	5	5	5	25	9	5	5
Q75 MR16/NSP (Halo Z40) 	3,500	13°x 12° 	7	297	2	2	2	6	276	2	2	2	4	364	2	2	2	2	573	2	1	1
			10	146	3	3	3	9	123	4	3	3	6	162	4	3	2	3	255	3	2	2
			13	86	4	4	4	12	69	5	5	4	8	91	5	4	3	4	143	5	2	2
			16	57	5	5	5	15	44	6	6	5	10	58	6	4	4	5	92	6	3	3
Q75 MR16/FL (Halo Z45) 	3,500	39°x 39° 	4	148	4	4	3	3	199	3	3	3	2	301	3	2	2	1	645	2	1	1
			6	66	5	5	5	5	72	5	4	4	3	134	4	3	3	2	161	3	2	2
			8	37	7	7	7	7	37	7	6	6	4	75	5	3	3	3	72	5	3	3
			10	24	9	9	9	9	22	9	8	8	5	48	7	4	4	4	40	7	4	4

What lamp would specified if you want 50fc in a 6" diameter circle for a hall fixture 8" from the floor?

# INCANDESCENT LAMPS - SPECIFICATION



Lamp	Rated Life	Beam Spread	0° Aiming Angle					30° Aiming Angle					45° Aiming Angle					60° Aiming Angle				
			D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S	D	FC	L	W	S
75 PAR30/ CAP/NSP 	2,000	12°x 12° 	7	217	3	3	2	6	192	3	3	2	4	239	3	2	2	2	363	3	1	1
			10	106	4	4	3	9	85	4	4	3	6	106	4	3	3	3	161	4	2	2
			13	63	5	5	4	12	48	6	5	5	8	60	6	4	4	4	91	5	3	3
			16	42	6	6	5	15	31	7	6	6	10	38	7	5	5	5	58	7	4	3
75 PAR30/ CAP/NFL 	2,000	32°x 32° 	4	194	3	3	3	3	226	3	3	2	2	320	3	2	2	2	154	4	2	2
			6	86	5	5	4	5	81	5	4	4	3	142	4	3	3	3	68	6	3	3
			8	48	6	6	6	7	42	7	6	5	4	80	6	4	4	4	39	8	4	4
			10	31	8	8	7	9	25	9	8	7	5	51	7	5	5	5	25	9	5	5
Q75 MR16/NSP (Halo Z40) 	3,500	13°x 12° 	7	297	2	2	2	6	276	2	2	2	4	364	2	2	2	2	573	2	1	1
			10	146	3	3	3	9	123	4	3	3	6	162	4	3	2	3	255	3	2	2
			13	86	4	4	4	12	69	5	5	4	8	91	5	4	3	4	143	5	2	2
			16	57	5	5	5	15	44	6	6	5	10	58	6	4	4	5	92	6	3	3
Q75 MR16/FL (Halo Z45) 	3,500	39°x 39° 	4	148	4	4	3	3	199	3	3	3	2	301	3	2	2	1	645	2	1	1
			6	66	5	5	5	5	72	5	4	4	3	134	4	3	3	2	161	3	2	2
			8	37	7	7	7	7	37	7	6	6	4	75	5	3	3	3	72	5	3	3
			10	24	9	9	9	9	22	9	8	8	5	48	7	4	4	4	40	7	4	4

What lamp would you specify to illuminate a painting on the wall at a distance of 8' at 45 degree angle? The painting is 3' X3' and can not have more than 100fc.

# Incandescent Light Sources



# Incandescent Light Sources



Residential

Retail

Showrooms

Restaurant  
and  
Hospitality



# INCANDESCENT LAMPS - SPECIFICATION



# INCANDESCENT LAMPS - SPECIFICATION



project  
**Plaza Las Fuentes  
Hotel**  
Pasadena, CA  
architect  
**Moore Rubell Yudell**  
interior  
**Babey-Moulton, Inc.**  
photographer  
**Jaime Ardiles Arce**

Massive hanging chandeliers dominate the aesthetics of this passage, providing the general illumination and an intriguing design element. Seating groups are each in the warm light of a large table lamp. Lit upper balconies create definition and add perspective to the space.

# INCANDESCENT LAMPS - SPECIFICATION



# INCANDESCENT LAMPS - SPECIFICATION

Reveals texture and material.

Provides focus.



# INCANDESCENT LAMPS - SPECIFICATION

Creates sparkle.



Produces sharp shadows.



# INCANDESCENT LAMPS - SPECIFICATION

Warm color  
temperature.

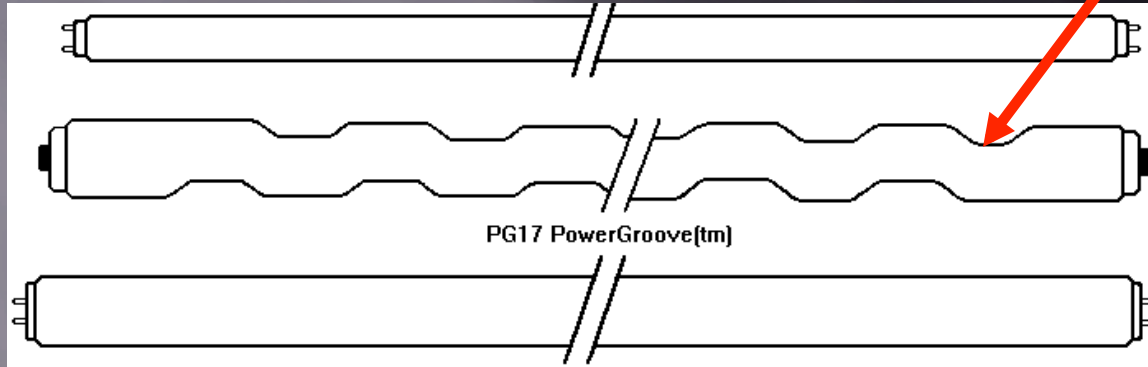


# Lighting: Fluorescent

- ❑ Most common commercially used light source
- ❑ How it works: electrons are released into a glass tube covered with phosphors. These electrons excite various metal vapors (mercury) and they release UV radiation that excite the phosphors to glow.
- ❑ Properties:
  - ❑ Moderate initial cost
  - ❑ Inexpensive operating cost
  - ❑ CRI is moderate to good (70 – 90)
  - ❑ Color Temperature is warm to cool
  - ❑ A ballast/transformer is required – electronic/magnetic
  - ❑ Expensive to dim
  - ❑ Instant on with electronic ballast not with magnetic
  - ❑ Provides diffuse light
  - ❑ Excellent efficacy at 70 lpw
  - ❑ Excellent lamp life
  - ❑ Prefers warmer temperature to operate most efficiently
  - ❑ Very little heat is generate (still warm to touch)
  - ❑ Magnetic ballast produce humming / buzzing sound, electronic not as bad.

# FLUORESCENT LAMPS

## Lamp Shapes - Tubes



Grooves provides a larger surface area for light to be emitted from the lamp.



Tube fluorescent lamps are large (12"-96" in length). The large size makes optical control difficult. They are good for providing large amounts of light over a large area. Many ambient lighting systems are created with tube fluorescent lighting systems.



# FLUORESCENT LAMPS

## Lamp Shapes - Tubes



T lamps sized refer to the diameter of the tube.

A T12 is 12 1/8 inches in diameter or 1 1/2" These lamps are being phased out in new fixtures. They are common in older fixtures.

A T8 is 1" in diameter. This is the most common lamp type for 2X4 fluorescent fixtures. They allow greater control of light and more energy efficiency. The mercury arc is closer to the phosphor.

T5 lamps are now being implemented in newer fixtures. The smaller size allows for greater control of light.

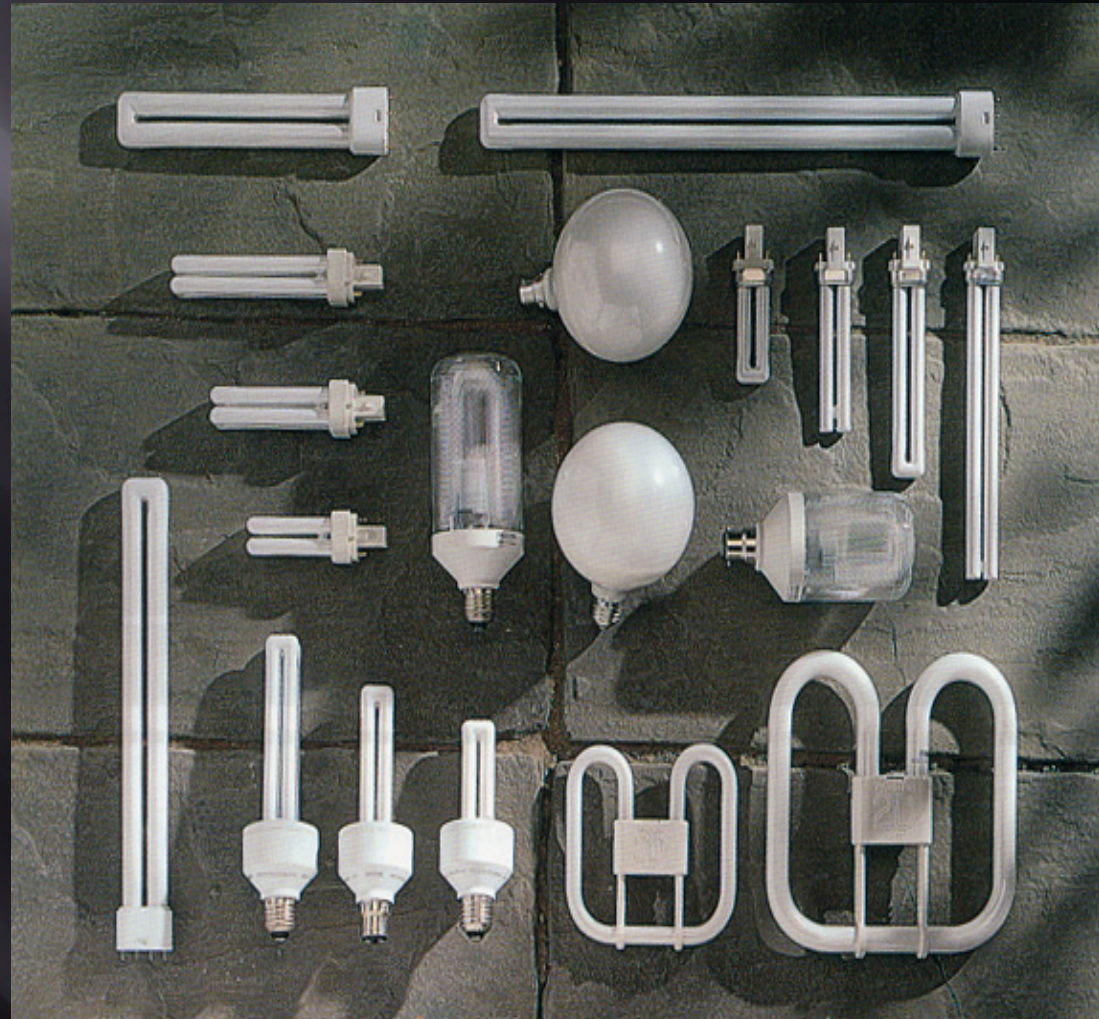
# FLUORESCENT LAMPS

## Lamp Shapes \_ Compact

Why Smaller and More Compact Fluorescent Shapes?

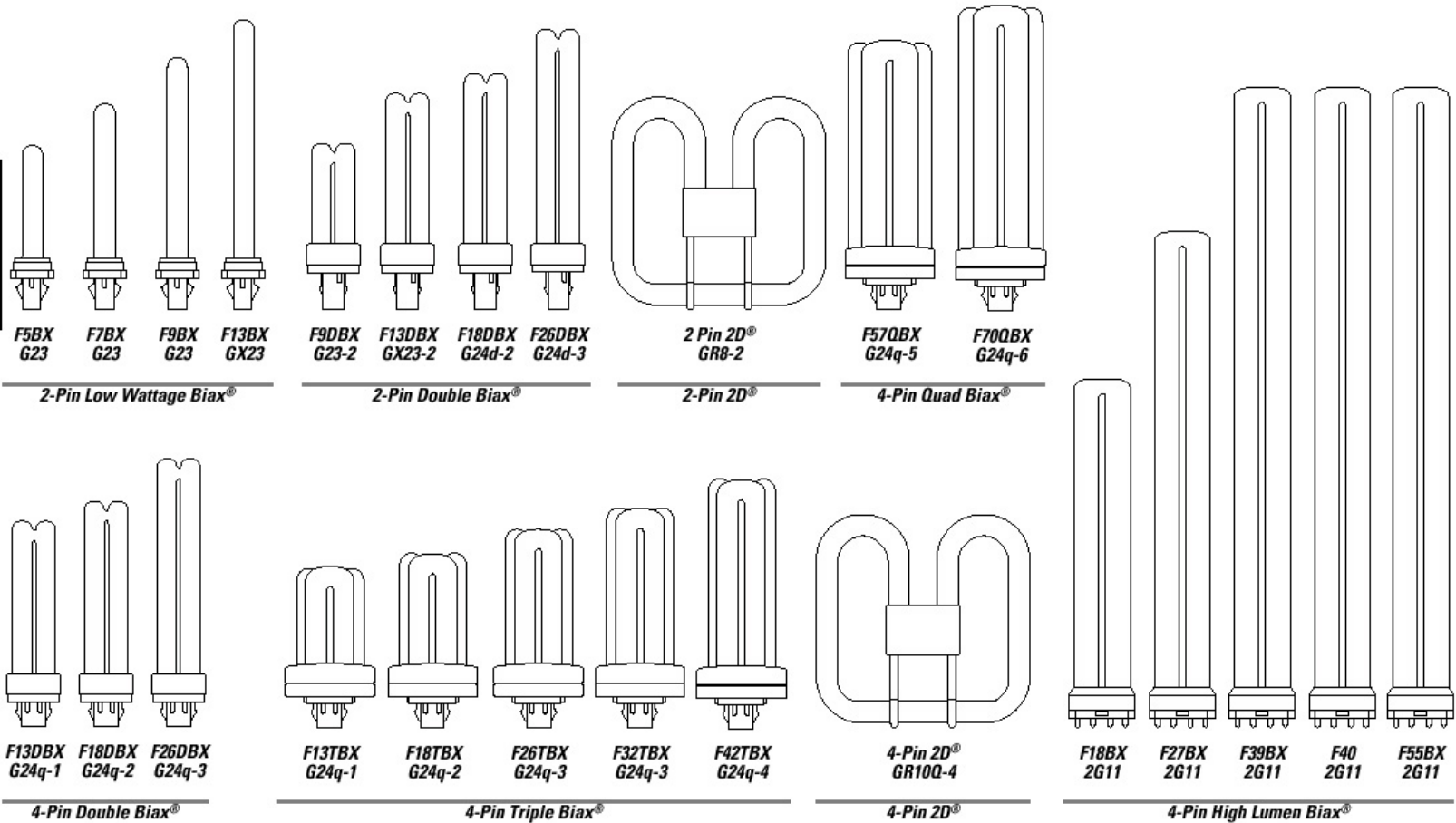
The smaller the light source the easier the optical control. Thus glare may be reduced.

Compact fluorescent lamps are slightly less energy efficient compared to tube fluorescent. The bend in tube creates energy inefficiency and shorter lamp life.



# FLUORESCENT LAMPS

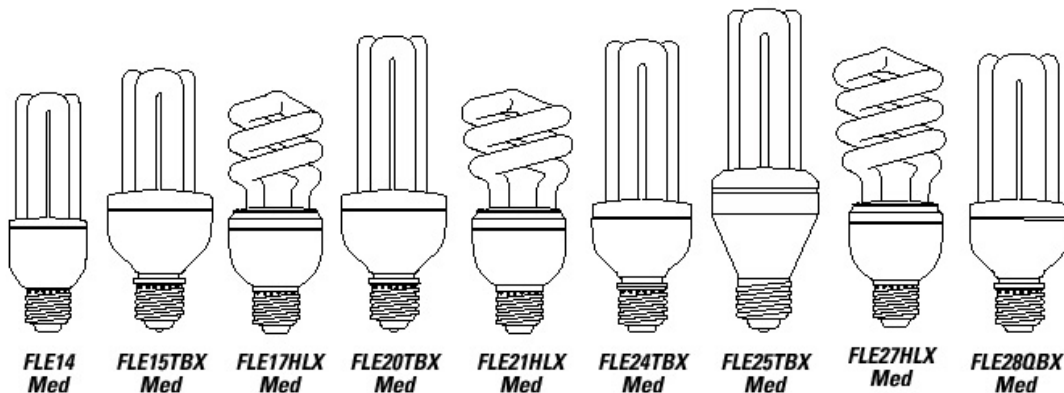
## Lamp Shapes - Compact



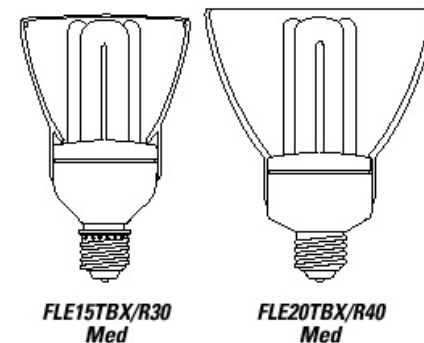
Plug-in Lamps

# FLUORESCENT LAMPS

## Lamp Shapes - Compact

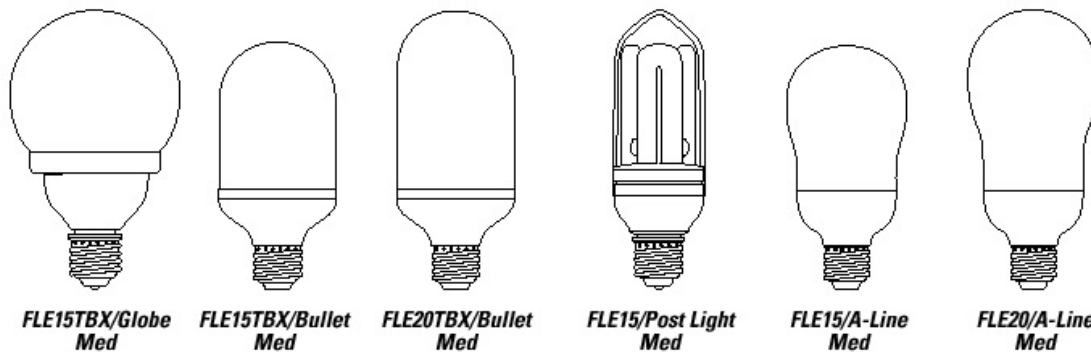


Electronic Performance Biax®



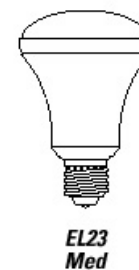
Reflectors

Reflector shapes to direct light.



Covered (A-Line, Bullet, Post, and Globe)

Diffusing Covers to Reduce Glare

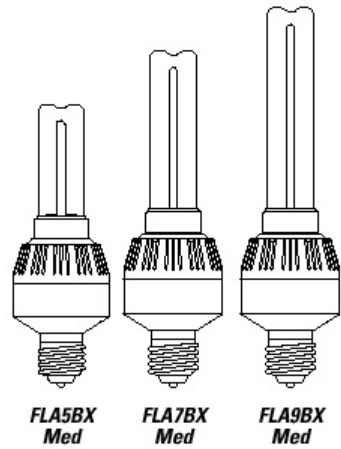


Genura™

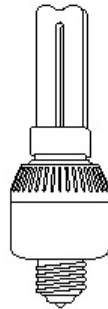
Self Ballasted Lamps

# FLUORESCENT LAMPS

## Lamp Shapes - Compact

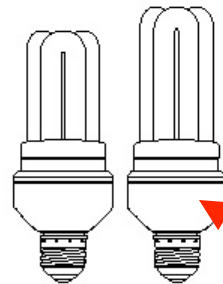


*Biax®-Magnetic*



FLA13DBX Med

*Double Biax®-Magnetic*



FEA13TBX Med  
FEA18TBX Med

*Triple Biax®-Electronic*

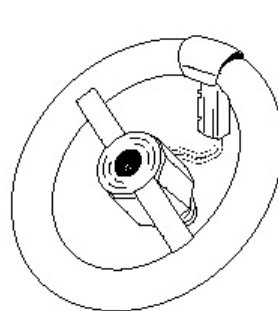
Self ballasted shapes to be used in traditional incandescent fixtures.

Ballast

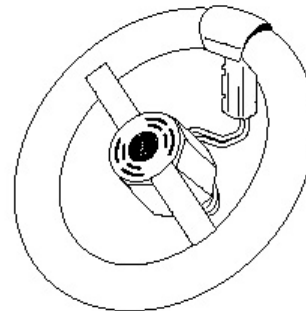


FEA 2D Med

*2D®-Electronic*



FCA21 Med



FEA30 Med

*Circlite*

**Lamps and Adapters**

# FLUORESCENT LAMPS

## Ballast

1. provides energy for start up arc
2. limits and regulates the current to the lamp

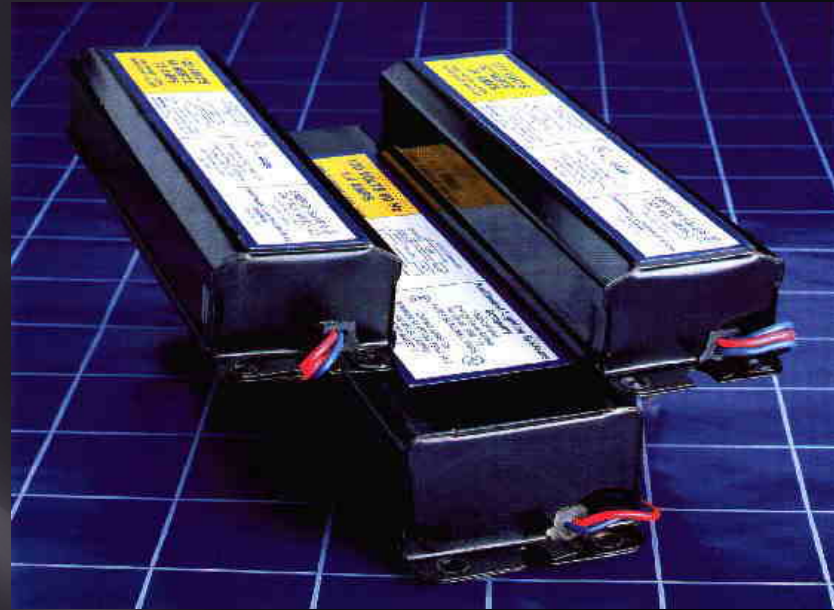
### TYPES

Magnetic (being phased out) --60hz coil transformer-- Hum --- Consume part of the energy through heat loss.

**Electronic**-- uses solid state circuits-- no heat generated -- more energy efficient.

Ballast -- designed for one two three and 4 lamps

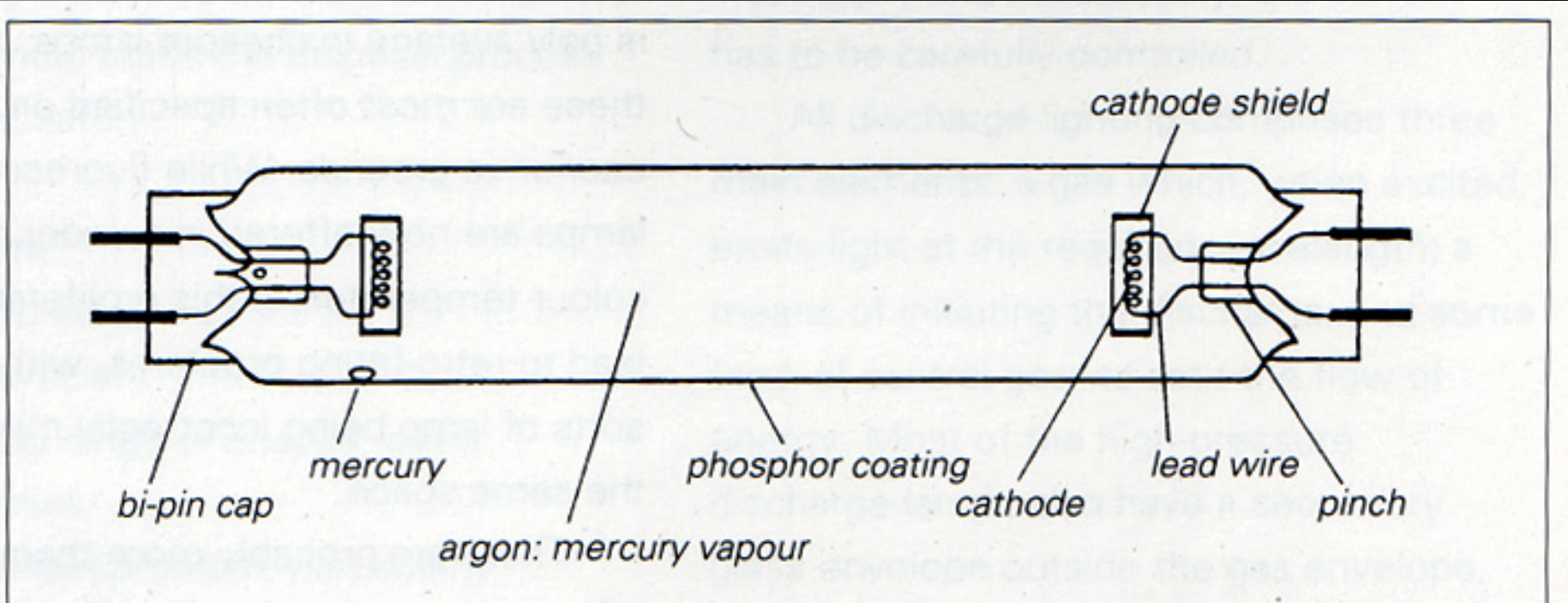
-- do not run less lamps than the ballast is designed for.



The ballast allows fluorescent lamps to be dimmed. NOT ALL BALLASTS ALLOW FLUORESCENT LAMPS TO BE DIMMED. A dimmable ballast must be specified. Dimmable ballast run at a higher frequencies.

# FLUORESCENT LAMPS

## Lamp Operation

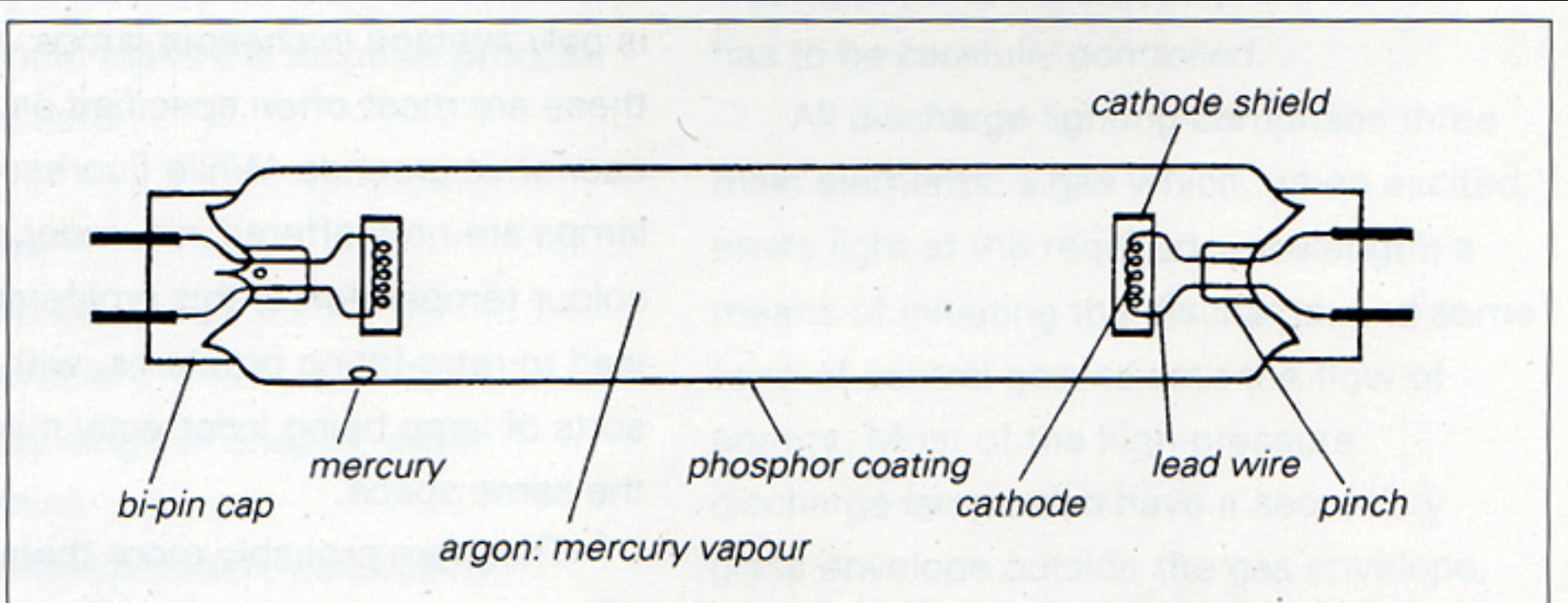


## Fluorescent is a low-pressure gas discharge system

- electrical power is provide from the ballast to the cathode and produces an arc that produces ultra-violet radiation. **Do we see UV radiation?**
- the phosphorus coating is activated by the UV producing visible light

# FLUORESCENT LAMPS

## Lamp Operation

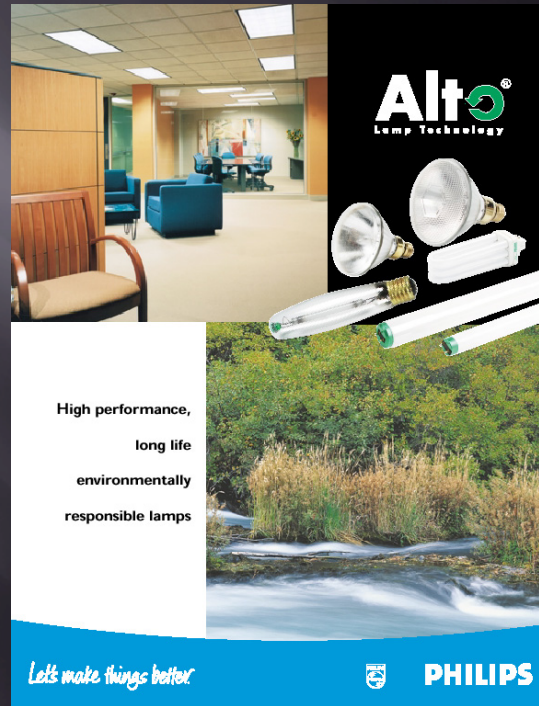


The mercury provides the vapor for the UV arc. Mercury is classified by the EPA as a hazardous waste. Disposal of large amounts of fluorescent lamps is a hazardous waste problem.



# FLUORESCENT LAMPS

## Lamp Operation

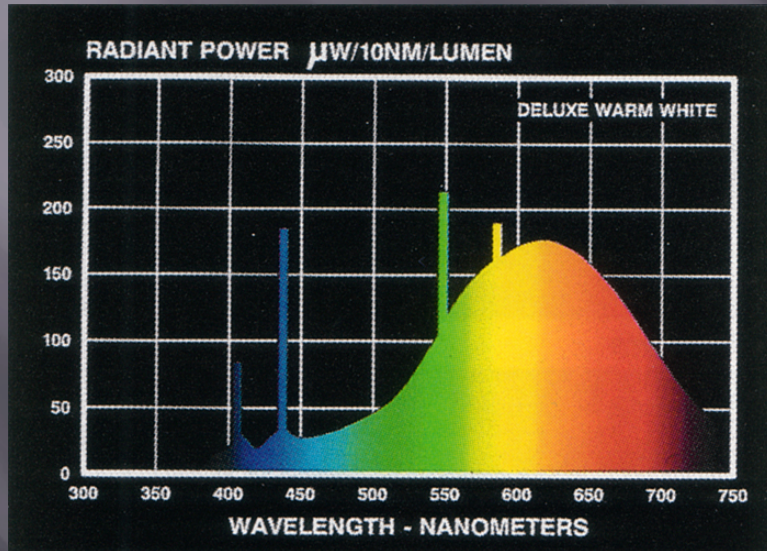


Lamp manufactures are creating low mercury lamps that exceed minimum standards for hazardous waste. No other material can be substituted for the mercury. The use of fluorescent is a balance of energy efficiency and waste.

# FLUORESCENT LAMPS

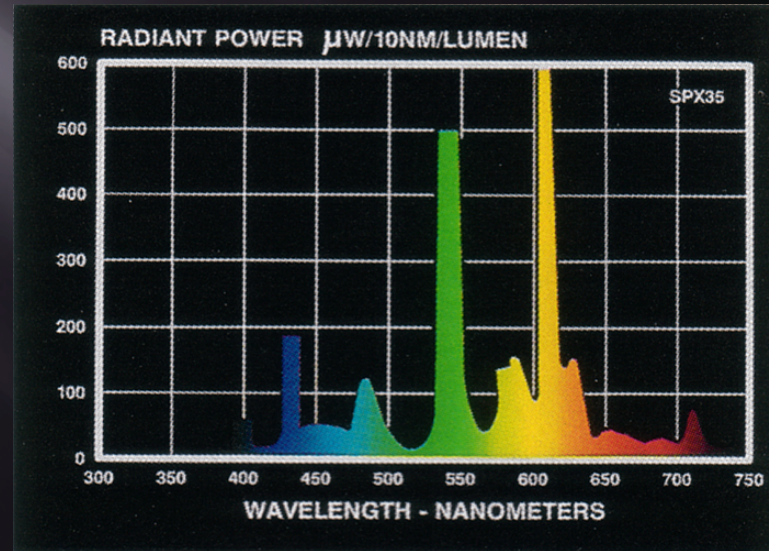
## Lamp Operation

The quality, type, and mixture of different phosphors determine the color temperature and color rendering of a fluorescent lamp.



### Warm White Deluxe

Notice more energies in the warm wave lengths.

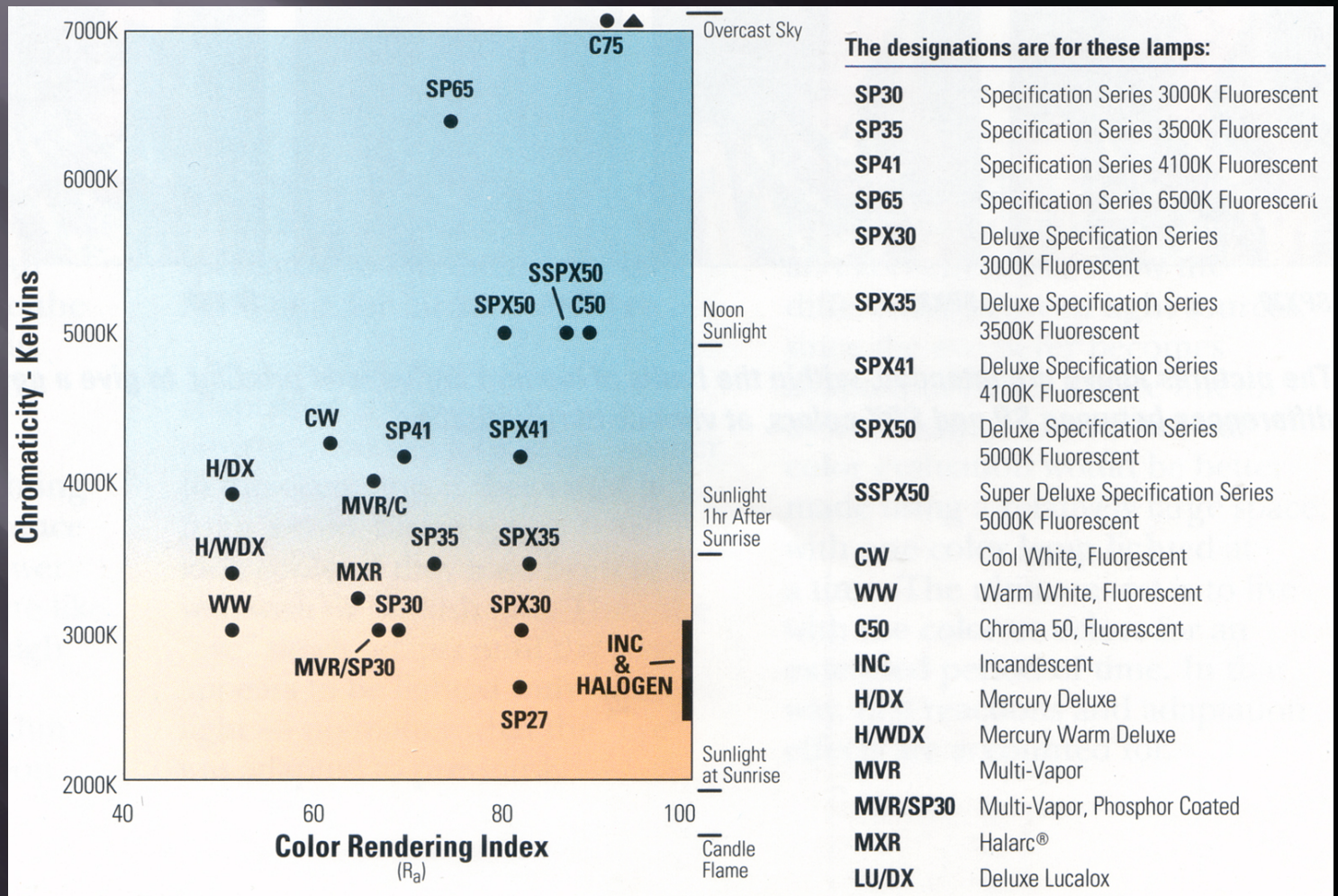


### SPX 35

Higher CRI and 3500 K color temperature

# FLUORESCENT LAMPS

The quality, type, and mixture of different phosphors determine the color temperature and color rendering of a fluorescent lamp.



# FLUORESCENT LAMPS

## Color Temperature

2700 deg. - 3200 deg. Warm Light

3200 deg. - 3500 deg. “White Light”

3500 deg. = Cool Light

## Color Rendering\*

90 - 100 Excellent

80 - 90 Very Good

70 - 80 Risky Color Rendering

Below 70 Poor

\* Color rendering scale does not guarantee colors will be accurate. It is an indication that a wide range of colors may be rendered well. Always test colors under the specified light source.

# FLUORESCENT LAMPS - SPECIFYING

## Product Code:

It is important to use this five-digit code when ordering to ensure that you receive the exact product you require.

## Nominal Length in.:

Lamp length including base and/or pins.

## Mean Lumens:

Lamp light output at 40% of rated lamp life.

## Color Temperature Kelvins (K):

A measure of the visual "warmth" or "coolness" of the light from the lamp. The higher the value, the whiter or "cooler" the light appears.

## Watts:

Energy used (as defined by FTC Lamp Label Rules). To estimate energy consumption (kWh), multiply watts x hours of use and divide by 1000.

## Initial Lumens:

Lamp light output after the initial 100 hours of operation.

## Color Rendering Index (CRI or R<sub>a</sub>):

An indication of the ability of the lamp to render object colors in a normal, natural way. The higher the number (0-100), the better the color appearance.

## Bulb:

Bulb shape followed by its size (the maximum diameter of the bulb expressed in eighths of an inch).

## Rated Average Life - Hours:

Lamp burning hours to median life expectancy.

## Case Quantity:

Number of product units packed in a case.



Means this lamp meets Federal Minimum Efficiency Standards.



Indicates that this is a lamp with high color rendering, which helps objects and persons illuminated to appear more true to life.



Indicates that this is a reduced wattage option for lamps normally used in this application. Be sure to check wattage, lumens and life to determine which lamp is best suited to your needs.

## Base:

The type of base.

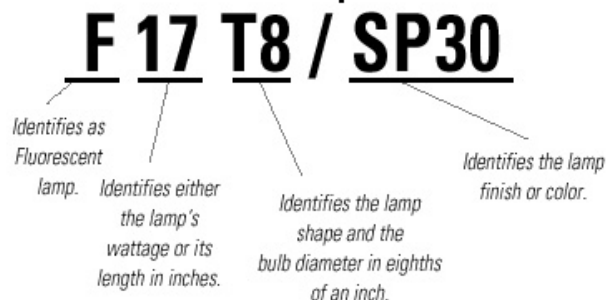
## Lamp Description:

The lamp's identification code.

## Additional Information:

Typical application and/or other important information.

Bulb	Base	Watts	Nominal Length in.	Order Code	Description	Case Qty.	Rated Avg. Life Hours	Initial Lumens	Mean Lumens	Color Temp. K	CRI	Additional Information	Footnotes
<b>T8 STARCOAT™ LAMPS</b>													
<b>STARCOAT™ T8</b>													
T8	Medium Bipin (G13)	17	24	17033	<b>F17T8/SP30</b>	24	20000	1325	1260	3000	78	RE 730 Phosphor, Starcoat™	



## WHEN YOU DON'T KNOW THE LAMP DESCRIPTION

1. Identify bulb shape by using table on page 4-2.
2. Measure bulb diameter using ruler in Appendix section page A-1 to determine width in eighths of an inch.
3. Identify base type using table on page 4-3.
4. Find your lamp in the table containing the bulb shape, size and base.

# FLUORESCENT LAMPS

## Specifying

Bulb	Base	Nominal Watts	Nominal Length in.	Order Code	Description	Case Qty.	Rated		Color		Additional Information	Footnotes
							Avg. Life Hours	Lumens Initial	Temp. K	CRI		
<b>T12 LAMPS (CONTINUED)</b>												
<b>F40 STANDARD</b>												
T12	Medium Bipin (G13)	40	48	10514	F40/B	24	20000	1200	720			Blue
				13794	F40/C50	30	20000	2250	1870	5000	90	⊕ Chroma 50
				25399	F40/C50/UPC	30	20000	2250	1870	5000	90	⊕ Chroma 50, UPC Code
				13795	F40/C75	30	20000	1950	1680	7500	92	⊕ Chroma 75
				13969	F40/D/ULTRA 6PK	24	20000	3050	2775	6500	75	⊕ Daylight ULTRA™, Retail Pack
				14654	F40/DX	30	20000	2250	1910	6500	84	⊕ Deluxe Daylight
				10517	F40/G	24	20000	4000	2000			Green
				40333	F40/KB/2PK/PP	9	20000	3400	3090	3000	82	⊕ Kitchen and Bath ULTRA™, Twin Pack
				21323	F40/KB 6PK	24	20000	3400	3090	3000	82	⊕ Kitchen and Bath ULTRA™
				13797	F40/N	30	20000	2100	1740	3700	90	⊕ Natural
				14440	F40/RES/SLV	30	15000	3150	2860	4100	72	⊕ Residential Light, Sleeved
				14433	F40/RES/SLV 6PK	24	15000	3150	2860	4100	72	⊕ Residential Light, Sleeved, 6 Pack
				14441	F40/RES/TWIN 9PK	9	15000	3150	2860	4100	72	⊕ Residential Light, Twin Pack
				15075	F40/SP30	30	20000	3250	2950	3000	70	⊕ RE 730 Phosphor
				15077	F40/SP35	30	20000	3200	2910	3500	73	⊕ RE 735 Phosphor
				15078	F40/SP41 30PK	30	20000	3200	2910	4100	72	⊕ RE 741 Phosphor
				23382	F40/SP41/C	10	20000	3200	2910	4100	72	⊕ RE 741 Phosphor, Pro-line™ Commercial Pack
				12133	F40/SP65	30	20000	3050	2775	6500	75	⊕ RE 765 Phosphor
				25400	F40/SP65/UPC	30	20000	3050	2775	6500	75	⊕ RE 765 Phosphor, UPC Code
				15079	F40/SPX30	30	20000	3400	3090	3000	82	⊕ RE 830 Phosphor
				15083	F40/SPX35	30	20000	3400	3090	3500	82	⊕ RE 835 Phosphor




# FLUORESCENT LAMPS

## Specifying

Bulb	Base	Nominal Length Watts	Order in. Code	Description	Case Qty.	Rated Avg. Life Hours	Lumens Initial	Color Temp. Mean K	CRI	Additional Information	Footnotes
<b>T8 STARCOAT™ LAMPS (CONTINUED)</b>											
<b>STARCOAT™ T8 (CONTINUED)</b>											
T8	Medium Bipin (G13)	25	36	15943 F25T8/SP30	24	20000	2080	1970	3000	78	RE 730 Phosphor, Starcoat™
				15944 F25T8/SP35	24	20000	2080	1970	3500	78	RE 735 Phosphor, Starcoat™
				15945 F25T8/SP41	24	20000	2080	1970	4100	78	RE 741 Phosphor, Starcoat™
				22648 F25T8/SPX30	24	20000	2150	2040	3000	86	RE 830 Phosphor, Starcoat™
				22650 F25T8/SPX35	24	20000	2150	2040	3500	86	RE 835 Phosphor, Starcoat™
				22651 F25T8/SPX41	24	20000	2150	2040	4100	86	RE 841 Phosphor, Starcoat™
		32	48	15946 F32T8/SP30	36	20000	2850	2710	3000	78	RE 730 Phosphor, Starcoat™
				25396 F32T8/SP30/UPC	36	20000	2850	2710	3000	78	RE 730 Phosphor, Starcoat™, UPC Code
				15947 F32T8/SP35	36	20000	2850	2710	3500	78	RE 735 Phosphor, Starcoat™
				41604 F32T8/SP35/C	12	20000	2850	2710	3500	78	RE 735 Phosphor, Starcoat™
				25392 F32T8/SP35/UPC	36	20000	2850	2710	3500	78	RE 735 Phosphor, Starcoat™, UPC Code
				15949 F32T8/SP41	36	20000	2850	2710	4100	78	RE 741 Phosphor, Starcoat™
				23384 F32T8/SP41/C	12	20000	2850	2710	4100	78	RE 741 Phosphor, Starcoat™, Pro-line™ Commercial Pack
				25394 F32T8/SP41/UPC	36	20000	2850	2710	4100	78	RE 741 Phosphor, Starcoat™, UPC Code
				14613 F32T8/SP50	36	20000	2750	2610	5000	78	RE 750 Phosphor, Starcoat™
				12132 F32T8/SP65	36	20000	2700	2565	6500	75	RE 765 Phosphor, Starcoat™
				22655 F32T8/SPX30	36	20000	2950	2800	3000	86	RE 830 Phosphor, Starcoat™
				22656 F32T8/SPX35	36	20000	2950	2800	3500	86	RE 835 Phosphor, Starcoat™
				22657 F32T8/SPX41	36	20000	2950	2800	4100	86	RE 841 Phosphor, Starcoat™
				23460 F32T8/SPX50	36	20000	2800	2660	5000	86	RE 850 Phosphor, Starcoat™

# FLUORESCENT LAMPS

## Specifying

Base	Nominal Length Watts	Order in.	Code	Description	Case Qty	Rated Avg. Life Hours	Lumens		Color Temp.		Min. Start Temp. F (°C)	Power Factor	Adapter		Footnotes
							Initial	Mean	K.	CRI			THD	Life	
<b>PLUG-IN LAMPS (CONTINUED)</b>															
<b>4-PIN DOUBLE BIAX®</b>															
	G24q-1	13	5	10580 F13DBX/SPX30/4P	50	12000	900	755	3000	82	32		RE 830 Phosphor		⚡ 1, 2, 8
				30035 F13DBX/SPX27/4P	50	12000	900	765	2700	82		RE 827 Phosphor		⚡ 1, 2, 8	
				30037 F13DBX/SPX35/4P	50	12000	900	765	3500	82		RE 835 Phosphor		⚡ 1, 2, 8	
				30038 F13DBX/SPX41/4P	50	12000	900	765	4100	82		RE 841 Phosphor		⚡ 1, 2, 8	
	G24q-2	18	5.8	12865 F18DBX/SPX27/4PL	50	12000	1150	970	2700	82			RE 827 Phosphor		⚡ 1, 2, 6, 8
				12866 F18DBX/SPX30/4PL	50	12000	1150	970	3000	82		RE 830 Phosphor		⚡ 1, 2, 6, 8	
				12869 F18DBX/SPX35/4PL	50	12000	1150	970	3500	82		RE 835 Phosphor		⚡ 1, 2, 6, 8	
				12870 F18DBX/SPX41/4PL	50	12000	1150	970	4100	82		RE 841 Phosphor		⚡ 1, 2, 6, 8	
	G24q-3	26	6.4	35235 F26DBXT4SPX30/4P	50	12000	1710	1440	3000	82			RE 830 Phosphor		⚡ 1, 2, 8
				35236 F26DBXT4SPX41/4P	50	12000	1710	1440	4100	82		RE 841 Phosphor		⚡ 1, 2, 8	
				35247 F26DBXT4SPX27/4P	50	12000	1710	1440	2700	82		RE 827 Phosphor		⚡ 1, 2, 8	
				35248 F26DBXT4SPX35/4P	50	12000	1710	1440	3500	82		RE 835 Phosphor		⚡ 1, 2, 8	



# Fluorescent Lamps

Lamp	Hours	Watts	Lumens	Efficacy	Color Temp.	CRI	Shape Size
F40T12/ SP35	20,000	40	2910	72.8 L/ W	3500	73	T 1 1/2"
F32T8/ SPX35	20,000	32	2800	87.5 L/ W	3500	86	T 1"
F13DBX/ SPX27	12,000	13	765	58.8 L/ W	2700	82	DBX/ Compact
60A19	1000	60	840	14 L/W	2800	99	A 2 3/8"

## KEY FACTORS:

Lamp Life (Hours)

Lumens Per Watt

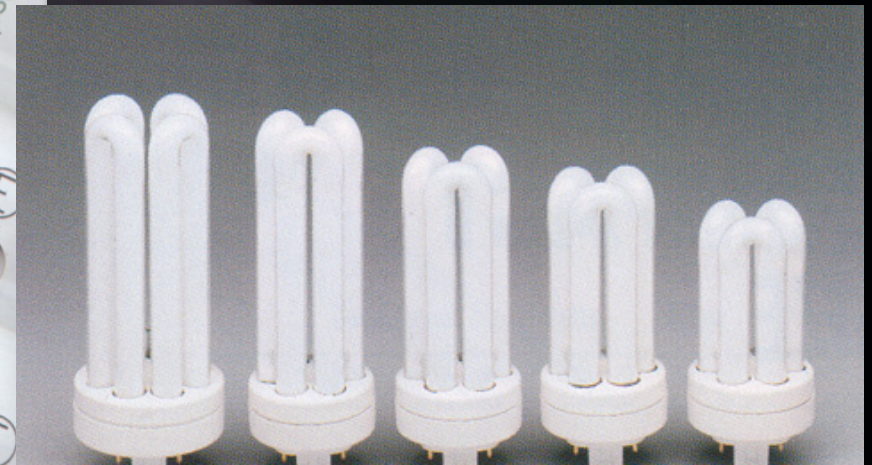
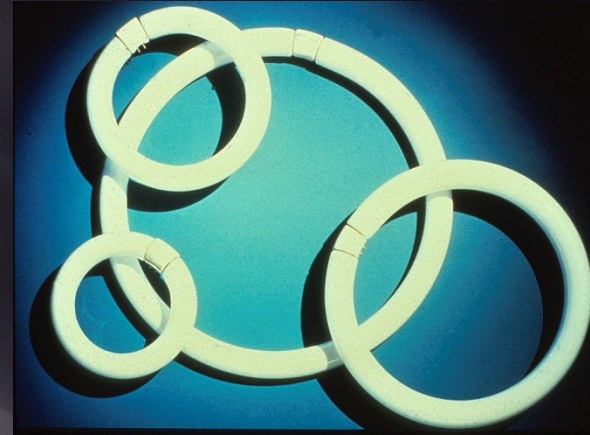
Color Temperature and Color Rendering

# Fluorescent Lamps

## Key Considerations for Fluorescent Lamps:

- Longer lamp life than incandescent 6,000-20,000++
- Efficient 40w incandescent produces 460 lumens, 40w fluorescent produces 30 50 lumens
- Lumens depreciate over life a lamp may be 50% of designed lumens but not “burned out” need good lamp replacement program. Lumens can depreciate as much as 10% in the first 100 hrs of operation.
- Not typically for exterior use
- Linear source, difficult to control
- May produce glare
- Lower CRI and sometimes unsatisfactory CCT as compared to Incandescent
- Difficult dimming \$\$\$\$ Becoming easier with electronic ballasts.

# Fluorescent Light Sources



# Fluorescent Light Sources



Office

Institutional

Educational

# Fluorescent Lamps

Fluorescent light sources can emphasize linear direction.



Fluorescent light sources can be used to define shape through cove detailing.



Careful use of fluorescent lamps can allow use for ambient, task and accent lighting.



# Lighting: Cold Cathode

- ❑ “Neon”
- ❑ How it works – similar to fluorescent
  - ❑ Glass tubes are filled with Mercury, Neon, Argon gas mixtures.
  - ❑ Electric arcs excite the gas filled tubing creating a glow.
  - ❑ Color is based on gas mixture and glass color.
- ❑ Properties:
  - ❑ Moderate/high initial cost
  - ❑ Moderate /Expensive operation cost
  - ❑ Poor CRI (50)
  - ❑ Color temperature cool (varies per the gas)
  - ❑ Requires a ballast/transformer
  - ❑ Difficult to dimmed
  - ❑ Has a long delay in starting up
  - ❑ Diffuse light
  - ❑ Poor efficacy at 15 lumens per watt (lpw)
  - ❑ Medium to good lamp life
  - ❑ Requires moderate temperatures to operate
  - ❑ Generates heat
  - ❑ Generates a lot of noise noise

# Cold Cathode 'Neon'





# Cold Cathode 'Neon'

Cold Cathodes are low pressure lamps that rely on high voltage (4000-6000V) electrodes that create a discharge.

The operation is similar to fluorescent, but much less energy efficient.

The two leading gases used in cold cathode lamps is argon (blue-green) and neon (red-orange).

Cold cathodes are available in most colors. Can be bent into most any shape and are created in tubes between 9mm - 25mm.

# Cold Cathode 'Neon'

Cold cathode lamps are almost always custom made.

They are typically used for accent lighting.

Due to a flicker at each cathode located at the end of the glass tube they are not suitable for any situation where visual acuity is important.

Light output is low and efficacy is about  $\frac{1}{10}$  as compared to a fluorescent.

The lamp is long lasting, but initial installation is costly and requires bulky equipment.

# Cold Cathode 'Neon'

## Typical uses of cold cathode:

Signage

Edge lighting

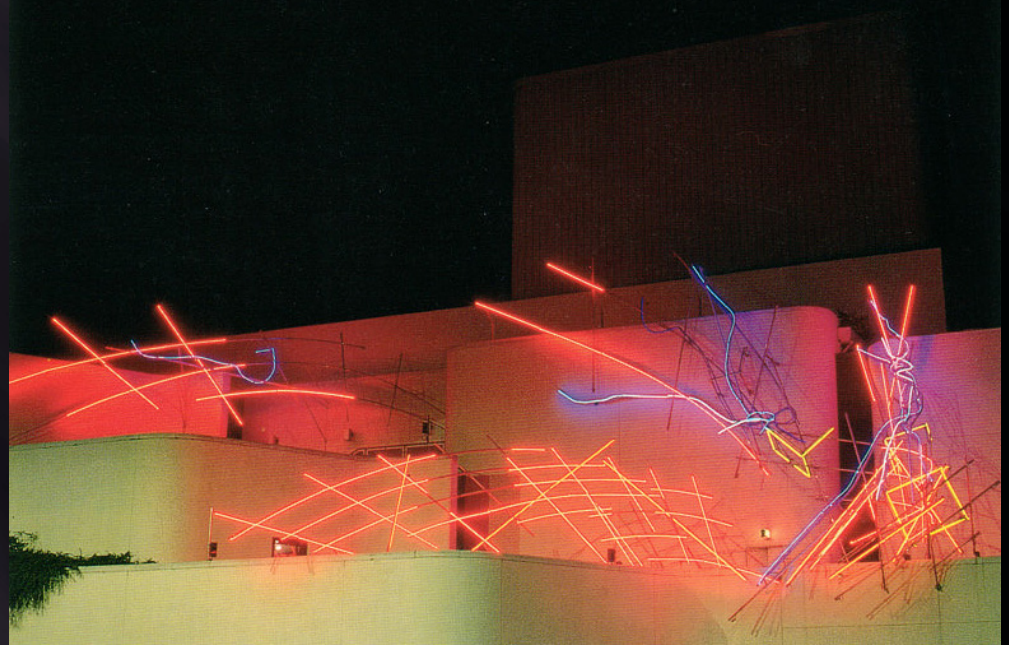
Cove lighting

Accent lighting

**Advantages:** Custom shapes, custom colors, long lasting, low surface temperature

**Disadvantages:** High initial cost, flicker, low light output

# Cold Cathode 'Neon'



# Lighting:

## High Intensity Discharge (HID)

- ❑ Most commonly used as outdoor lighting
- ❑ How it works: similar to fluorescent. An electric arc is created in a tube surrounded by an outer bulb that is coated with a metal vapor that when excited glows. High Pressure Sodium, Metal Halide, Ceramic Metal Halide
- ❑ Properties:
  - ❑ High initial cost
  - ❑ Inexpensive operating cost
  - ❑ CRI is poor to good (50 – 90) (think street lamps)
  - ❑ Color Temperature is warm to cool (pink to green)
  - ❑ A ballast/transformer is required – electronic/magnetic
  - ❑ Difficult to dim
  - ❑ No instant on option
  - ❑ Provides good to great directionality
  - ❑ Excellent efficacy at 70 to 120 lpw
  - ❑ Has a good lamp life
  - ❑ No temperature requirements to operate
  - ❑ Very little heat is generated (still warm to touch)
  - ❑ Magnetic ballast produce humming / buzzing sound, electronic not as bad.

# High Intensity Discharge (HID) Light Sources



Stadiums

Parking Lots

Streets

Warehouses

Retail

High Bay Areas

# HID LAMPS

## Common Types:

Metal Halide

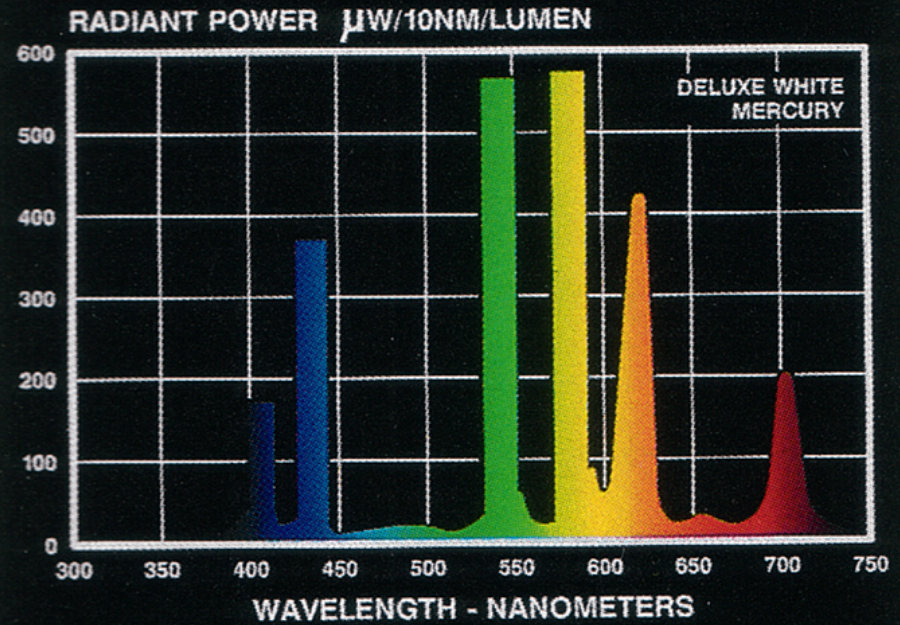
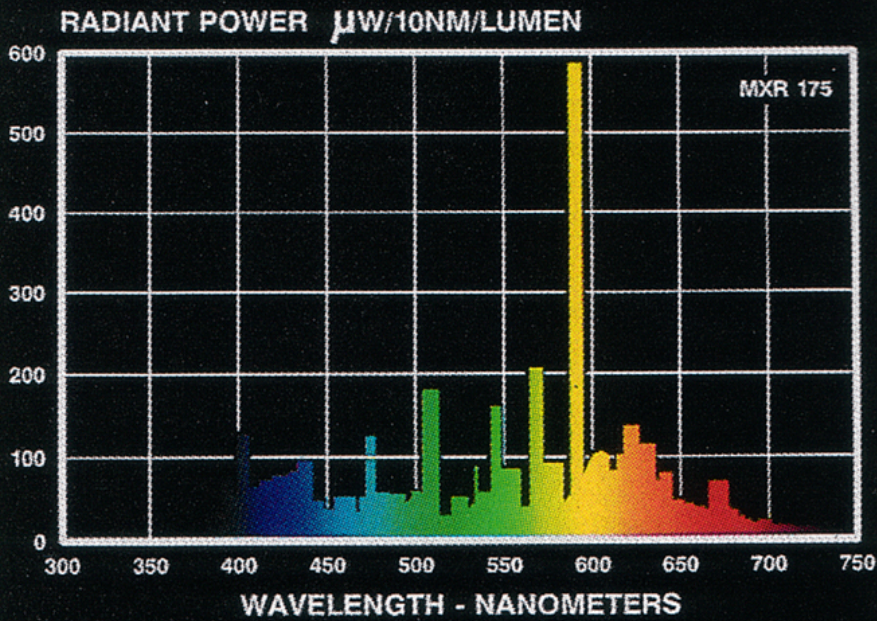
Ceramic Metal Halide

High Pressure Sodium

Mercury



# HID LAMPS



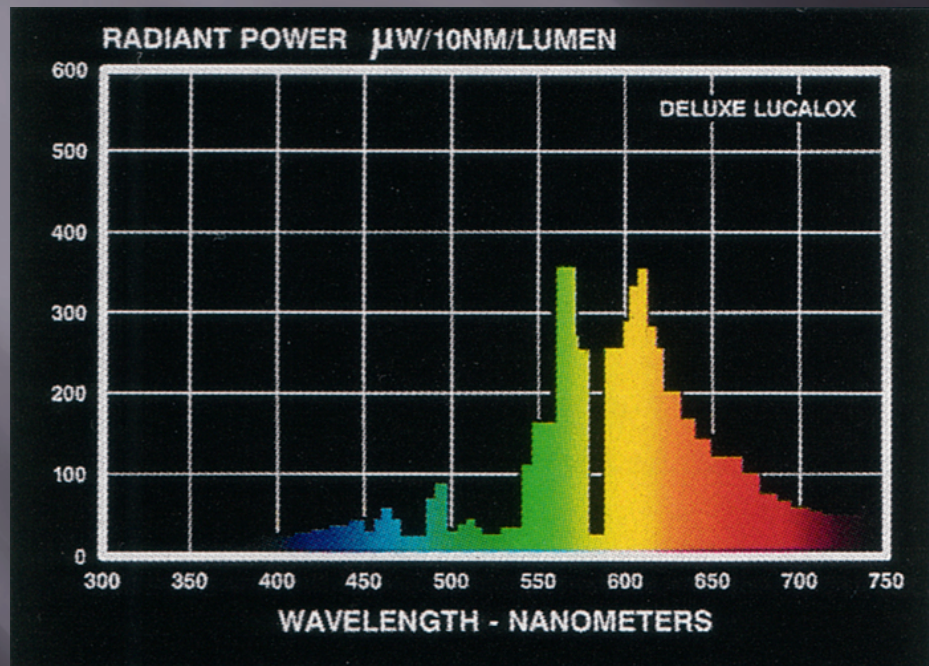
Metal Halide Spectrum

Deluxe Mercury

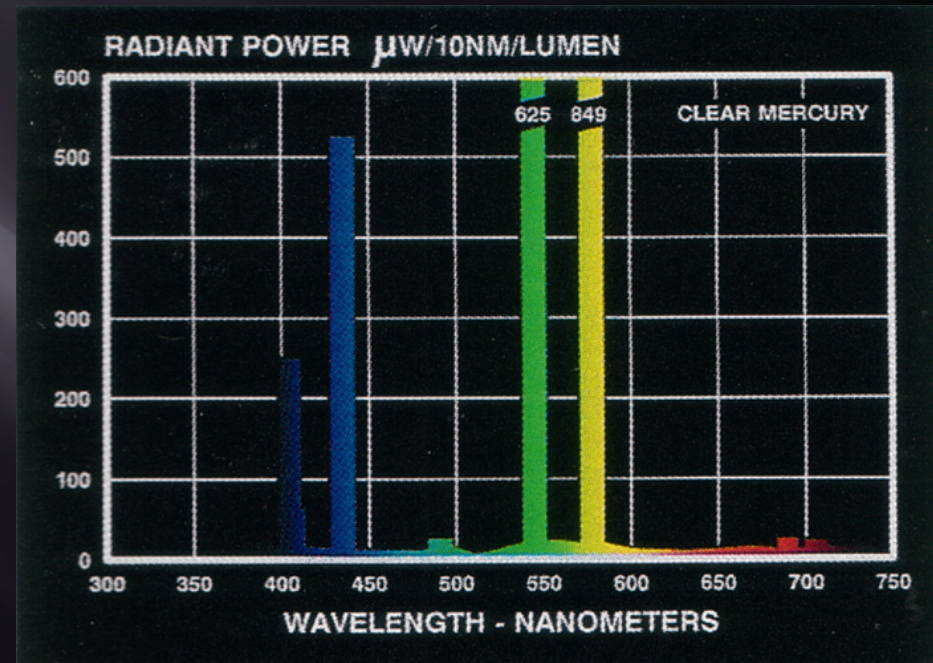
The Spike are a signature of High Intensity Discharge Sources



# HID LAMPS

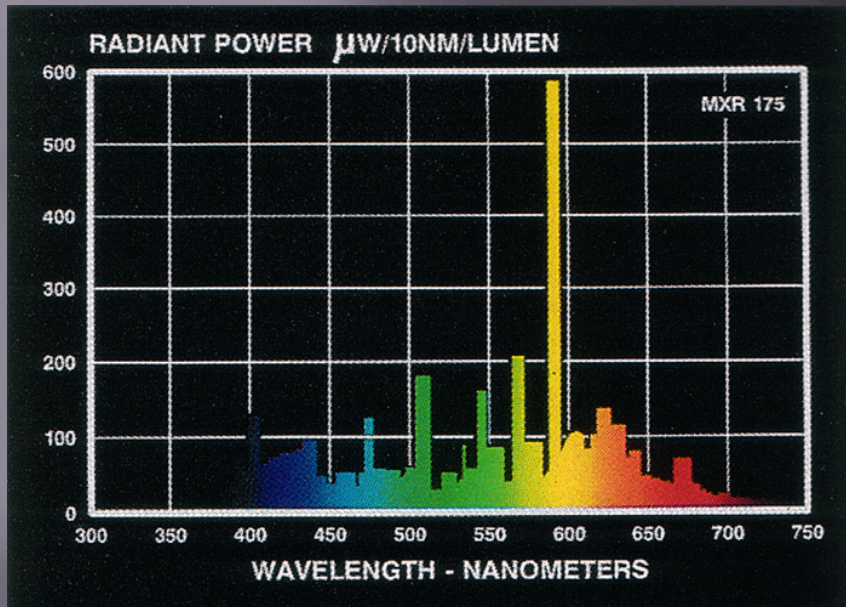


Deluxe High Pressure Sodium Spectrum



Clear Mercury  
Very Poor CRI

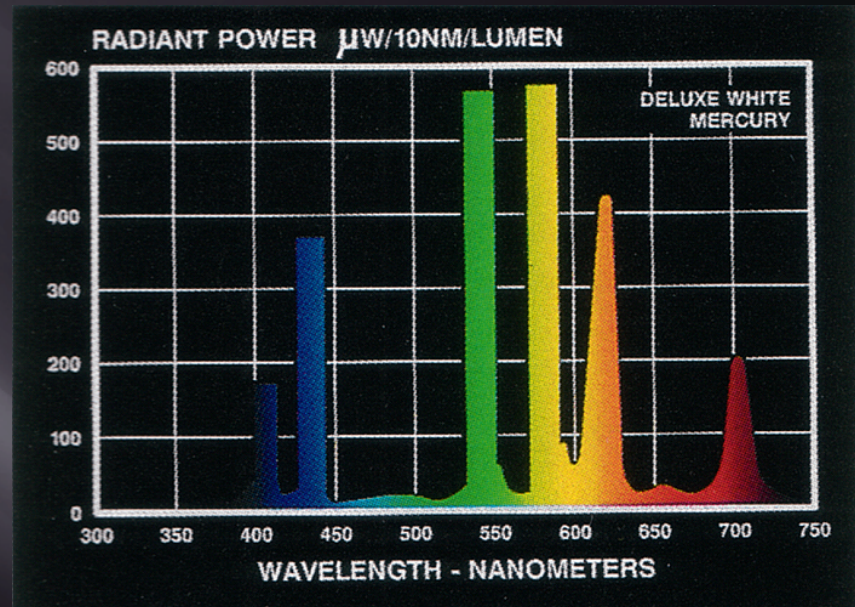
# HID LAMPS



Metal Halide Sources tend to have a high color temperature (visually cool)

The source seems to be 'whiter' and cleaner than deluxe mercury lamps.

Available with good CRI.

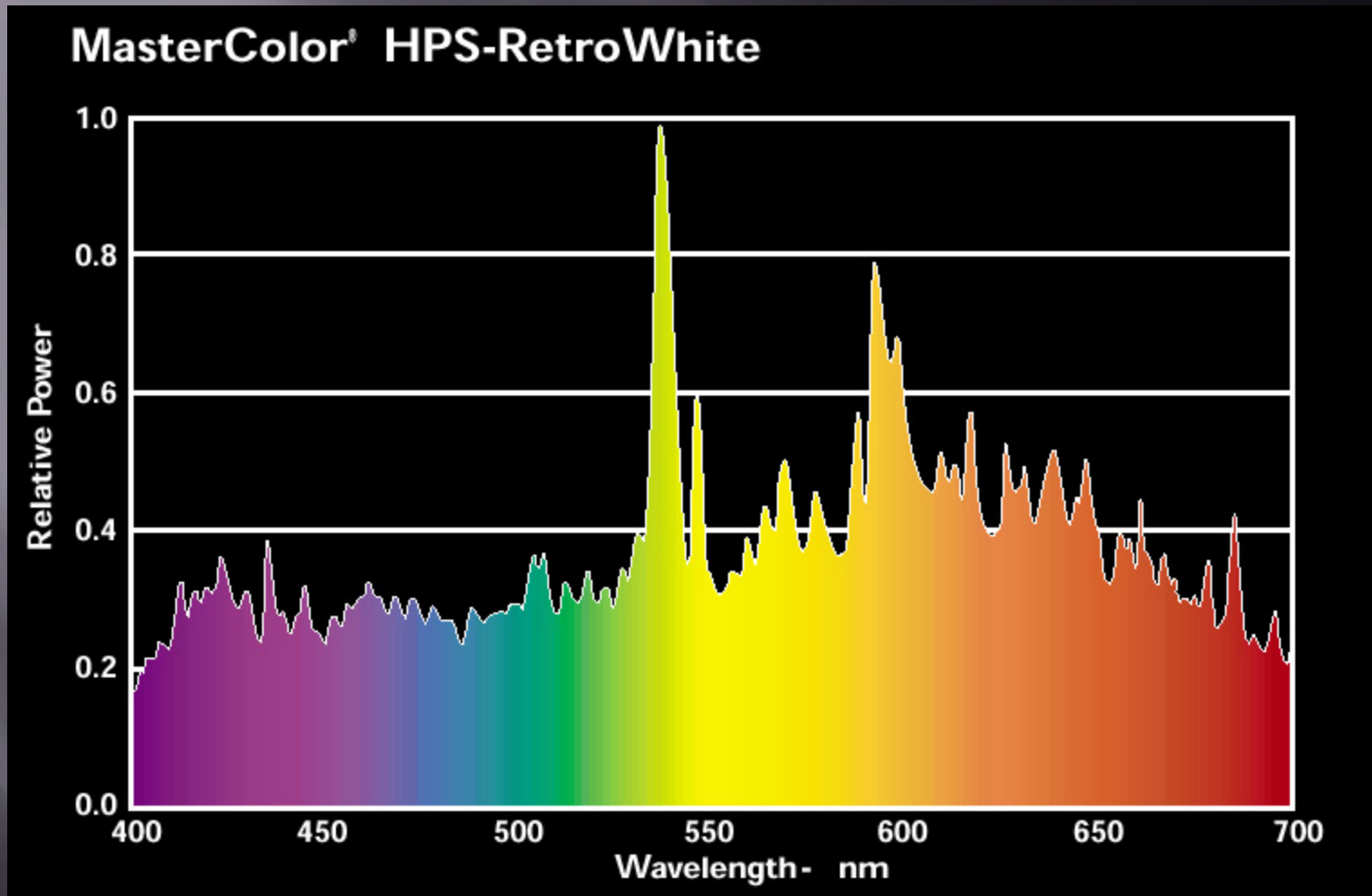


Deluxe Mercury sources tend to have a low color temperature (visually warm)

The source emphasizes the yellow, oranges and reds.

Available with risky CRI.

# HID LAMPS



Ceramic Metal Halide (Halogen 'white light') with very good CRI. Ceramic Metal Halides are the predominate HID lamp source for architectural applications.

# HID LAMPS

## Operation

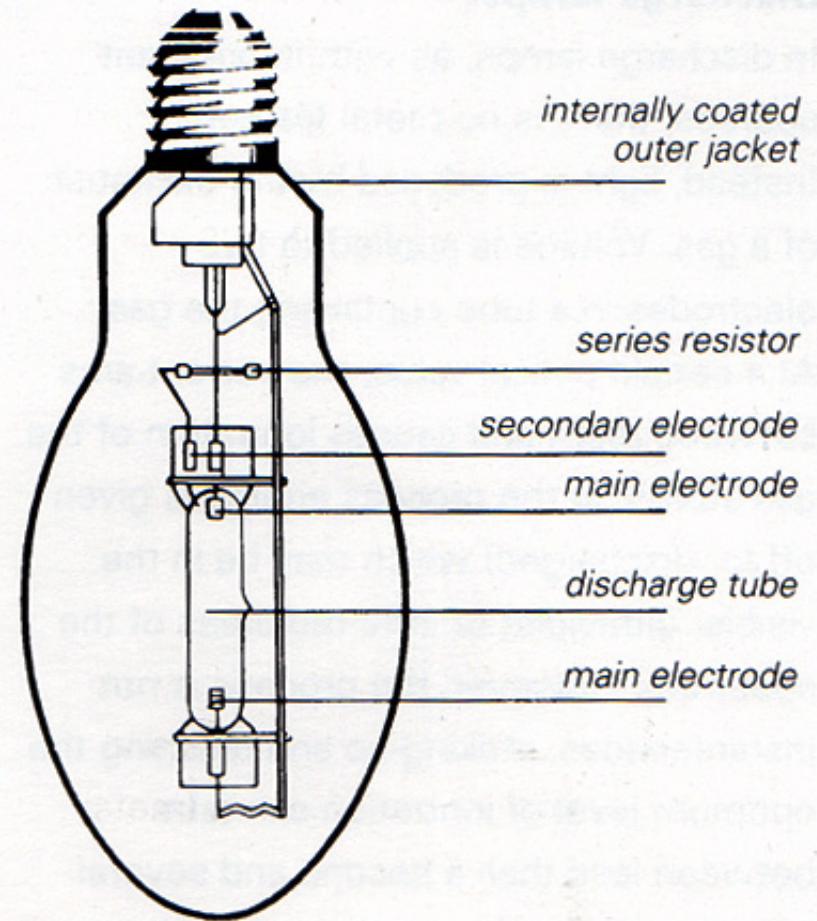
-- An electric arc is discharged in a sealed tube with a protective jacket.

-- Voltage is applied to electrodes, the electrons emitted vaporize elements in the tube producing light.

-- The elements in the tube determine the efficacy and color characteristics.

-- HID lamps operate at very high temperatures.

-- HID sources create a lot of UV radiation. The outer jacket prevents UV from being released from the lamp.

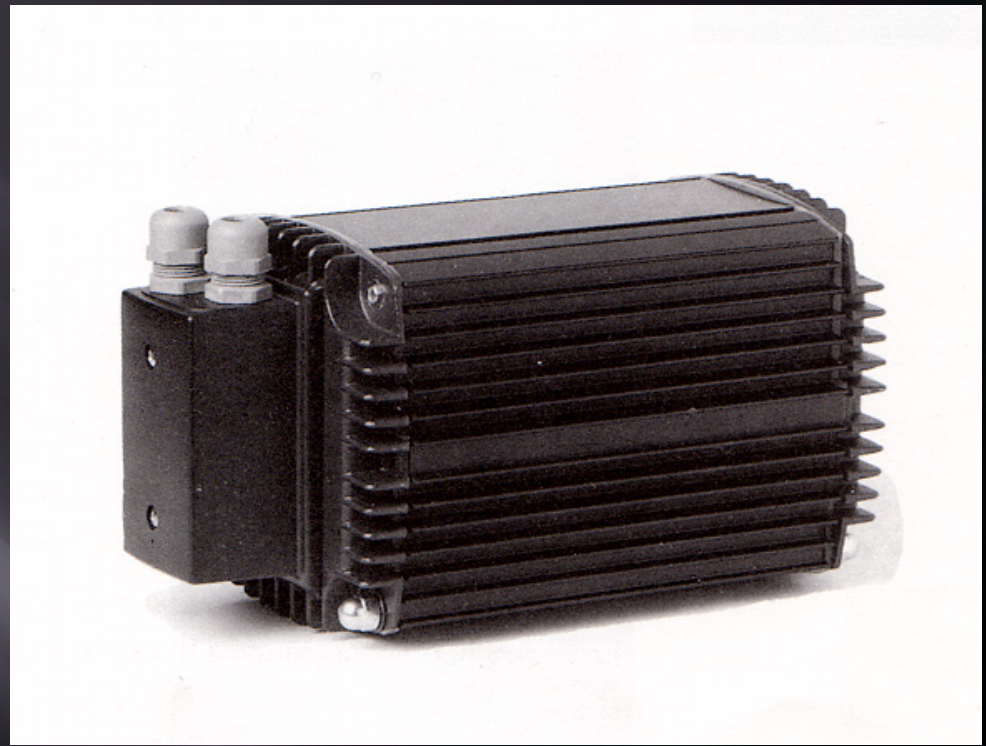


**Figure 4 Schematic diagram of a typical high-pressure mercury discharge lamp**

# HID LAMPS

## Ballast

- The arc requires a ballast for operation.
- The ballast provides voltage for initial striking of the lamp.
- The ballast maintains the voltage for lamp operation.
- The ballasts for HID lamps are often large and bulky.



# HID LAMPS

Most HID lamps do not come on instantly when turned on. HID lamps require a 'Strike Time' .

The strike time is typically around 5 minutes.

If an HID source loses power, such as in a power outage, the lamp must cool down before it is restruck.

HID lamps must be accompanied by an auxiliary lighting systems to meet emergency lighting requirements.

# HID LAMPS

Most HID sources last between 5000 and 15,000 hours in architectural applications.

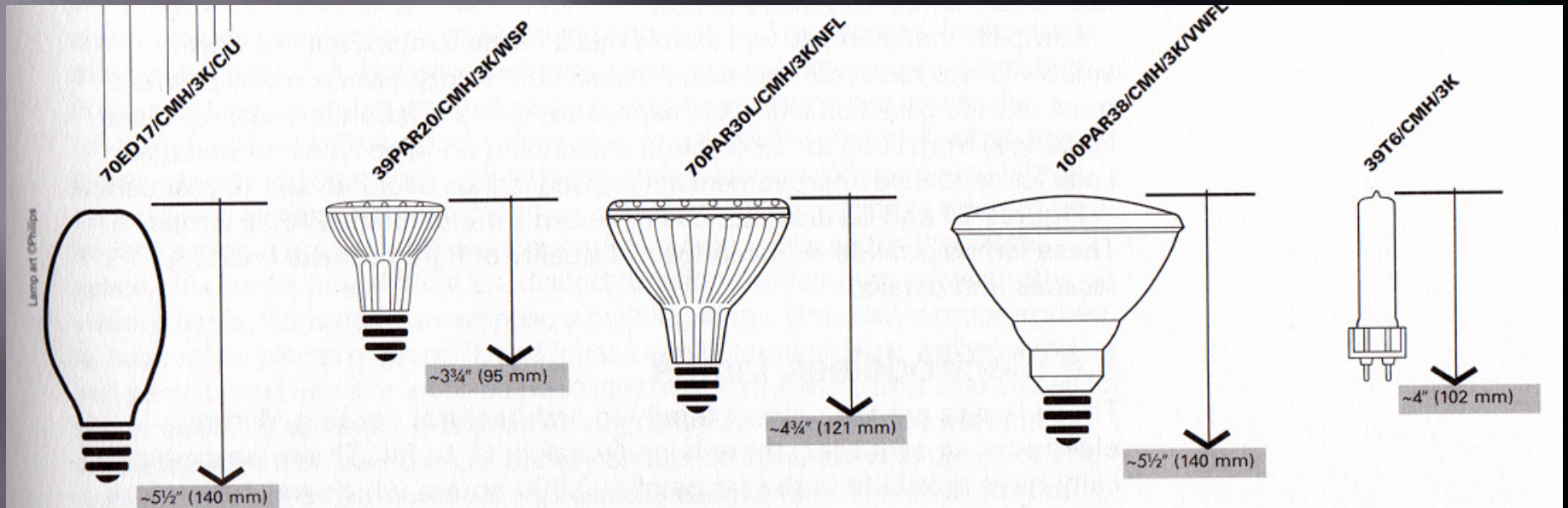
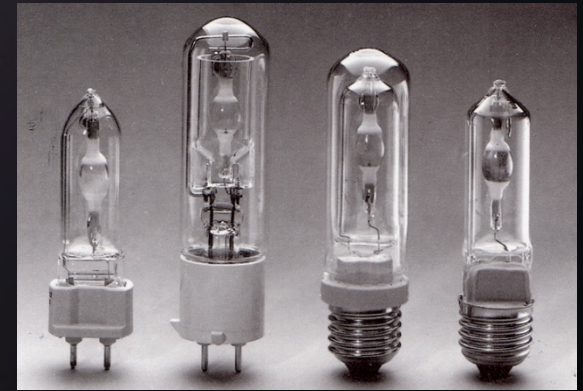
Dimming HID sources can be accomplished technically, but the quality of light is diminished to the point to make it an unsatisfactory option.

One of the central problems with HID lamps is color shift. The color of the light changes over the life of the lamp. Color Rendering and Color Temperature change as the lamp ages. (This problem is significantly reduced with ceramic metal halides.)

Metal Halide sources are the predominate lamps used in architectural applications.

# HID LAMPS

## Metal Halide Lamp Shapes



Ellipsoidal

PAR

PAR

PAR

Tube

CRI for HID range between 82 and 93.

Color temperature range between 3000 and 4100 degrees.



# HID LAMPS

HID lamps are typically found in high bay areas where re-lamping is an important issue.

With the recent development of ceramic HID and PAR shapes HID sources are being used in retail and other color important design applications.

HID lamps have an efficacy of 75-125 lumens per watt. Incandescent lamps have a efficacy of 20 lumens per watt. (Large energy and labor savings.)

# HID LAMPS

## Bulb:

Bulb shape followed by its size (the maximum diameter of the bulb expressed in eighths of an inch).

## Lamp Description:

The lamp's identification code.

## Color Rendering Index (CRI or R<sub>a</sub>):

An indication of the ability of the lamp to render object colors in a normal, natural way. The higher the number (0-100), the better the color appearance.

## Color Temperature Kelvins (K):

A measure of the visual "warmth" or "coolness" of the light from the lamp. The higher the value the whiter or "cooler" the light appears.

## Lumens- Mean:

Lamp light output (lumens) at 40% of rated lamp life for Metal Halide lamps and 50% of rated life for Mercury and HPS lamps.

## MOL:

Maximum Overall Length in inches.

## LCL:

Distance between the center of the filament and the Light Center Length reference plane, in inches.

## Lumens - Initial:

Initial light output.

## ANSI Ballast Type:

Ballast type used to operate lamp.

## Case Qty:

Number of product units packed in a case.

## Fixture Req:

Describes fixture requirements for this lamp (see page 3-21).

## Additional Information:

Typical application and/or other important information including footnotes ( )\*.

## Rated Avg Life - Hrs:

Lamp burning hours to median life expectancy.

## Product Code:

It is important to use this five-digit code when ordering to ensure that you receive the exact product you require.

## Base:

The type of base.

Bulb	Base	Product Code	Lamp Description	Case Qty.	Fix. Req.	Additional Information	ANSI Ballast Type	Lumens Initial	Lumens Mean <sup>†</sup>	Rated Avg. Life Hours	MOL in.	LCL in.	Color Temp. K	CRI
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## HIGH OUTPUT MULTI-VAPOR® METAL HALIDE LAMPS

### 400 WATTS

ED37	Mog	49656	<b>MVR400/C/VBU</b>	6	0	Coated, Vertical Base Up ±15°	M59	41000	25000	20000	11 <sup>5/16</sup>	7	3700	70
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# MVR400 / C / VBU

Identifies as Multi-Vapor® lamp.

Identifies the lamp's wattage.

Outer bulb finish.

Burning position (see page 3-21)

# HID LAMPS

<i>Bulb</i>	<i>Base</i>	<i>Product Code</i>	<i>Lamp Description</i>	<i>Case Qty.</i>	<i>Fix. Req.</i>	<i>Additional Information</i>	<i>ANSI Ballast Type</i>	<i>Lumens Initial</i>	<i>Lumens Mean</i>	<i>Rated Avg. Life Hours</i>	<i>MOL in.</i>	<i>LCL in.</i>	<i>Temp. K</i>	<i>Color CRI</i>
<b>LUCALOX® HIGH PRESSURE SODIUM LAMPS (Continued)</b>														
<b>150 WATTS</b>														
B17	Med	13252	LU150/MED	6	0	Clear	S55	16000	14400	24000 +	5 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	2000	22
		26424	LU150/MED/CP	4	0	Clear, Consumer Pack	S55	16000	14400	24000 +	5 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	2000	22
		13253	LU150/D/MED	6	0	Diffuse	S55	15000	13500	24000 +	5 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	2000	22
ED23 <sup>1</sup> / <sub>2</sub>	Mog	44043	LU150/55	12	0	Clear	S55	16000	14400	24000 +	7 <sup>3</sup> / <sub>4</sub>	5	2000	22
		26429	LU150/55/CP	4	0	Clear, Consumer Pack	S55	16000	14400	24000 +	7 <sup>3</sup> / <sub>4</sub>	5	2000	22
		44045	LU150/55/D	12	0	Diffuse	S55	15000	13500	24000 +	7 <sup>3</sup> / <sub>4</sub>	5	2000	22
		19266	LU150/55/SBY/LL	12	0	Clear, Standby Longlife, Dual Arc Tube	S55	16000	14000	40000	7 <sup>3</sup> / <sub>4</sub>	5	2000	22
ED28	Mog	44243	LU150/100	12	0	Clear	S56	15000	13500	24000 +	8 <sup>5</sup> / <sub>16</sub>	5	2000	22
		18245	LU150/100/D	12	0	Diffuse	S56	14000	12600	24000 +	8 <sup>5</sup> / <sub>16</sub>	5	2000	22

<i>Bulb</i>	<i>Base</i>	<i>Product Code</i>	<i>Lamp Description</i>	<i>Case Qty.</i>	<i>Fix. Req.</i>	<i>Additional Information</i>	<i>ANSI Ballast Type</i>	<i>Lumens Initial</i>	<i>Lumens Mean</i>	<i>Rated Avg. Life Hours</i>	<i>MOL in.</i>	<i>LCL in.</i>	<i>Temp. K</i>	<i>Color CRI</i>
<b>MERCURY LAMPS (Continued)</b>														
<b>400 WATTS</b>														
BT37	Mog	32313	HR400DX33/BT	6	0	Deluxe White	H33	22600	14400	24000 +	11 <sup>5</sup> / <sub>16</sub>	7	3900	50
ED37	Mog	23974	HR400A33	6	0	Clear	H33	21000	13400	24000 +	11 <sup>5</sup> / <sub>16</sub>	7	5700	15
		23998	HR400DX33	6	0	Deluxe White	H33	22600	14400	24000 +	11 <sup>5</sup> / <sub>16</sub>	7	3900	50
R52	Mog	33879	HR400RDX33	6	0	Reflector, Deluxe White, 160° Beam Spread	H33	20800	13400	24000 +	11 <sup>3</sup> / <sub>4</sub>		3900	50

High pressure sodium and mercury lamps typically have unacceptable characteristics for use in architectural interiors. (Color rendering and color temperature.)

# HID LAMPS

Bulb	Base	Product Code	Lamp Description	Case Qty.	Fix. Req.	Additional Information	ANSI Ballast Type	Lumens Initial	Lumens Mean†	Rated Avg. Life Hours	MOL in.	LCL in.	Color Temp. K	CRI
<b>CONSTANTCOLOR® CMH™ METAL HALIDE LAMPS</b>														
<b>70 WATTS</b>														
T6	G12	35421	CMH70/T/830/G12	10	E	Clear (31, 33)*	M85 or M98 (Alt)	6200	4750	6000	3 <sup>15</sup> / <sub>16</sub>	2 <sup>3</sup> / <sub>16</sub>	3000	85
T6	R7s	34519	CMH70/TD/830/R7S	12	E	Clear, Horizontal ±45° Only (31, 33)*	M85 or M98 (Alt)	6200	4750	10000	4 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>4</sub>	3000	85
BD17	Med	22119	CMH70/U/830/MED	6	E	Clear	M98	6200	4470	7500	5 <sup>7</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>8</sub>	3000	85
		22124	CMH70/C/U/830/MED	6	E	Coated	M98	5890	3800	7500	5 <sup>7</sup> / <sub>16</sub>	3 <sup>3</sup> / <sub>8</sub>	3000	85
PAR30L	Med	22152	CMH70/U/PAR30L/15	6	0	Beam Spread 15°, 25,000 CBCP	M98	4100	3140	6000	4 <sup>3</sup> / <sub>4</sub>		3000	85
		22159	CMH70/U/PAR30L/40	6	0	Beam Spread 40°, 7,000 CBCP	M98	4100	3140	6000	4 <sup>3</sup> / <sub>4</sub>		3000	85

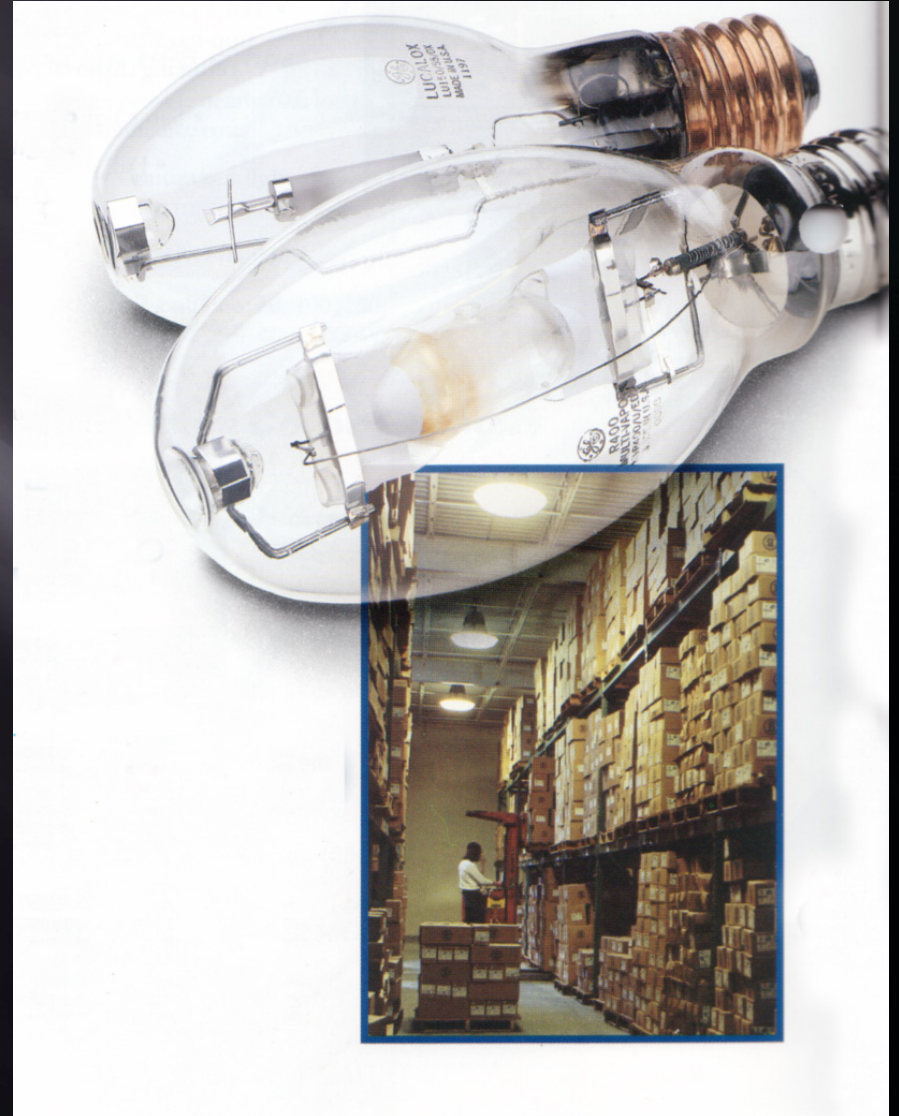
Bulb	Base	Product Code	Lamp Description	Case Qty.	Fix. Req.	Additional Information	ANSI Ballast Type	Lumens Initial	Lumens Mean†	Rated Avg. Life Hours	MOL in.	LCL in.	Color Temp. K	CRI
<b>HIGH OUTPUT MULTI-VAPOR® METAL HALIDE LAMPS</b>														
<b>175 WATTS</b>														
ED23 <sup>1</sup> / <sub>2</sub>	Mog	11420	MXR175/VBD	6	E	Clear, Vertical Base Down ±15°, Integral Ignitor (13)*	M57	17200	13400	10000	7 <sup>3</sup> / <sub>4</sub>	5	3200	70
		11417	MXR175/VBU	6	E	Clear, Vertical Base Up ±15°, Integral Ignitor (13)*	M57	17200	13400	10000	7 <sup>3</sup> / <sub>4</sub>	5	3200	70
		11203	MXR175/C/VBU	6	E	Coated, Vertical Base Up ±15°, Integral Ignitor (13)*	M57	16300	12500	10000	7 <sup>3</sup> / <sub>4</sub>	5	3200	70

Note the difference between Ceramic Metal Halides and Multi-Vapor Metal Halide lamps in color temperature and color rendering.

# HID Lamps

Lamp	Hours	Watts	Lumens	Efficacy	Color Temp.	CRI	Shape Size
LU150/MED (HPS)	24000	150	14400	96 l/w	2000	22	B 17
HR400DX33 (Mercury)	24000	400	14400	36 l/w	3900	50	BT37
CMH70/T830	6000	70	4750	68 l/w	3000	85	T6
MXR175/VBD	1000	175	13400	77 l/w	3200	70	ED 231/2

# HID Lamps



# HID Lamps



# HID Lamps





# Lighting:

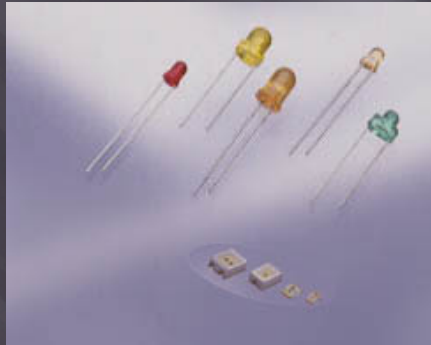
## Light Emitting Diode (LED)

- ❑ Smallest light source
- ❑ How it works: A diode is electrified to emit light of a specific wavelength (color) of radiation depending on the compound of the diode.
- ❑ Properties:
  - ❑ Very high initial cost
  - ❑ Very inexpensive operating cost
  - ❑ CRI is moderate to good (70 – 80)
  - ❑ Color Temperature is cool to cold (greenish to bluish)
  - ❑ A ballast/transformer is required – proprietary transformer
  - ❑ Dimming is possible
  - ❑ Has an instant on
  - ❑ Provides great directionality
  - ❑ Good efficacy at 30 to 50 lpw
  - ❑ Has a great lamp life
  - ❑ No temperature requirements to operate
  - ❑ Very little heat is generate
  - ❑ No noise

# LED - Light Emitting Diode

Solid state lamps created from semiconductor materials

Narrow band emitters they illuminate in a specific visible color or in the infrared



# LED LAMPS

## Light Emitting Diode Lamps

- No weak component in the construction and operation of the lamp. Lamp life is up to 100,000 hours
- Typically used in accent application, but expect this to change.
- Solid state lamps created from semiconductor materials
- Narrow band emitters they illuminate in a specific visible color or in the infrared
- To achieve the display screen effect three lamps are grouped together. (red green and blue)

# LED LAMPS

A leader in research and manufacturing of LED sources is Lumileds.

<http://www.lumileds.com/>

Low voltage Direct Current (DC) operation

Available with highly controlled option. (Similar to MR 16)

Lamps are cold to the touch

Fully dimmable

Similar energy efficiency as halogen incandescent.

# LED Lamps

## Wavelength Characteristics

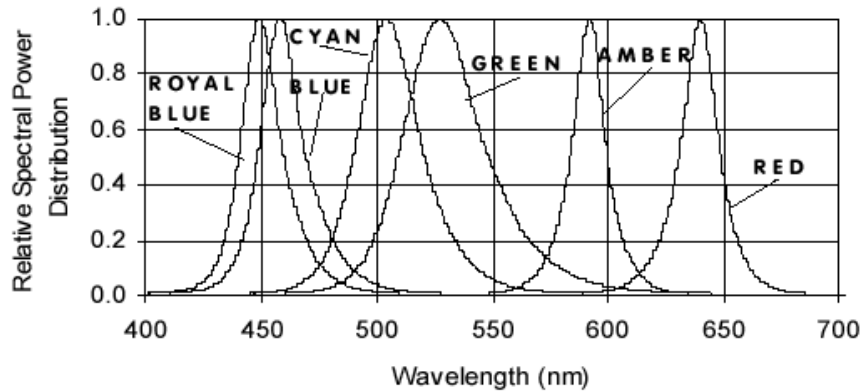
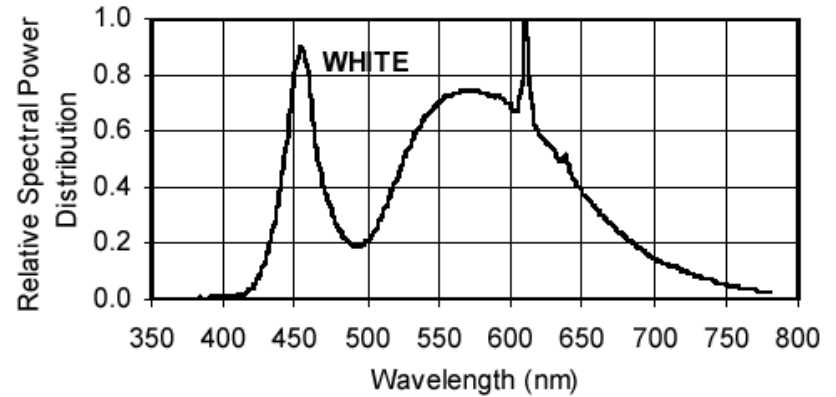


Figure 1. Relative Intensity vs. Wavelength



Narrow band emitters for different colored lamps.

Single white light sources available.

# LED Lamps

## Single Lamp Configurations

1" X 1" and smaller

Typically found as reading lights in cars and airplanes. Can be used for accent lighting in small display cases.



# LED LAMPS

Linear - for under shelf, cove and concealed lighting applications.

1.5" X 10"



# LED Lamps

Rings -Accent Lighting

Little over 3" in diameter





# LED Lamps

Flood

Little over 2" X 2"

Accent lighting applications



COLOR	DOMINANT WAVELENGTH OR COLOR TEMP.	LED COUNT	PART NUMBER	TYPICAL FLUX (lm)
WHITE	5500 K	12	LXHL-NW96	185
GREEN	530nm	12	LXHL-NM96	255
CYAN	505 nm	12	LXHL-NE96	300
BLUE	470 nm	12	LXHL-NB96	50
RED	627 nm	12	LXHL-ND92	450
AMBER	590 nm	12	LXHL-NL92	370
WHITE	5500 K	6	LXHL-NW97	90
GREEN	530 nm	6	LXHL-NM97	130
CYAN	505 nm	6	LXHL-NE97	150
BLUE	470 nm	6	LXHL-NB97	25
RED	627 nm	6	LXHL-ND93	225

# Lighting:

## Lamp Naming Logic

- ❑ Name based on shape and size.
  - ❑ Letters are the shape of the lamp
  - ❑ Numbers are the size based on 1/8" increments
    - ❑ A = Arbitrary shape (classic bulb shape)
    - ❑ MR = Multi-faceted reflector
    - ❑ PAR = Parabolic Aluminum Reflector
    - ❑ T = Tubular
- ❑ Lamp's CRI and Color Temperature
  - ❑ 3 number code
    - ❑ First = CRI: 7 = 70' s, 8 = 80' s, 9 = 90' s etc.
    - ❑ Second two = CT:
      - ❑ 28 = 2800 K = warm = incandescent
      - ❑ 30 = 3000 K = neutral = halogen
      - ❑ 35 = 3500 K = cool
      - ❑ 41 = 4100 K = cool
      - ❑ 50 = 5000 K = cool