Energy Efficient Lighting Technologies

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Agenda

Lighting

- Background
- Linear Fluorescent Systems
- Compact Fluorescents

Lighting

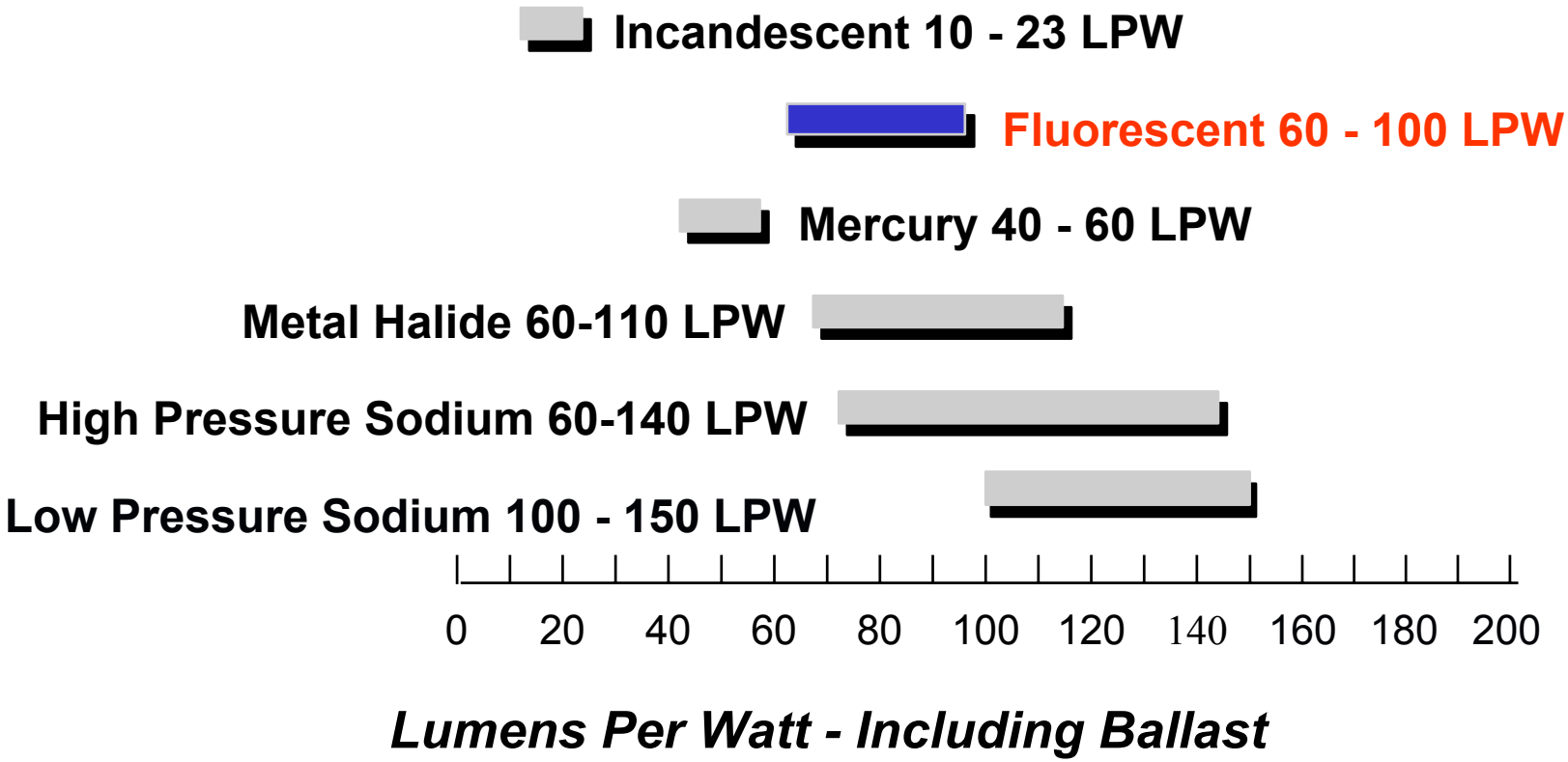
Good lighting….

- … supports the "human needs" (visibility, task performance, safety, etc.)
- **is efficient and lowers energy costs**
- … reduces impact on the environment
- … is responsive to architectural form and style
- … is easy to maintain

A room 25x30x12 feet in Central School, Glencoe, Ill., has an average intensity of twelve foot-candles provided by six 300-watt indirect units.

INFORMATIONS

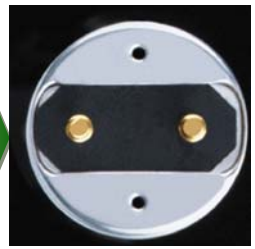
Lamp Efficacy



Technology Moved Forward

1.5” T12

1.0” T8



0.625” T5

T8 Vs T12

	T12	T8
Watts	40	32
Initial Lumens	3350	2950
Mean Lumens	3050	2800
Mean LPW	76.3	87.5
Lumen Maintenance	78%	90%
CRI	80	86

The T8 gave us a 15% improvement in efficacy while improving on lumen maintenance and color rendering.

Lamp Description

F32T8/835

Fluorescent Lamp

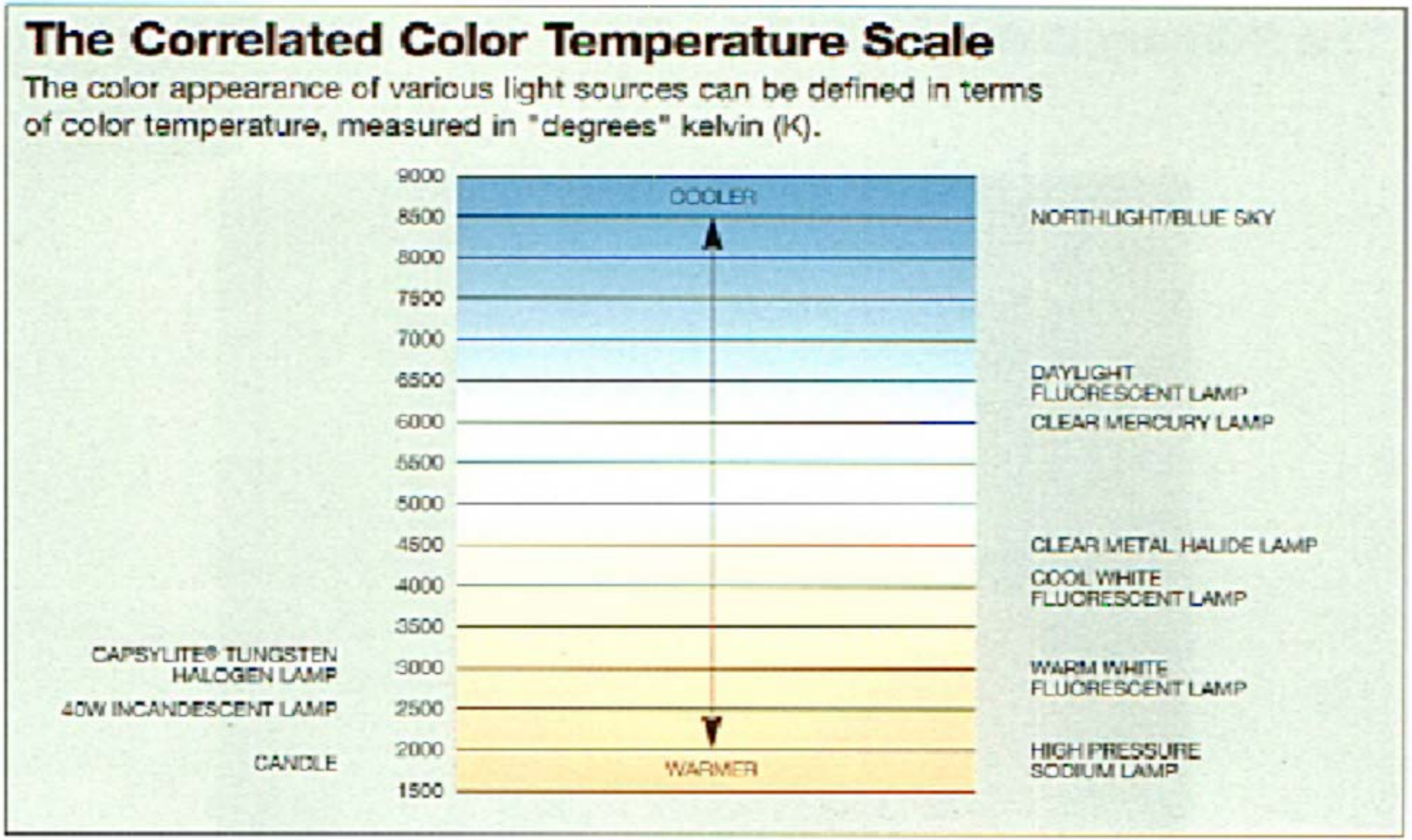
Performance Criteria

- Color/CRI
- Lumen Output
- Lumen Maintenance
- Life

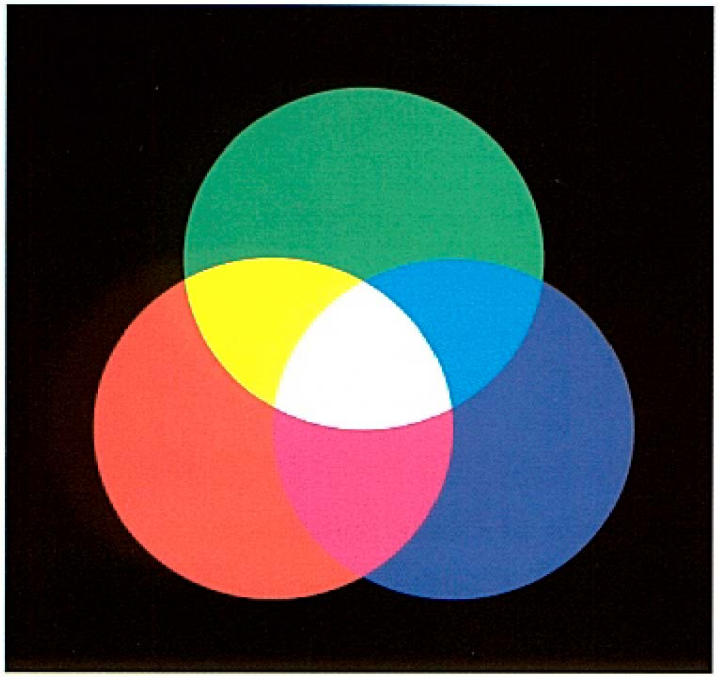
Color Rendering Index (CRI)

- Scale of 0 - 100%
- Average measure of color shift
- Generally, higher CRI means colors appear more like we expect them to
- Directly related to color temperature, so only compare CRI of sources with similar CCT

Color Temperature (CCT)



Primary Colors of Light



A combination of all three primary colors of light (red, green and blue) appears white. Combinations of two primaries produce the "secondary" colors—magenta, cyan and yellow. The three primary colors can be mixed to create almost any other color light.

Fluorescent Lamp

Performance Criteria

- Color/CRI
- *Lumen Output*
  - *Depends on Phosphor*
  - *Depends on Temperature*
- Lumen Maintenance
- Life

T8 Lamp *Color Choices*

- 700 Series (75 CRI)
  - 730, 735, 741, 750*, 765*
- 800 Series (82 CRI)
  - 827, 830, 835, 841, 850
- 900 Series (90 CRI)
  - 950*

* lower lumens

Questions on Fluorescent Lamps?

Fluorescent Ballast Regulations

Enacted efficiency requirements eliminating electromagnetic ballasts for 40T12 (4'), F96T12 (8'), and F96T12HO (8') fluorescent lamps.

- April 1, 2005
  - Eliminates production for use in new fixtures
  - Ballasts for replacement can still be produced/sold
- July 1, 2010
  - Eliminates all production, including replacement ballasts for existing installations.

Ballast Basics

Ballasts

- Functions
- Types

Systems

New technology / Applications

Ballast Functions

Start the lamp

- Lamp starting voltage
- Lamp coil heating (on most types)
- Limit lamp current after starting

Ballast Types

Magnetic (Low frequency, 60 Hz)

- "Standard": most types outlawed due to inefficiency
- "Energy saving": Use better grade magnetic materials

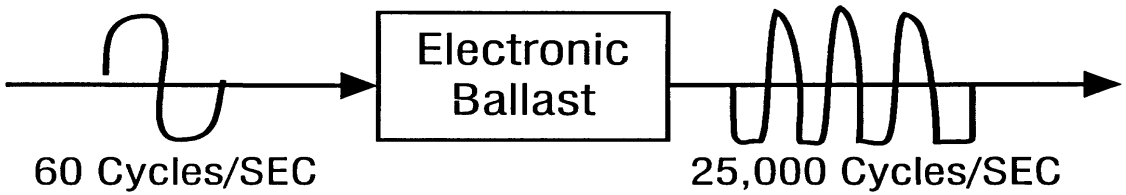
Electronic (High frequency, 20,000 kHz)

- More efficient (10 - 20%)
  - **Less power, less heat, "cooler operation"**
- Undetectable lamp flicker
- Smaller / lighter ballast components
- Reduce eye stress

Electronic Ballasts

- Electronic High Frequency Benefits
- High efficiency circuit (low ballast losses)
- Save energy (30-40% less power)
- Lamps are more efficient at high frequency
- Smaller / lighter ballast components
- 1-4 lamp ballasts
- Undetectable lamp flicker

FLUORESCENT ELECTRONIC BALLAST



- Up to 40% efficiency improvement over electromagnetic ballasts
- No ballast "hum"
- Cooler operation for reduced air conditioning load
- Can drive up to 4 lamps/ballasts
- Low temperature operation
- High Power Factor
- Low THD
- Light weight
- Instant on
- No flicker
- Universal Input Voltage

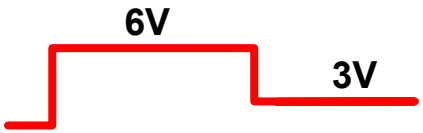
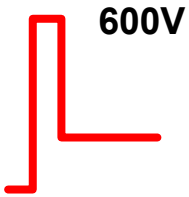
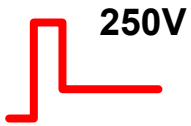
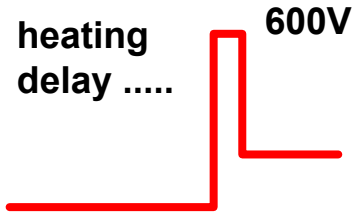
Ballast Basics

Instant Start

Rapid Start

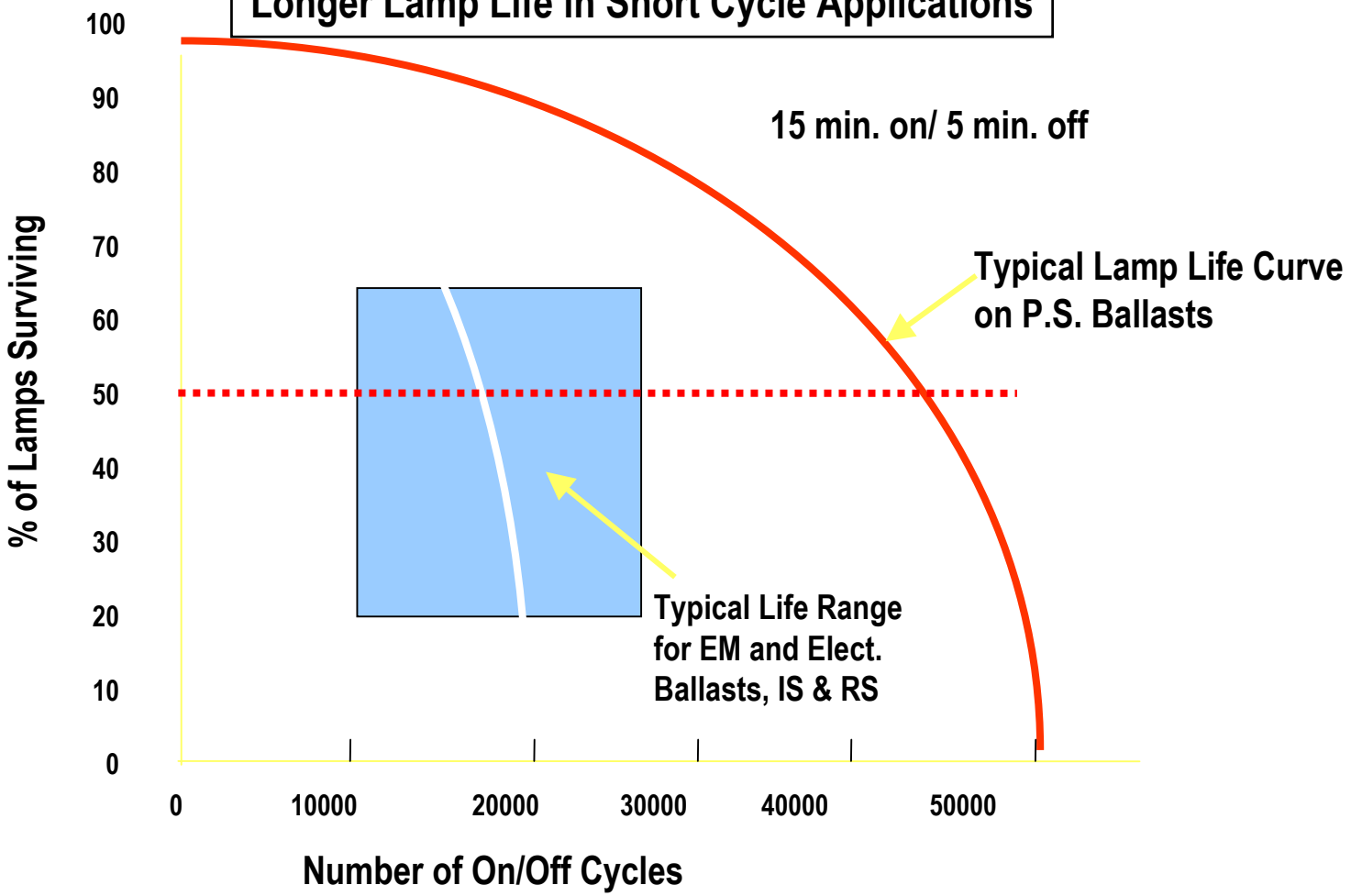
PROgrammed Start

Starting Method Comparison

	Instant Start	Rapid Start	Programmed Rapid Start
Cathode Voltage			
Starting Voltage			
Start Cycles	Up to 20k	Up to 20k	Up to 50k+
Start Temp	0° F	50° F	0° F
Input Power (2 Lamp)	55W	63W	60W
Wiring	Parallel	Series	Series
Lamp Life (3hrs/start)	15k	20k	20K

Programmed Start Ballasts

Longer Lamp Life in Short Cycle Applications



Ballasts: Some Things to Remember...

Ballast Factor : Multiplier of rated lamp lumens emitted when using lamps on this ballast (Approximately .7 - 1.3 available)

Minimum Start Temperature: Minimum temperature lamp will start when using this ballast (NOT a guarantee of light output)

New Generation of Electronic Ballasts: ~5% higher system efficiency

End of Life Protection (EOL): Built into Electronic ballasts for lamps <= T5

Universal Input Voltage: Typically operates from 105 AC - 305 AC

Programmed Start Ballasts: Long Lamp life at short cycles

Questions on Fluorescent Ballasts?

Energy Efficiency

Reducing lamp power by only 1 Watt can save*:

A 500 lamp store: (4500 hrs/year)	**$225 /yr.**
A 2000 lamp school: (3000 hrs/year)	**$600 /yr.**
A 5000 lamp hospital: (8760 hrs/year)	**$4,380 /yr.**

* Assumes $0.10/kWh, excludes A/C savings

T8

What's new in fluorescent lighting?

- Longer life fluorescent lamps
- Reduced wattage T8 systems

T8

- Longer life fluorescent lamps
  - Standard T8 (IS) 15,000 hrs.
  - Standard T8 (RS / PRS) 20,000 hrs.
  - Long life T8: 30,000+ hrs. (3 hrs/start)
- What does this mean?

Less maintenance, fewer lamps to purchase and longer group relamp intervals

2 lamp System Comparison

- Lower wattage T8 Systems
  - F34T12 / Magnetic 82 W
  - F32T8 / Electronic IS 59 W
  - High efficiency ballast T8 system 55 W
  - High efficiency ballast (.71BF) with reduced wattage 28W lamps 40 W
- **Less energy consumption / reduced operating costs and faster payback**

2 lamp System Comparison

Lamp Type and Ballast	Ballast Factor (BF)	System Watts	System Lumens*	% L Output	System LPW	% Energy Savings
F34T12/SS Magnetic	.88	82	4750	100%	58	0%
FO32T8/800XP QT2X32 ISN	.90	59	5400	114%	92	28%
FO32T8/800XP QT2X32 ISH	1.20	78	7200	152%	92	5%
FO28T8/800/SS QHE2X32 ISL	**.78**	**42**	**4250**	**90%**	**101**	**49%**
FO28T8/800XP/SS QT2X32 PSX	.71	40	3870	81%	97	51%

System Parameters

- Where are the Watts?
- Std. Magnetic 2-lamp F34T12, RS, 95% BF

Ballast losses (20% of total) =	19W
Circuit losses (coil heat) 1.5W / lamp (2) =	3W
Lamp wattage (2) (31.5W X 0.95 BF) =	60W
Ballast input wattage	**82W**

- Electronic 2-lamp FO32, IS, 90% BF

Ballast losses (12% of total) =	7W
Circuit losses (coil heat) no coil heat =	0W
Lamp wattage (2) (28W X 0.90 BF) =	52W
Ballast input wattage	**59W**

T8 Lamp and Ballast Systems

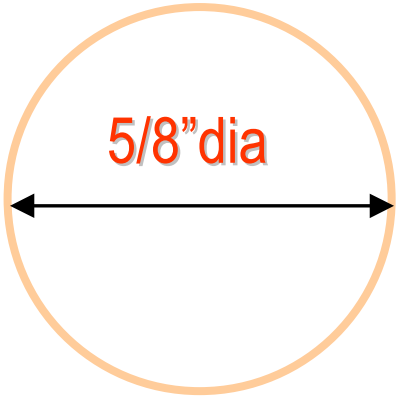
APPLICATIONS:

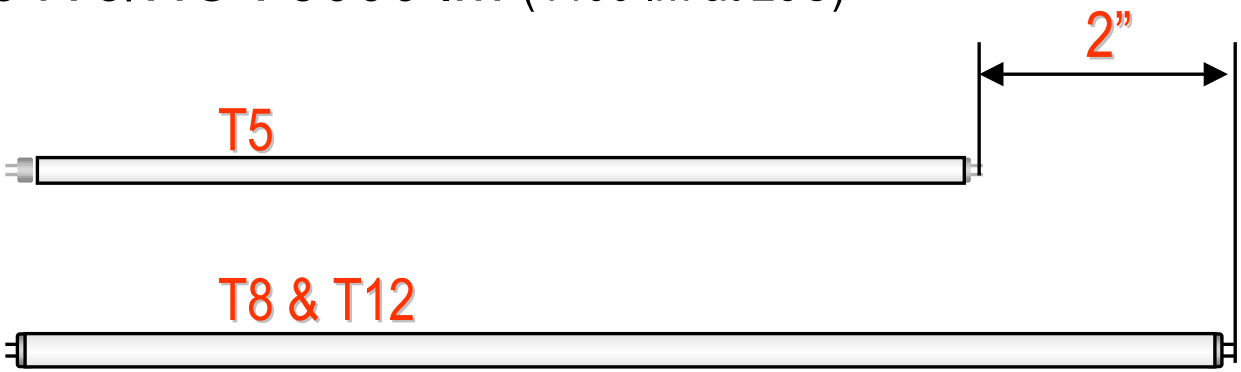
- Office
- Schools
- Retail
- General lighting

T5

What about T5 lamps?

- 14W - 80W
- 2, 3 ,4 & 5 foot lengths
- 20,000 hr life, 85 CRI
- Superior performance at elevated temperatures (35°C / 95 ° F)
- F54T5/HO : 5000 lm (4400 lm at 25C)





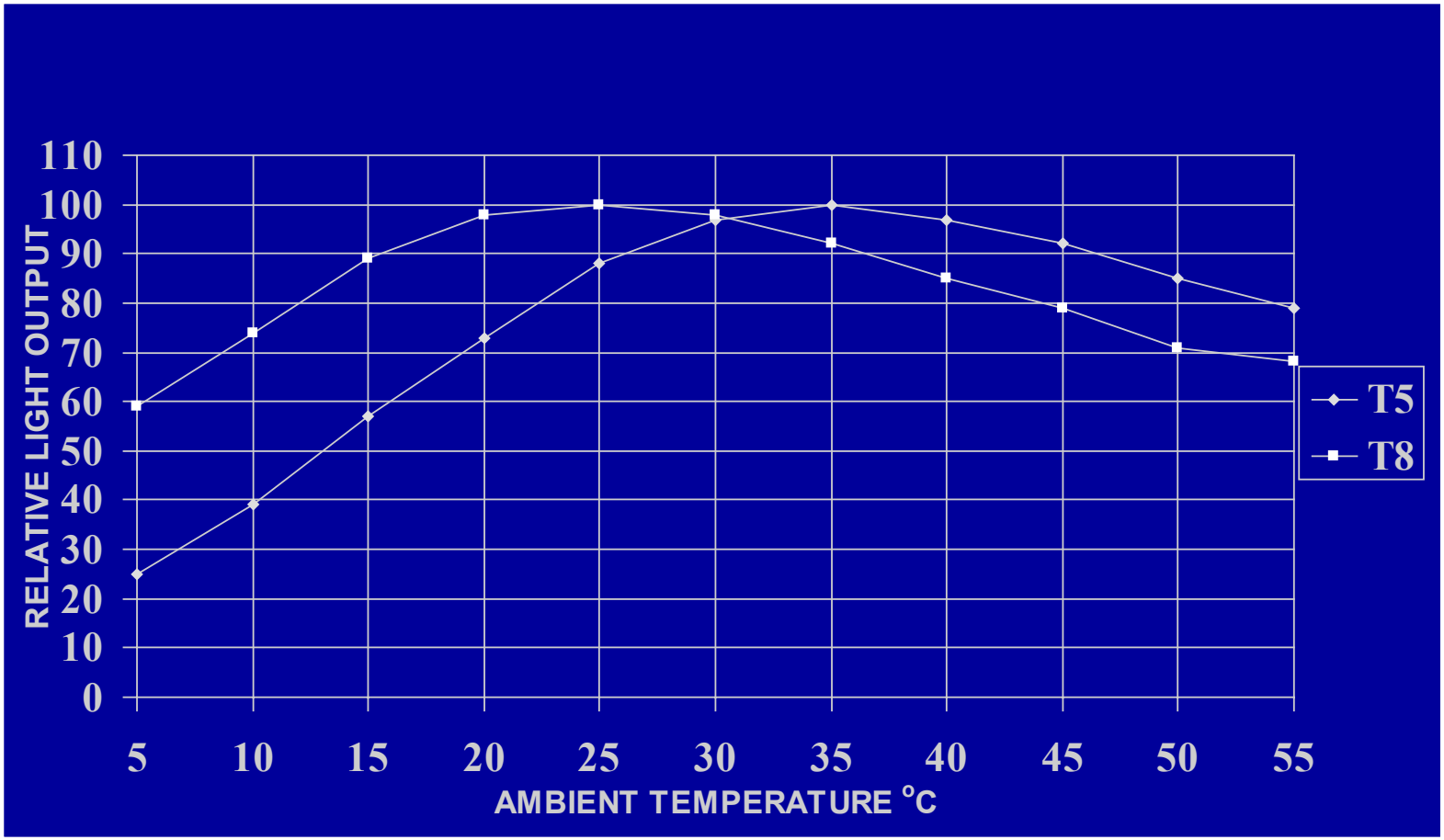
T5 Vs T8

	T8	T5	T5HO
Watts	32	28	54
Initial Lumens	2950	2900	5000
LPW	92	104	93
Lumen Maintenance	90%	93%	93%
CRI	86	82	82

The T5 gave us continued improvement in efficacy and lumen maintenance.

T5 vs T8 Temperature Curves

LUMEN OUTPUT VS. TEMPERATURE T8/T5



T5 vs. T8

When do you use T8 vs. T5?

T8 Applications

- Retrofitting T12 fixtures
- New direct fixtures

T5 / T5HO Applications

- New indirect fixtures
- Multi-lamp high bay fixtures
- Not really a retrofit

T5HO – Indirect

Advantages

- Improved light quality
- Low glare; no shadows
- Low W/ft^2
- No wall wash fixtures needed
- Upscale and stylish

T5HO – High Bay

Lamp	Maintained Lumens at 8000 hrs	System Wattage*
4 - T5/HO lamps	18,600 lm	234 W
1 - M250/U	13, 500 lm	295 W
1 - M250/PS	17,000 lm	288 W
6 - T5/HO lamps	27,900 lm	351 W
1 - M400/U	23,500 lm	460 W
1 - M400/PS	31,000 lm	452 W

Advantages: No color shift, compatible with occupancy sensors, and instant on

T5 Lamp and Ballast Systems

APPLICATIONS

- Indirect
- Cove and Valance
- Shallow recessed
- Showcase
- Highbay Lighting

Compact fluorescent lamps, They are all the same...

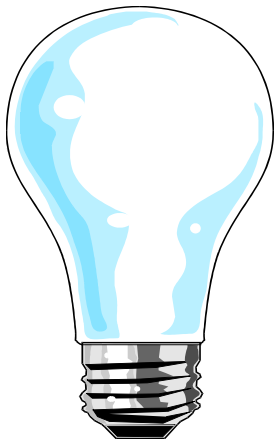
SYLVANIA calls them CF lamps
Philips calls them PL lamps
GE calls them Biax™ lamps

Compact Fluorescent

- Pin-based
  - Long lamp life
  - Flicker free
  - Higher wattages (57-70W)
- Screw-based / self ballasted
  - 3-way
  - Instant on
  - Every shape you can imagine (almost)

10 times longer life and 1/4 power consumption of standard incandescent

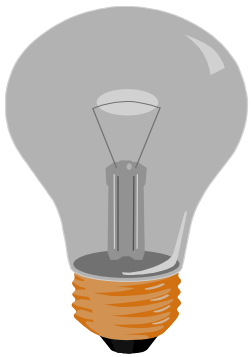
Compact Fluorescent
Light Output Equivalency



15 - watts	60 - watts
20 - watts	75 - watts
23 - watts	90 - watts

CFL Lamps

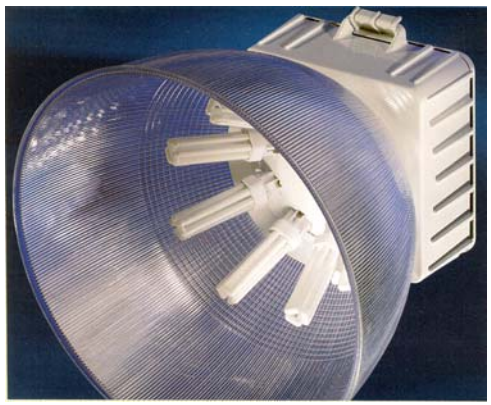
- High efficacy
  - **75% energy savings over standard incandescents**
- Long 10,000 hour life
  - **Reduced maintenance costs**



VS.

CFL Systems

- Applications: downlights, wall washers, wall sconces, table lamps, floor lamps, pendants, low and high-bay industrial/sports lighting



Questions ???