



# **Saving Money with Other White Light Sources**

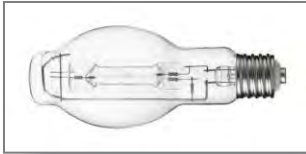
## **Ceramic Metal Halide The Best Traditional Light Source**

Kristen Mallardi, LC, Associate IES  
Business Development Manager – Energy Services  
EYE Lighting International of North America

- **Ceramic Metal Halide Technology Evolution**
  - Where have we been?
  - Where are we headed?
- **How The Eye Works**
  - Photoreceptors
  - Nighttime visual concepts
- **S/P Ratio and Mesopic Multipliers**
  - What are they?
  - How are they applied?
- **Case Studies**
  - How to save energy without breaking the bank

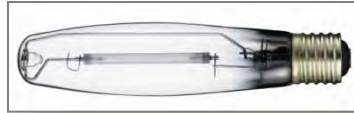
# EVOLUTION OF HID LIGHTING SOURCES

## Mercury



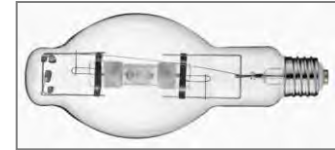
Blue Color  
Long Life  
Low Efficacy

## High Pressure Sodium



Yellow Color  
**Very Long Life** ✓  
**High Efficacy** ✓

## Quartz Metal Halide



**White Color** ✓  
Short Life  
Medium Efficacy

## Technological Advancement

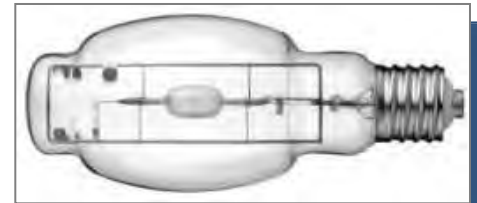
**HPS Arc Tube**  
(Polycrystalline Alumina)



**Metal Halide Chemistry**  
(various Halides)



**Ceramic Metal Halide**



**White Color** ✓

**Very Long Life** ✓

**High Efficacy** ✓

## Quartz HID arc tube

Exhaust tip acts as a heat sink., pulling heat from the arc tube and causing temperature variations inside the arc chamber.



“Pinched Fins” also act as heat sinks and also contribute to temperature variation in the arc chamber

## Ceramic HID arc tube



Arc tube is molded into a uniform shape. No exhaust tip, or “pinched fins” allows for a consistent temperature within the arc chamber and delivers improved light output, lumen maintenance and color uniformity across installations.

Inconsistent temperature in the arc chamber allows “halide salts” to cool and pool at the bottom of the arc tube. This is the major cause of performance issues in traditional metal halide lamps.



# CERAMIC HID ARC TUBE CONSTRUCTION COMPARISON

## Uniform body



## Benefit of the uniform body design

**Eliminates potential heat and gas leaks from the arc tube through multiple arc tube component “joints”.**

**Better temperature control in the arc tube increases efficacy, lumen maintenance and delivers better color rendition. While decreasing color uniformity issues across an installation.**

## 5 part assembly





# CERAMIC HID – BETTER TRADITIONAL LIGHT

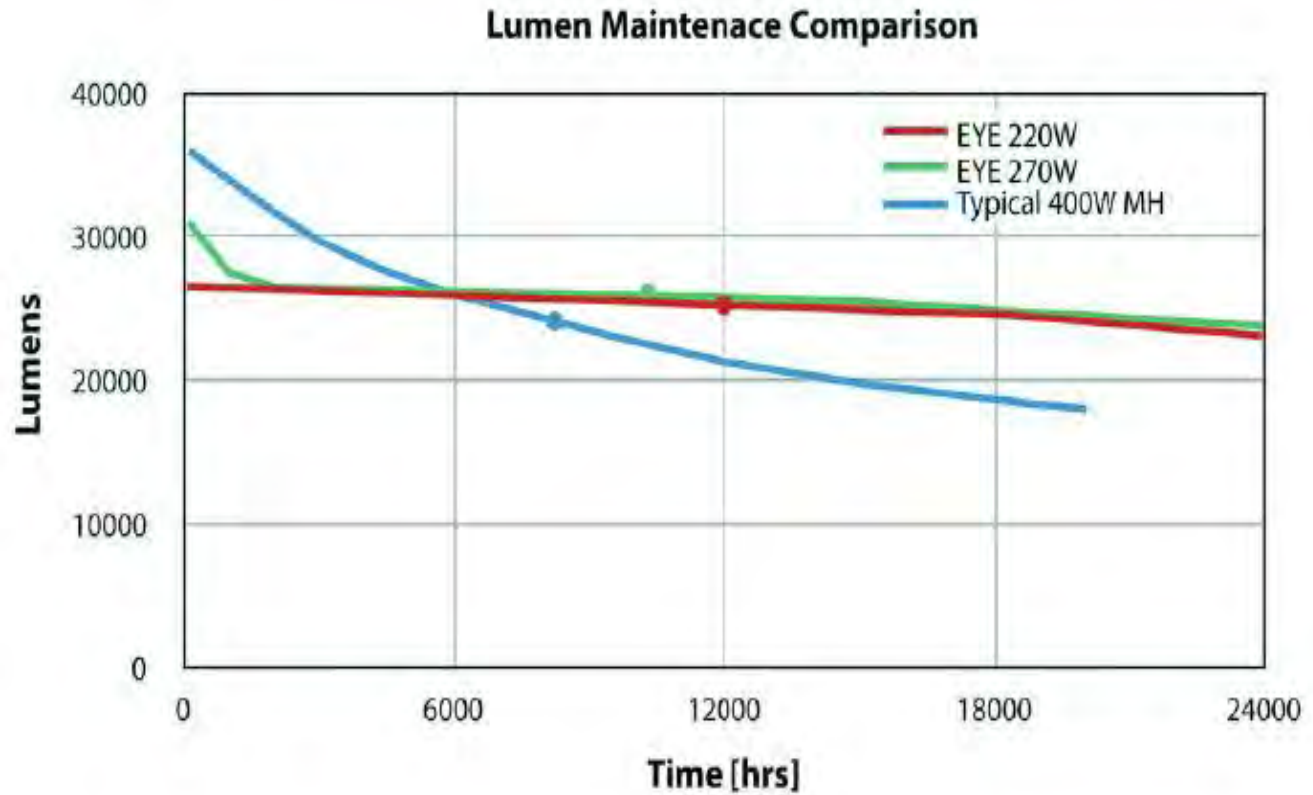
## Ceramic HID Outperforms Other Traditional Sources

	<u>HPS</u>	<u>Quartz MH</u>	<u>Ceramic MH</u>
Lumens per Watt	100-120	80-100	120-130
Rated Life	24,000 hours	20,000 hours	up to 30,000 hours
Lumen Maintenance	85-90%	80%	90%
CRI	28	68	95
CCT	2,700	4,000-5,000	3,500-4,200



# CERAMIC HID – BETTER TRADITIONAL LIGHT

## What Do the Numbers Mean?





## Electronic Ballasts Improve Lamp Performance



- Reduced arc tube blackening
- Lamp lumen depreciation is reduced – no wasted light
- Improves color uniformity
- Quiet operation
- Lengthens lamp life
- Controllability – even further energy savings
- “Smart ballast” allows active performance monitoring through wireless control/communication systems

- Can I use controls with HID?
- Can I “dim” HID systems?
  - Dimming vs. Power Reduction
  - Not linear relationship
    - Multiply % of power reduced by 1.4 for % light is reduced
      - 50% power reduction x 1.4 = 70% less light
      - 30% power reduction x 1.4 = 42% less light
- How far can I go?
  - Quartz HID systems can have power reduced by up to 50%
  - Ceramic HID systems can have their power reduced by up to 30%





- Lamp Performance in reduced power mode
  - CRI reduced minimally
  - Color shift – change in CCT
- Re-strike
  - Arc remains energized, no delay in returning to full power light output

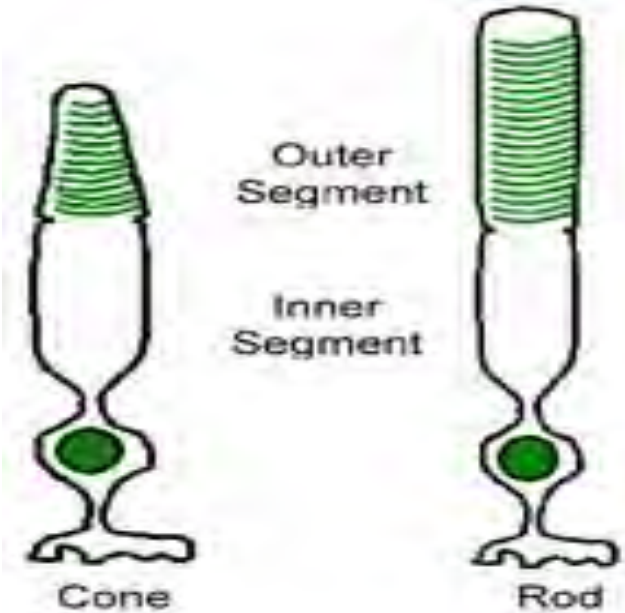
*HID lamp dimming EC&M magazine, Oct 2004, Craig DiLouie*



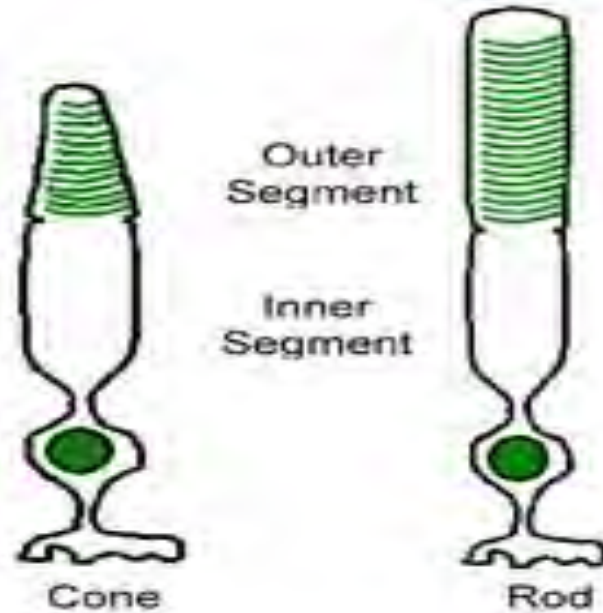
- Photoreceptors
- Nighttime visual concepts
- Extreme wattage reduction strategies

## Cones

- Color Vision
- No sensitivity in the dark
- Respond in bright light
- High visual acuity



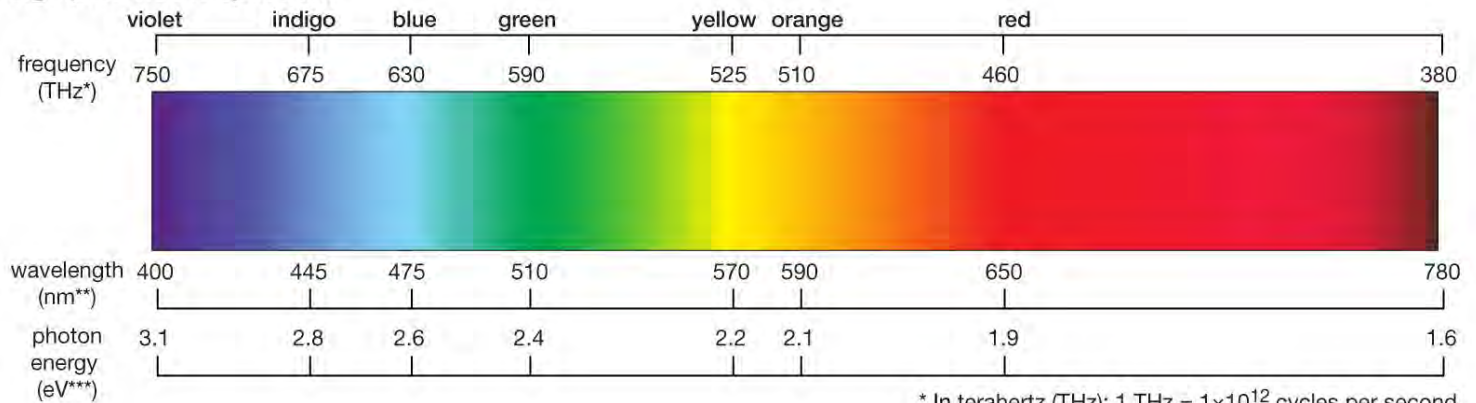
# PHOTORECEPTORS – RODS - OUTER SEGMENT



## Rods

- Monochromatic
- High sensitivity in the dark
- Low visual acuity

## Light, the visible spectrum



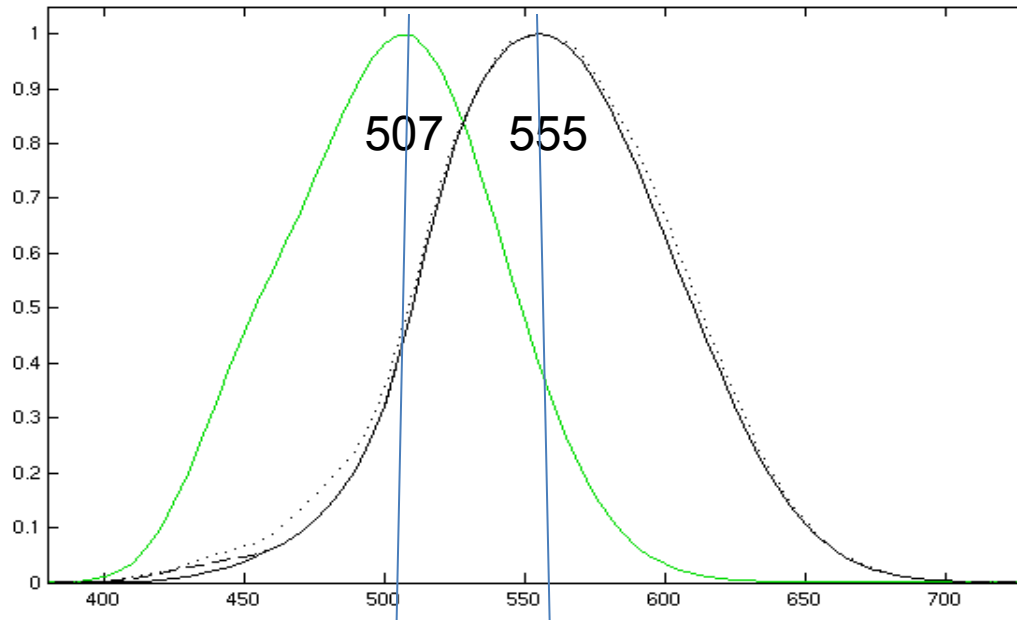
\* In terahertz (THz); 1 THz =  $1 \times 10^{12}$  cycles per second.

\*\* In nanometres (nm); 1 nm =  $1 \times 10^{-9}$  metre.

\*\*\* In electron volts (eV).

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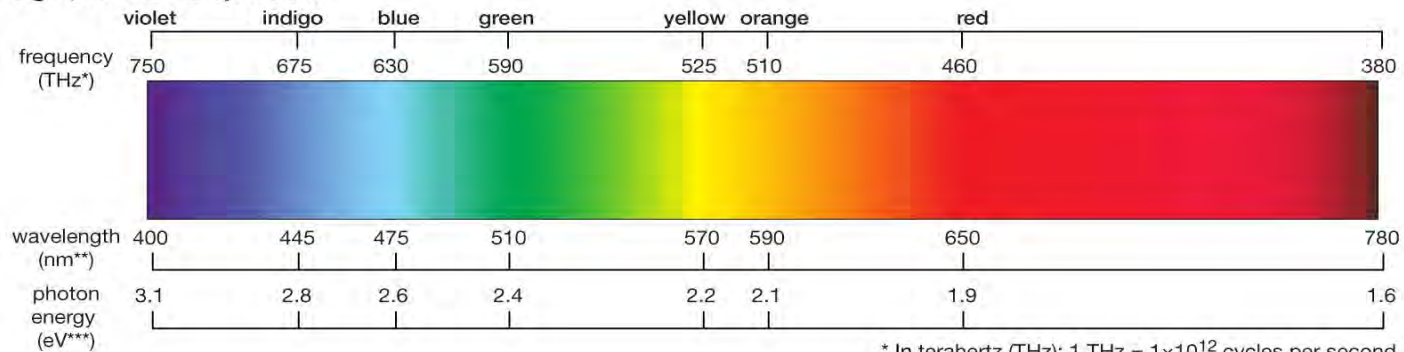
# SCOTOPIC AND PHOTOPIC CURVES - CIE



Photopic vision peaks at 555nm (middle wave length)

Scotopic vision peaks at 507nm (short wavelength)

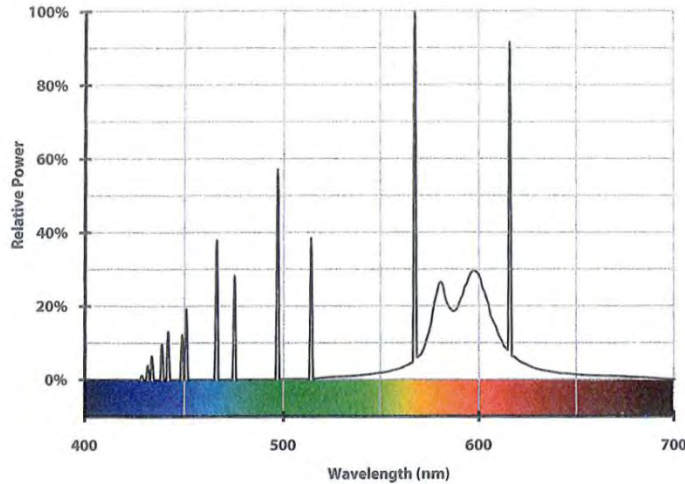
Light, the visible spectrum



\* In terahertz (THz); 1 THz =  $1 \times 10^{12}$  cycles per second.  
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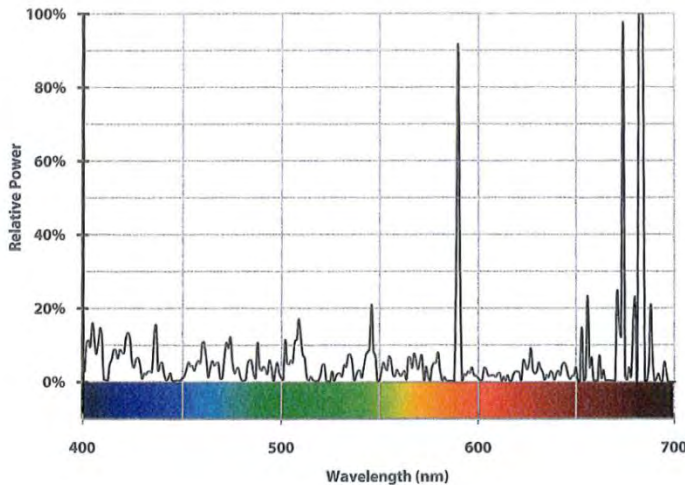
# HPS VS. QUARTZ MH SPECTRAL DISTRIBUTION



**Figure 1.10 | Spectrum of a High Pressure Sodium Discharge**

Optical radiation from a high pressure sodium discharge.

Peaks in yellow, orange, red portion of the spectrum



**Figure 1.11 | Spectrum of a Metal Halide Discharge**

Optical radiation from a metal halide lamp using mercury, sodium, and scandium.

More equally distributed

- Occurs at luminances higher than  $10 \text{ cd/m}^2$
- Visual response is dominated by the cone receptors
- Color is perceived and fine detail is resolved in the fovea

- Intermediate between photopic and scotopic states of adaptation
- Both cone and rod receptors are active
- Luminances between  $10 \text{ cd/m}^2$  and  $0.001 \text{ cd/m}^2$  produce this state of adaptation

- Occurs at luminances less than  $0.001 \text{ cd/m}^2$
- Only rod photoreceptors are engaged at this state of adaptation
- Fine detail appears in the periphery



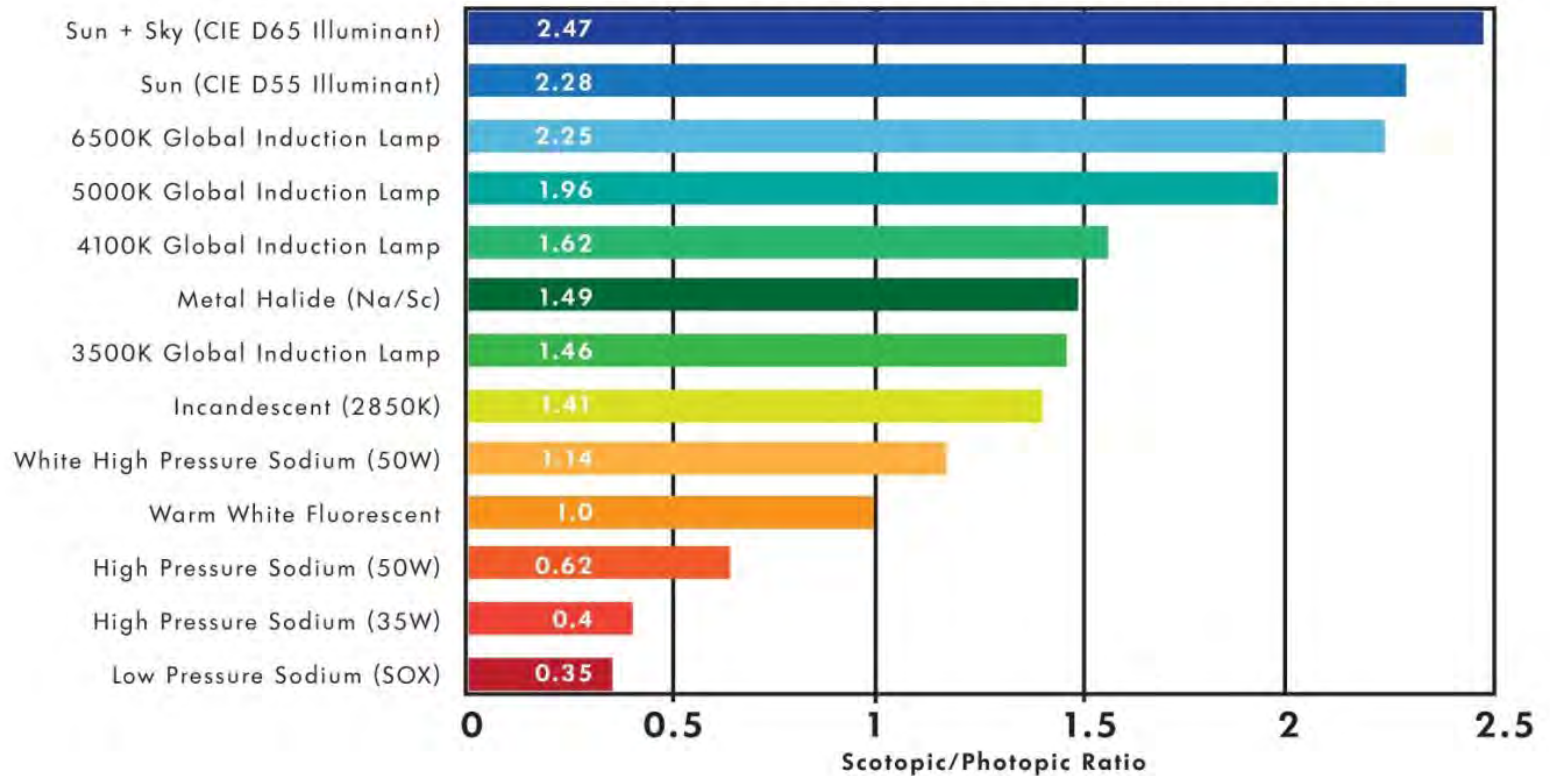
# HOW DO PHOTOPIC, MESOPIC AND SCOTOPIC CONCEPTS WORK?

- These are predominantly nighttime lighting concepts
- Scotopic, or more practically mesopic corrections increase the observed lighting in an area at night. White light sources have an S/P ratio greater than 1.0
- The question is by how much?

- IES 10<sup>th</sup> Lighting Handbook, 10<sup>th</sup> Ed, 2011
- Pages: 2.14, 2.16, 2.17, 4.32, 4.34

## Scotopic/Photopic Ratios for Various Light Sources

Courtesy of Francis Rubinstein - Lawrence Berkley National Library



Courtesy Lawrence Berkeley National Lab



# HOW DO WE APPLY MESOPIC MULTIPLIERS?

## Example

If the recommended photopic illuminance is 2 fc then the mesopically corrected values are:

3.0 fc under HPS

1.1 fc under 5000K MH

## This means

If the HPS light source is used the photopic target should be a light level of 3.0 fc.

If a 5000K source is used then the target would be only 1.1 fc.



# 400W HPS SYSTEM UPGRADE EXAMPLE

	400W HPS	220W CMH
<b>Light Output</b>		
Initial Lumens (Photopic)	50,000	26,500
LLD	0.90	0.9
Mean Lumens (Photopic)	45,000	23,850
Mean Lumens occur at this point in time	9,600	9,600
Photopic Lumens @ 9600 hours	45,000	23,850
S/P Ratio	0.6	<b>1.4</b>
Scotopic Lumens at 9600 hours	27,000	<b>33390</b>
More Light @ 9600 hours (Scotopic)		<b>24%</b>
CRI	28	<b>80</b>



## **Safety, Security, Visibility—Remain the Same But Priorities Have Changed**

### Past Concerns

- 1. Aesthetics**
- 2. Luminaire Efficiency**
- 3. Equipment Cost**
- 4. Maintenance**
- 5. Energy Use**

### Today's Concerns

- 1. Energy Use**
- 2. Maintenance**
- 3. Life Cycle Cost**
- 4. Luminaire Efficiency**
- 5. Light Trespass, Glow, Glare (B-U-G Ratings)**
- 6. Aesthetics**

## Existing System

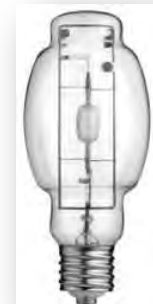
250W Pulse MH

### Energy Saving Retrofit

1. Retain the Luminaire
2. Retain the Ballast
3. Change 250W QMH to 220W CMH Lamp

### Benefits:

- 12% Energy Savings
- 25% more lumens-High CRI
- 30,000hr Rated Life: Lower Maintenance Cycle
- Simple Payback=less than 3 years



## Existing System

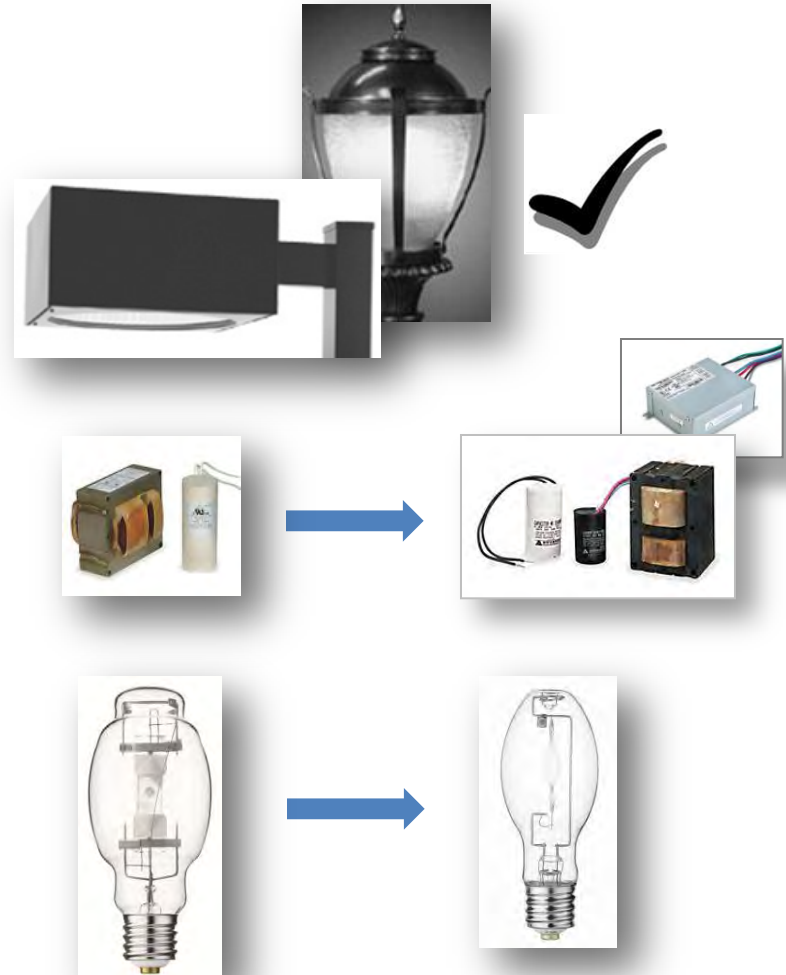
250W Probe MH

## Energy Saving Upgrade

1. **Retain the Luminaire**
2. **Change Ballast to 150W MH System (Magnetic or Electronic)**
3. **Change to 150W CMH Universal Lamp**

### Benefits:

- 36% Energy Savings
- 30% More lumens-High CRI
- 24,000 Rated Life: Lower Maintenance Cycle
- Simple Payback=less than 2 years



## Street or Area Lighting Application

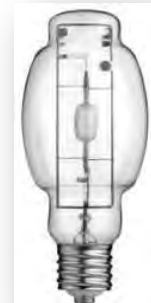
400W Probe MH System

### Energy Saving Upgrade

1. **Retain the Luminaire**
2. **Change Ballast to 250W PSMH System (Magnetic )**
3. **Change to 220W CMH Lamp**

### Benefits:

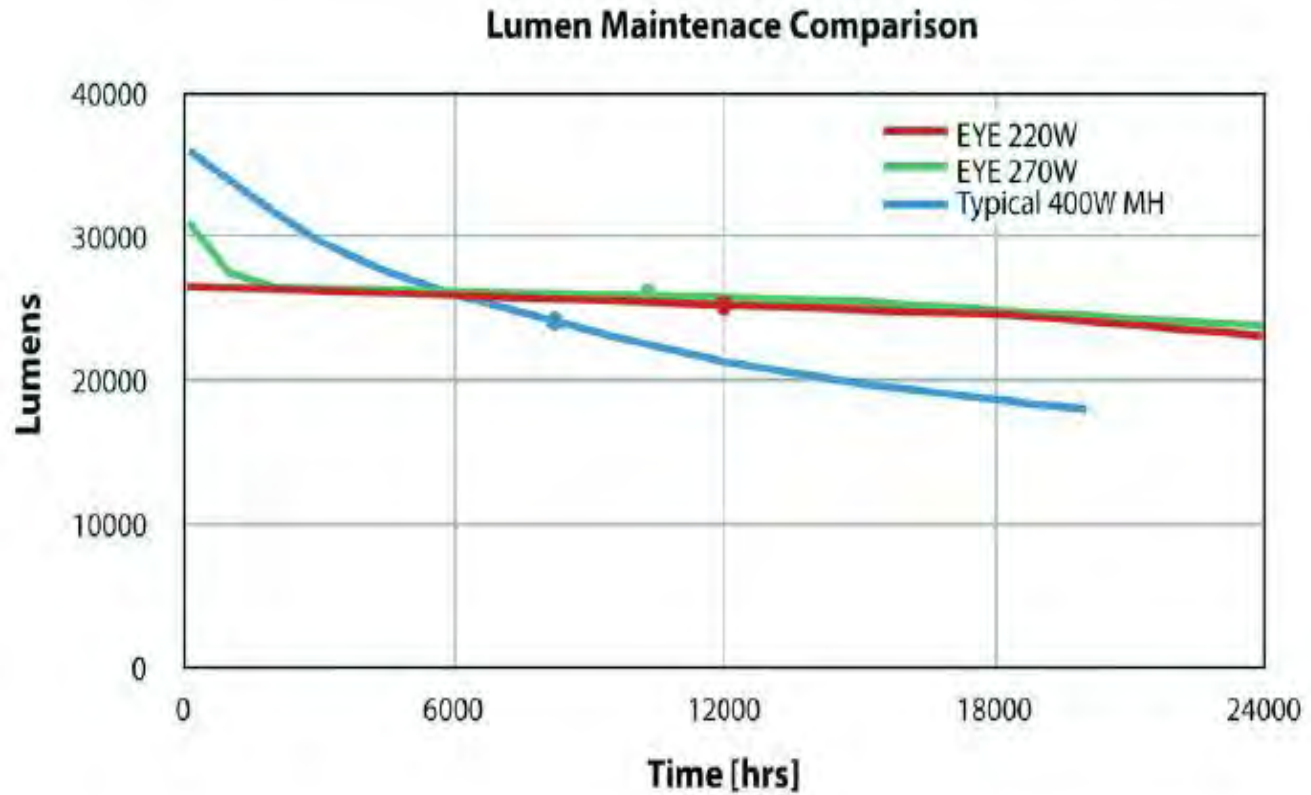
- 46% Energy Savings
- 15% More lumens-High CRI
- 30,000hr Rated Life: Lower Maintenance Cycle
- Simple Payback=less than 1 year





# CMH – BETTER TRADITIONAL LIGHT

## What Do the Numbers Mean?





### Application – Big Box Retail

- 350W PSMH to 270W Electronic Ballasted CMH system
- 395W to 292W - Saves 26% Energy
  - 450 Luminaires: Change one-for-one
  - Energy Use: 177 kW down to 131 kW
  - \$20,104.00 annual energy savings before dimming
  - Dimming Controls Save Even More
- Improved efficacy - Same Light on Task
- Longer life-reduced maintenance costs
- Better Visibility – Improved CRI
  - Vivid colors, displays and merchandise with improved visual appeal
  - Better visual acuity for worker comfort and fine detail work

## **Quartz MH systems can be upgraded using CMH technology**

- 400W MH to 220W CMH – saves 218 watts
- 250W MH to 150W CMH – saves 100 watts
- 175W MH to 100W CMH – saves 80 watts

## **HPS systems can also be replaced**

- 400W HPS to 220W CMH – saves 218 watts
- 250W HPS to 220W CMH - saves xxxwatts
- 200W HPS to 150W CMH – saves xxxwatts
- 150W HPS to 100W CMH saves xxxwatts

## **HPS to CMH Conversion Lamp – no ballast change**

- 250W HPS to 250W CMH



## CERAMIC MH – WHAT’S NEXT?

Lamp Technology

Improving-Generation 3 will be 150+lpw  
Higher wattage applications-1000watt

Ballast Manufacturers

Dimming and communications/diagnostic

End Users

Demanding “white light” for better visibility





Ceramic Technology	Highly efficient, long life, quality of light, robust proven technology, alternative to LED
Applications	Wide variety of wattages for any application
Implementation	Simple conversion process, either retrofit or new gear
Utilities	Supporting technology through incentives



# CERAMIC METAL HALIDE APPLICATIONS



BENCHTEST EYE LIGHTING CERA ARC

## The white stuff

**A cost-effective way to ensure the future of streetlighting isn't orange is to retrofit sodium lamps with white ceramic metal halides. And this is the lamp to do it, says Ray Molony**

Many streetlighting engineers tell us they're plagued by councilors, residents and others asking about LEDs. While the interest in lighting technology is obviously to be welcomed, it can't help engineers' workloads to be constantly explaining the pros and cons of solid-state lighting. Most local authorities these days have at least



Ceramic is better than quartz because it solves the problem of sodium depletion, which leads to colour shifts and poor lumen depreciation. Retrofitting with ceramic sources is a simple, effective, and low-cost way to upgrade from HPS to white light with higher lumen output and CRI. The best-known ceramic lamp is Philips' CosmoPlus. It's a great lamp, but you'll have to

Courtesy Lux Magazine

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