



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Lamp, Ballast, and Lighting Technologies

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First the basics...

LED Technology for Exit Signs





LED Exits = \$ Savings

	LED	Fluorescent	Incandescent
Lamp Cost	N/A	7.79	6.08
No. of Lamps	2	2	2
Lamp Life	Indefinite	10,000	7,000
Labor Rate	N/A	\$20 / Hr	\$20 / Hr
Input Watts	2W (2 lamps)	18 W	40 W
Energy Costs	.09 KwH	.09 KwH	.09 KwH
Relamp Labor	N/A	\$15 / Hr	\$15 / Hr
Lamp Maint Cost	0	\$16.28	\$18.97
Annual Energy Cost	\$1.58	\$14.19	\$31.54
Annual Operating Cost	\$1.58	\$30.47	\$50.51



Next... new HID technology

- Pulse Start
- Electronic Dimming





- Versus Standard Metal Halide:
 - Higher light levels
 - More energy efficient
 - Improved lumen maintenance
 - Faster re-strike and recovery after an outage





Higher Light Levels allow Fewer Fixtures

	400 watt Standard	400 Watt Pulse Start
Total Initial Lumens	36,000	42,000
Mean Lumens (@40%)	25,000	32,800
Rated Life (10 hrs/strt)	20,000	20,000
Input Watts	458	452
CRI	65	65



Higher Light Levels allow Fewer Fixtures

100,000 sq.. ft

20 Ft. Mounting Height

High Bay Fixture

50 FC Maintained



400 W. Standard:

290 Fixtures

400 W. Pulse Start:

208 Fixtures

Annual Operating Savings = \$8,847

(3800 hrs/yr @ .06kWh)



Or an Energy-Saving 1-for-1 Retrofit

	400 Watt Standard	320 Watt Pulse Start
Total Initial Lumens	36,000	32,000
Mean Lumens (@40%)	23,500	21,000
Rated Life (12 hrs/start)	20,000	20,000
Input Watts	458	349
Re-strike Time	10 - 20 Minutes	5 - 10 Minutes
CRI	65	65



Pulse-Start Metal Halide

Energy-Saving 1-for-1 Retrofit

Application Scenario:

100,000 sq.. ft

20 Ft. Mounting Height

High Bay Fixture

50 FC Maintained



400 W. Standard:

290 Fixtures

320 W. Pulse Start:

290 Fixtures

Annual Operating Savings = \$7,207

(3800 HRS/YR @ .06 kWh)

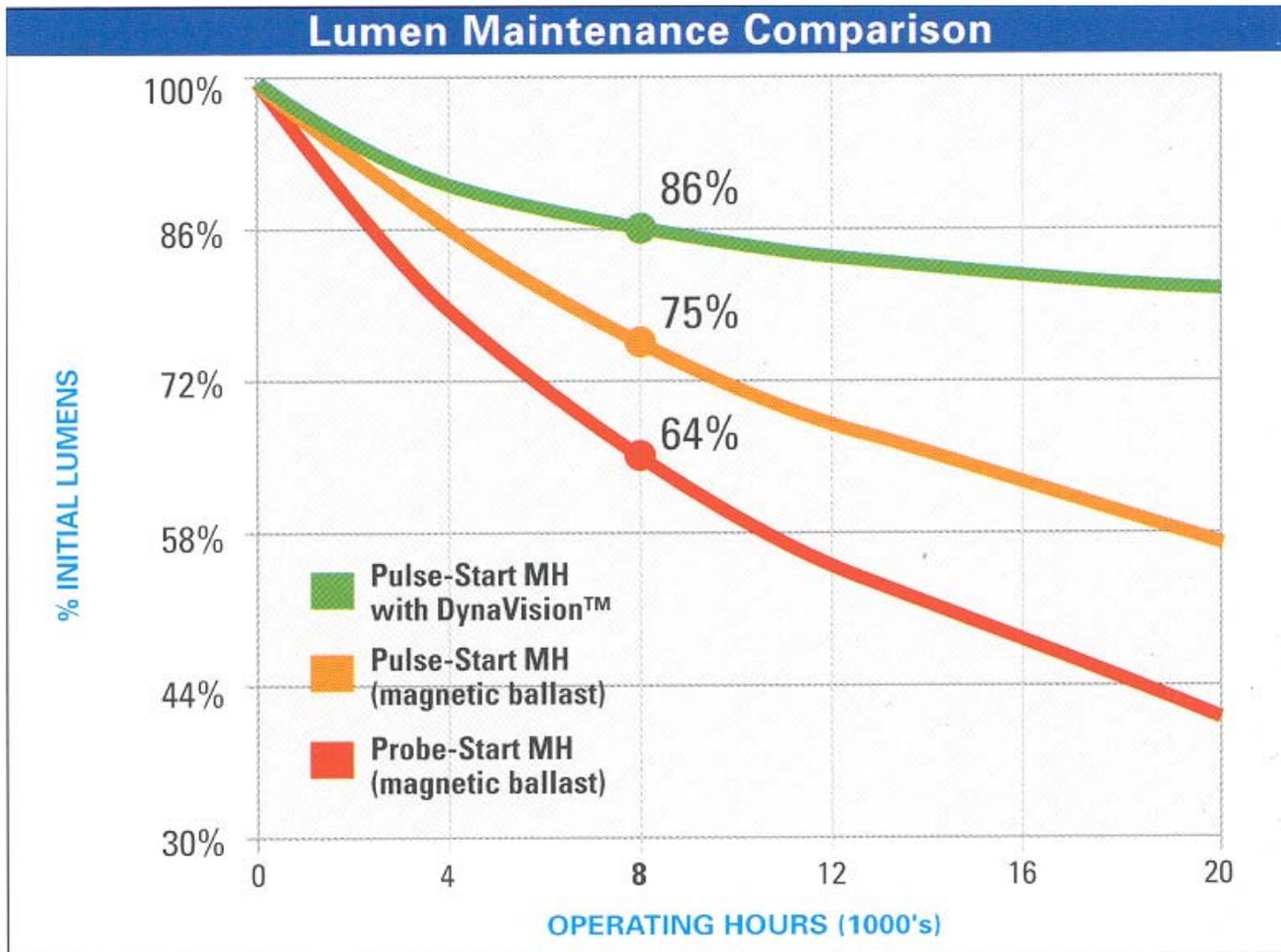


- Electronic Dimming HID
 - All Electronic
 - 320/350/400 Pulse Start
 - 200-277V, 50/60Hz
 - 40C Standard
 - 55C High Ambient Option
 - 100 to 28% Dimming
 - 10V DC Controls





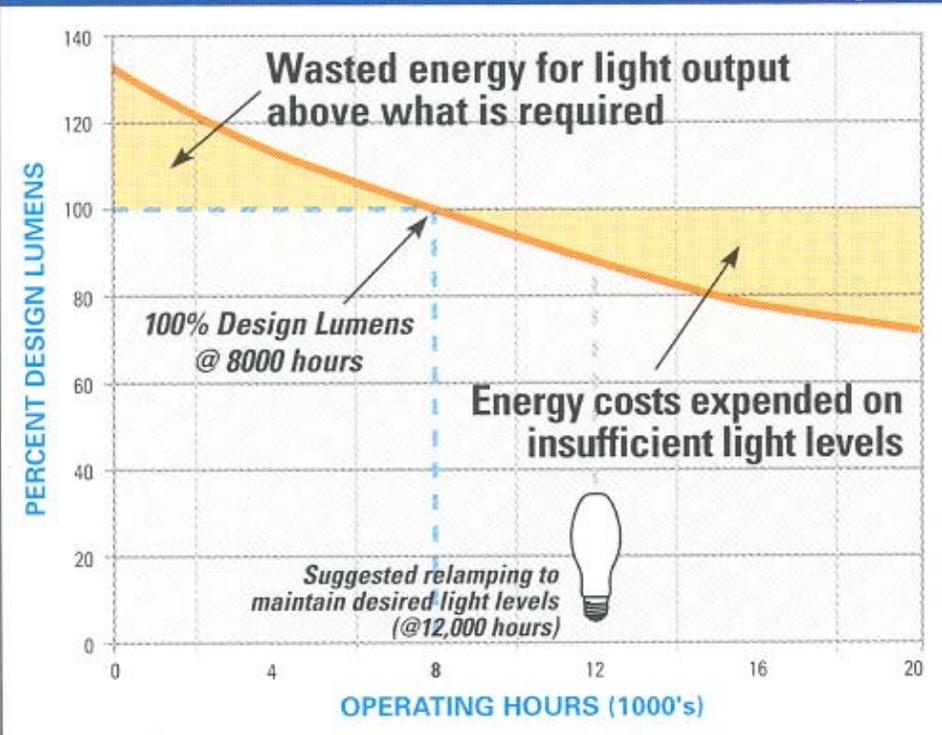
Electronic Dimming HID



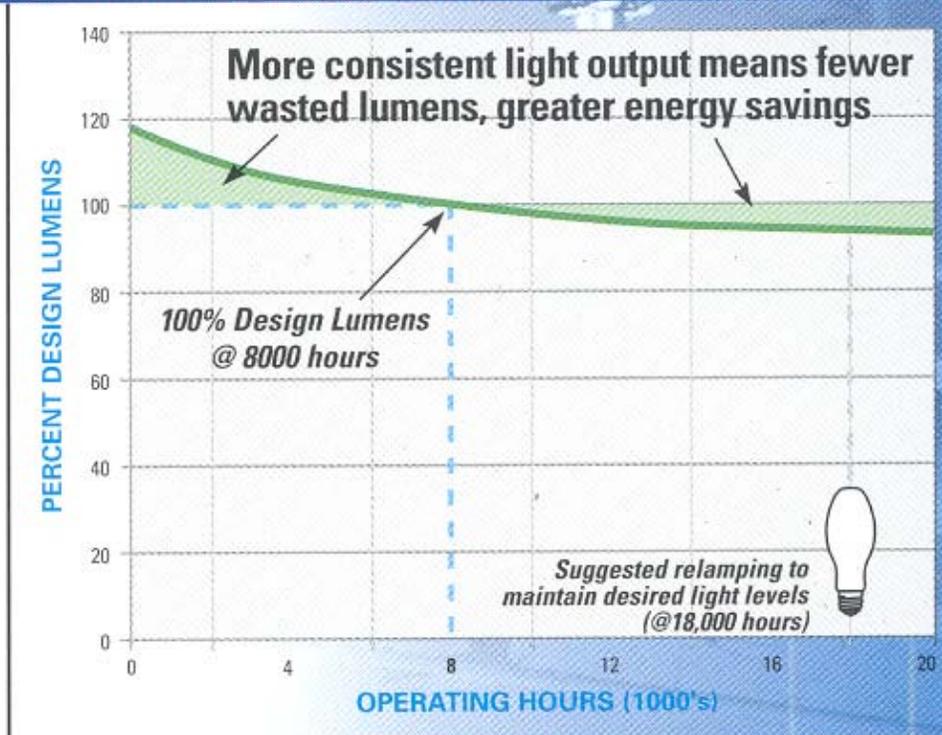


Electronic Dimming HID

Cost Benefits of Improved Lumen Maintenance



OLD – Magnetic Probe Start HID



NEW – DynaVision Electronic HID



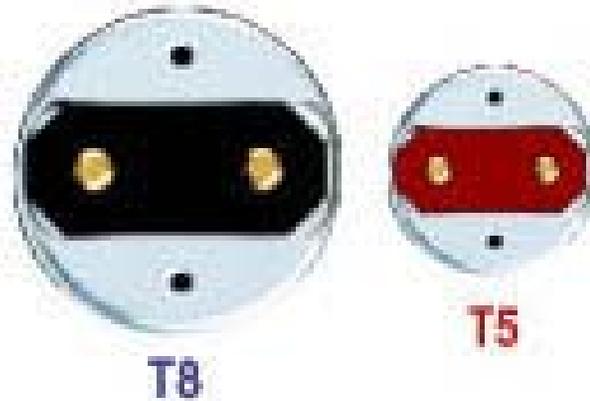
Electronic Dimming HID

	400W Probe Start Magnetic CWA	400W Pulse-Start Magnetic SCWA	400W Pulse-Start GEB	T5HO Industrial Luminaire
Mean Lumens/Lamp	23,000	30,240	37,000	28,440
No. Fixtures Req'd	124	100	77	100
Fixture cost ea.	\$ 101	\$ 121	\$ 295	\$ 162
Total Fixture Cost	\$ 20,526	\$ 18,600	\$ 28,440	\$ 24,200
Annual Energy Costs	\$ 33,386	\$ 27,480	\$ 19,601	\$ 21,060
3 Year Total Cost	\$ 120,684.52	\$ 101,040.00	\$ 87,241.62	\$ 87,380.00
Optimum Temp Range	85 C	85 C	75 C	10 C



Introducing – Fluorescent Alternatives

- T8
- T5HO





Fluorescent High-Bay

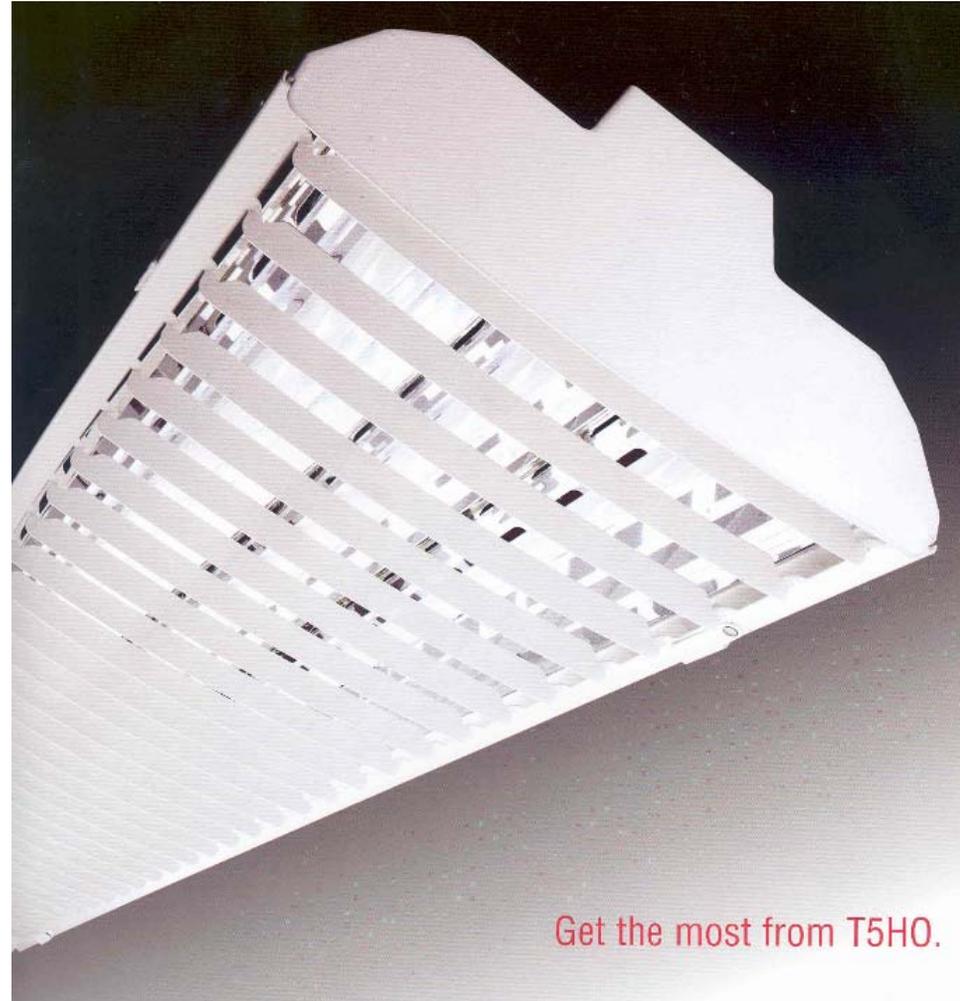
- Compact size for HID retrofit applications
- Single-point pendant mounting
- 4 to 6 to 8-lamp configurations
- Narrow and wide distributions





Linear Fluorescent High-Bay Fixtures

- Designed for aisles - retail and warehousing
- Precise optical control
- Uniform illumination
- Louvered design



Get the most from T5HO.



6-Lamp System Comparison

	400 watt Standard	6-Lamp T- 5 HO
Total Initial Lumens	36,000	30,000
Mean Lumens (@40%)	25,000	28,500
Rated Life (10 hrs/strt)	20,000	24,000
Input Watts	458	351
CRI	65	85



T-5HO Fluorescent

100,000 sq.. ft
20 Ft. Mounting Height
(6) 4' lamps



***400 W. Standard:
6-Lamp T5 HO:***

***290 Fixtures
290 Fixtures***

****Annual Operating Savings = \$7075***

(3800 Hrs/Yr @ .06 kWh)



Four-Lamp System Comparison

	400 watt Standard	4-Lamp T- 5 HO
Total Initial Lumens	36,000	20,000
Mean Lumens (@40%)	25,000	19,000
Rated Life (10 hrs/strt)	20,000	24,000
Input Watts	458	234
CRI	65	85



T-5HO Fluorescent

Application Scenario:

100,000 sq.. ft

20 Ft. Mounting Height

(4) 4' lamps



400 W. Standard:

290 Fixtures

4-Lamp T5 HO:

290 Fixtures

****Annual Operating Savings = \$18,000***

(3800 Hrs/Yr @ .06 kWh)



System Comparison

	400 watt Standard	6-Lamp T8
Total Initial Lumens	36,000	22,320
Mean Lumens (@40%)	25,000	21,204
Rated Life (10 hrs/strt)	20,000	24,000
Input Watts	458	234
CRI	65	80 - 85



Before

- 35-400W Metal Halide High-Bays w/ Spun Aluminum Reflector
- Fair color rendering
- 25 to 30 footcandles maintained
- 35 x 460 watts/fixture = **16.1 kW**
- 16.1 x 3000hrs x \$.08/kwh = **\$3,864**

After

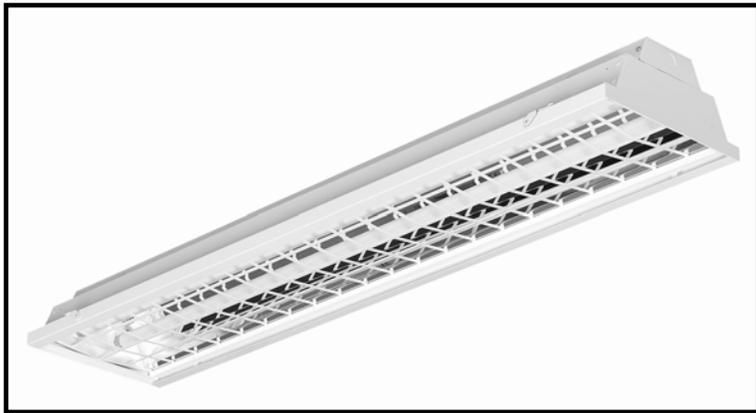
- 35- 6 F32T8 lamp Fluorescent High Bays with specular Miro4 Reflector
- High color rendering
- 50 to 60 footcandles maintained
- 21 x 234 watts/fixture = **4.9 kW**
- 4.9 x 3000 hrs x \$.08/kwh = **\$1,176**



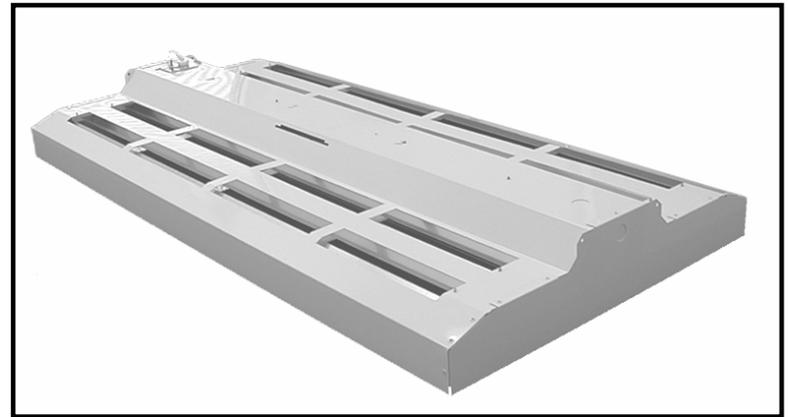
Doubled Light Level, Improved CRI(65 to 85), Lamp Life (15k to 24k hours)



Luminaires for Relighting Gymnasiums



Linear Fluorescent – with wire grille



Fluorescent Retrofit – with wire grille



So What Do I Use?

- Important Factors to Consider
- **Required Lighting Levels**
- Mounting Heights
- Distribution Needs
- Mounting Means and Constraints
- Ambient Temperature
- Supplemental Controls – occupancy sensors, photocells, step dimmers, dimmers



Required Light Levels

IES Recommended Levels of Illuminance

Storage/Warehousing

Inactive	5 fc
Active Large Items/Labels	15 fc
Active Small Items/Labels	25 fc



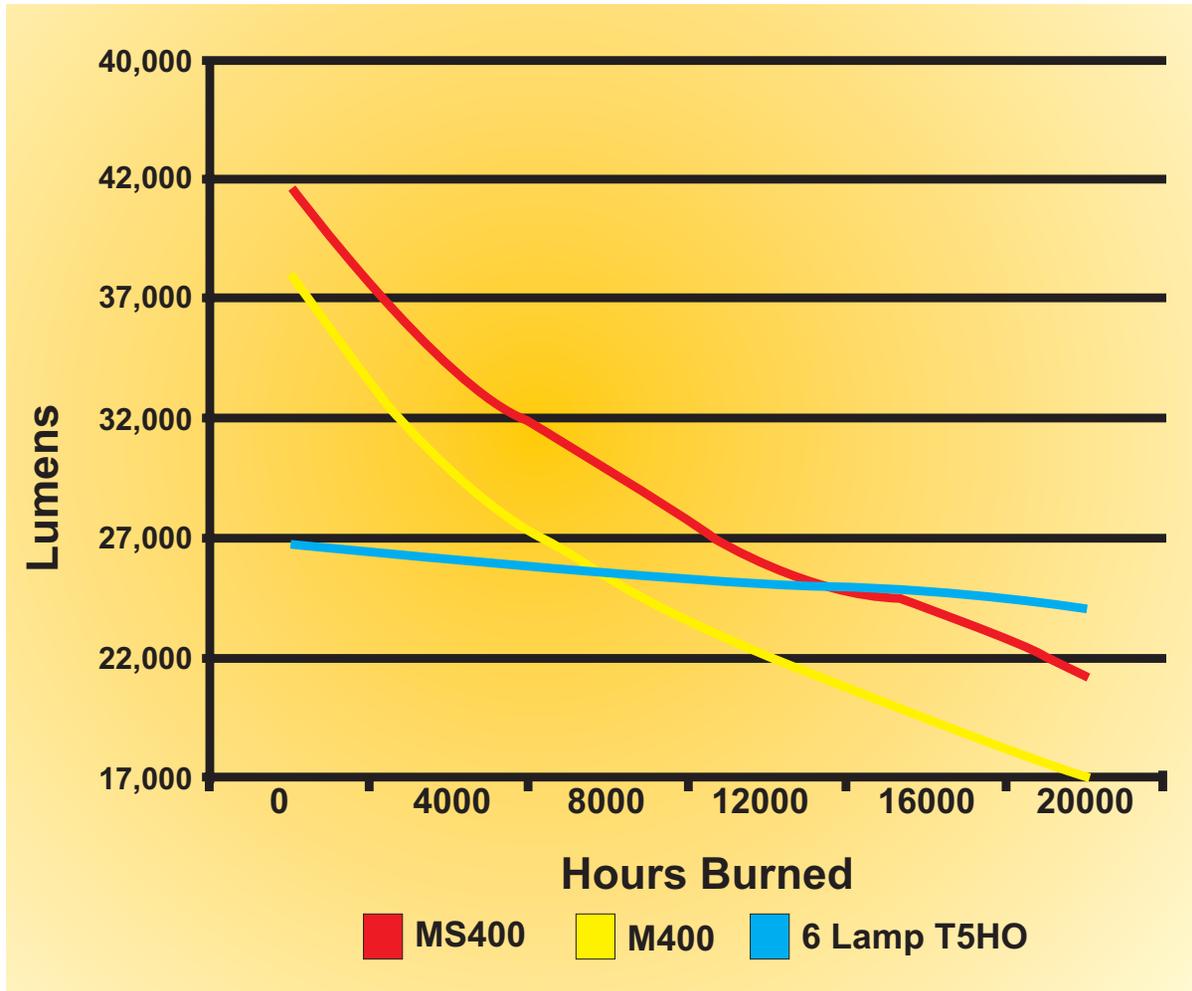
Before



After



Lumen Maintenance

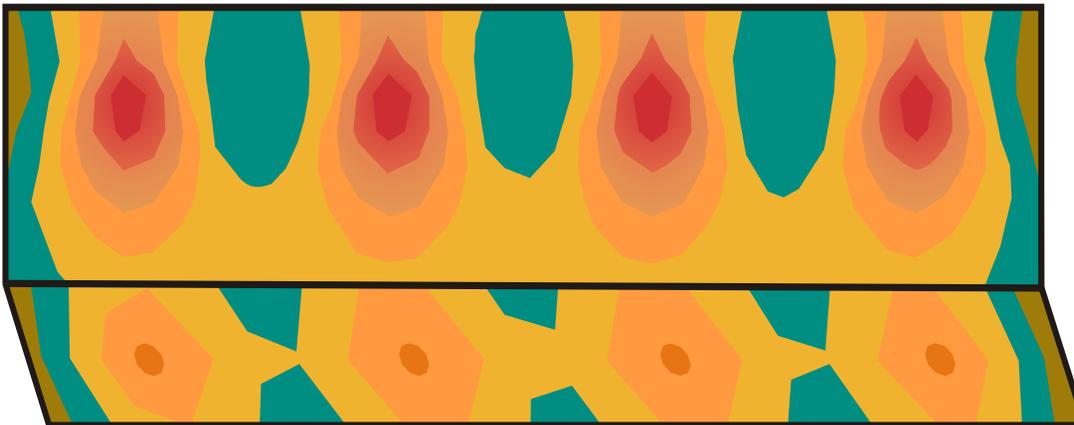




Uniformity



Linear T5HO



400W Metal Halide

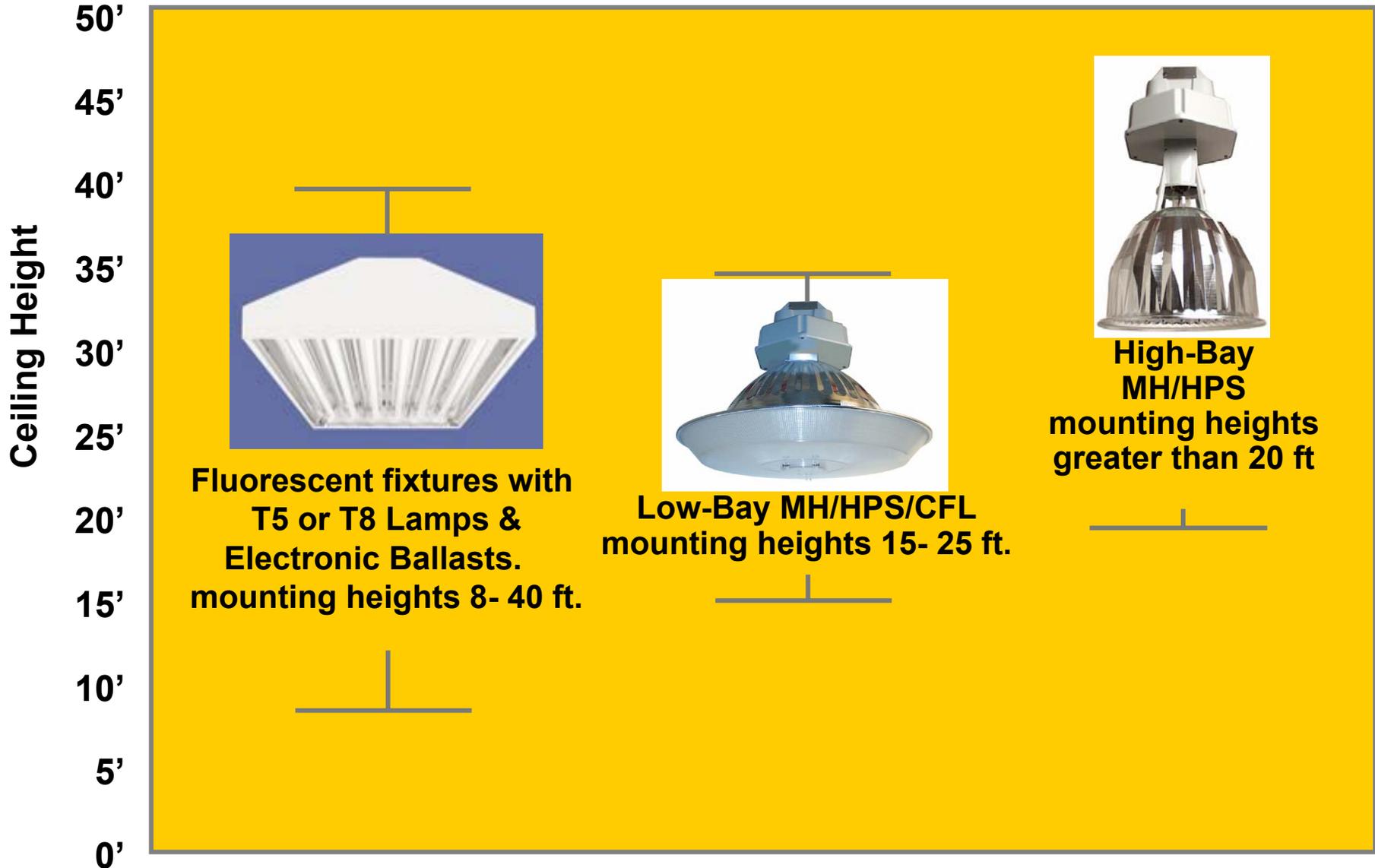


Factors to Consider

- Required Lighting Levels
- **Mounting Heights**
- Distribution Needs
- Mounting Means and Constraints
- Ambient Temperature
- Supplemental Controls – occupancy sensors, photocells, step dimmers, dimmers



Mounting Heights



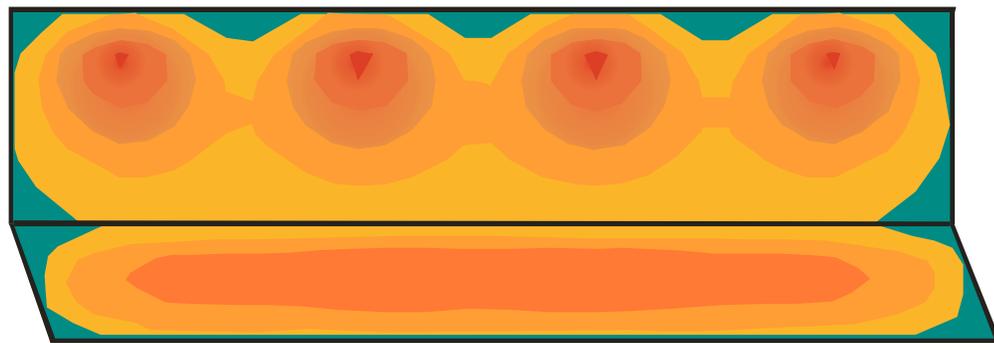
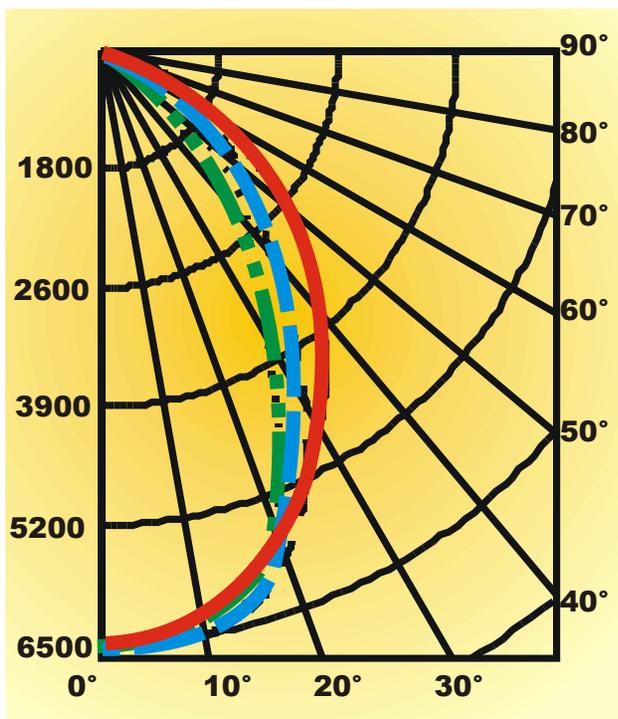


Factors to Consider

- Required Lighting Levels
- Mounting Heights
- **Distribution Needs**
- Mounting Means and Constraints
- Ambient Temperature
- Supplemental Controls – occupancy sensors, photocells, step dimmers, dimmers



Distribution for the Application



Linear Fluorescent



Factors to Consider

- Required Lighting Levels
- Mounting Heights
- Distribution Needs
- **Mounting Means and Constraints**
- Ambient Temperature
- Supplemental Controls – occupancy sensors, photocells, step dimmers, dimmers

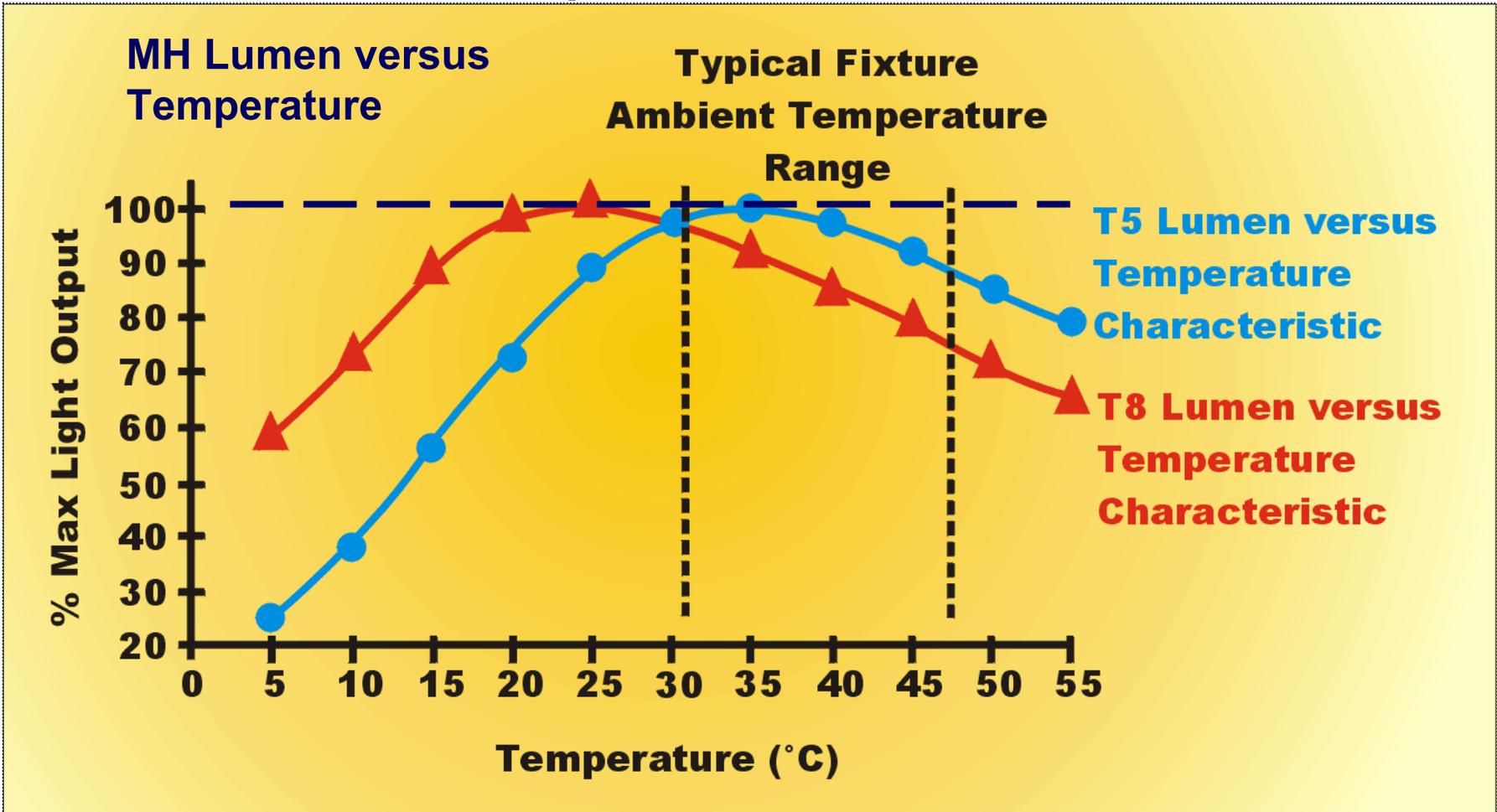


Factors to Consider

- Required Lighting Levels
- Mounting Heights
- Distribution Needs
- Mounting Means and Constraints
- **Ambient Temperature**
- Supplemental Controls – occupancy sensors, photocells, step dimmers, dimmers



Ambient Temperature





Factors to Consider

- Required Lighting Levels
- Mounting Heights
- Distribution Needs
- Mounting Means and Constraints
- Ambient Temperature
- **Supplemental Controls** – occupancy sensors, photocells, step dimmers, dimmers



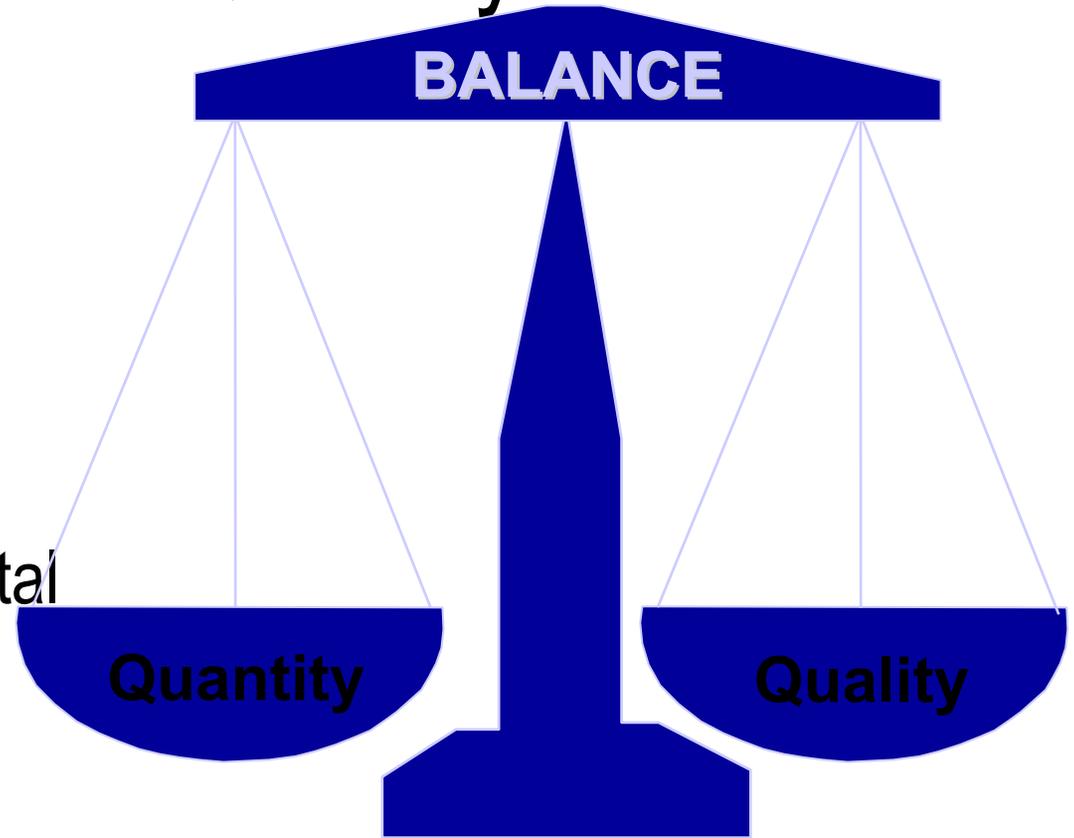
Supplemental Controls

- Occupancy Sensors – Nothing saves energy and improves lamp life like turning them off
- High/Low Dimming (HID)
- Linear Dimming
 - Fluorescent
 - HID
- Ambient Light Monitors / Daylight Harvesting



Balance Quality vs. Quantity

- Glare
- Contrast
- Uniformity
- Shadowing
- Color Quality
- Task & Supplemental





Not Recommended!





T- 8 Electronic Ballast Fixtures

- Lensed and Parabolic T8 troffers offer great opportunity for improved lighting over T-12 fixtures
 - Better performance (efficacy)
 - Compact design
 - Energy Savings
- All three and four-lamp fixtures are short payback opportunities due to the single three and four- lamp electronic ballast.
- Four lamp T-12 fixture conversion to a 3 lamp T-8



T-12 VS T-8 Fixture Comparison

	T12	T8
Light Output		
# of lamps	4	3
Lumens	2650	2850
Total Lumens	10600	8550
BF	0.88	0.9
Lamp Lumen Depreciation	0.87	0.95
Fixture Efficiency	66.6	80.1
Delivered Mean Lumens	5405	5855
% Light		108.3%
Energy		
Input Watts	164	81
hours burned	3800	3800
Cost per kWh	0.06	0.06
Annual Cost per fixture per year	\$ 37.39	\$ 18.47
Savings		\$ (18.92)
based on T12 energy saving lamp and energy saving ballast		
25% reduction of energy		



T-12 to T-8

Application Scenario:

10,000 sq.. Ft Office Space

9 Ft. Mounting Height

50 FC Maintained

4 Lamp T-12:

3 Lamp T-8:



81 Fixtures

81 Fixtures

Annual Operating Savings = \$1532

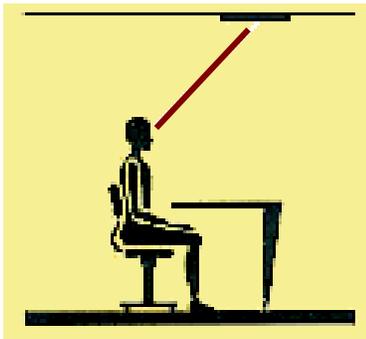


Suspended Direct/Indirect Luminaries

- Performance/Comfort
 - Even, low-glare illumination
 - Shadow-free
- Energy Saving T8 and T5HO Lamps
- Flexibility/Fast Installation
- Value – Low Installed Cost



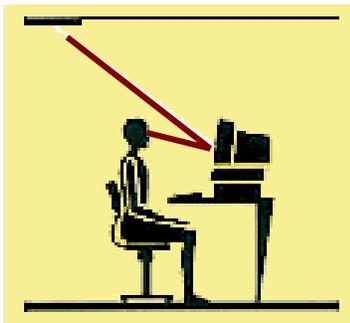
The wrong lighting contributes directly to eyestrain symptoms of headaches and decreased visual efficiency.



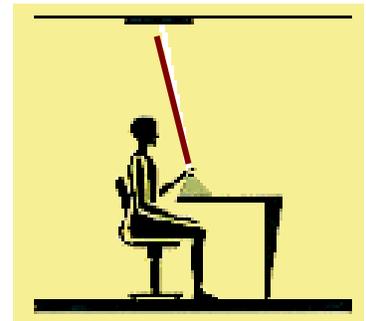
Direct Glare



Veiling Reflections



Reflected Glare



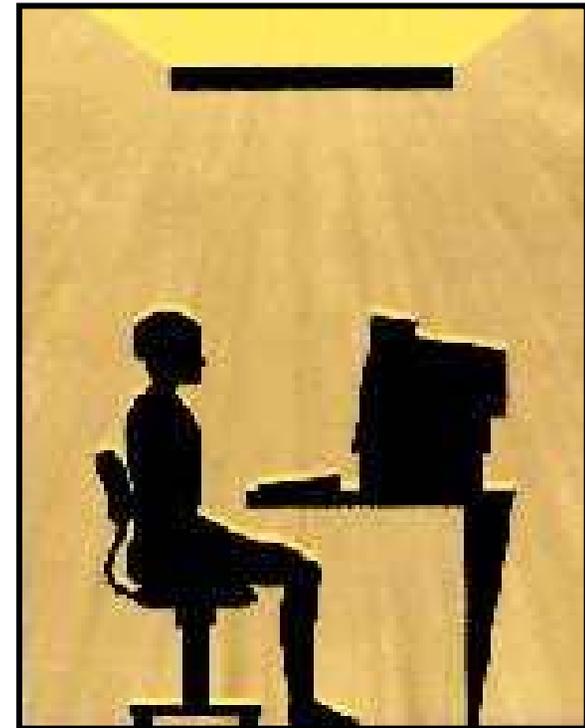
**Harsh
Shadows and
High Contrast**

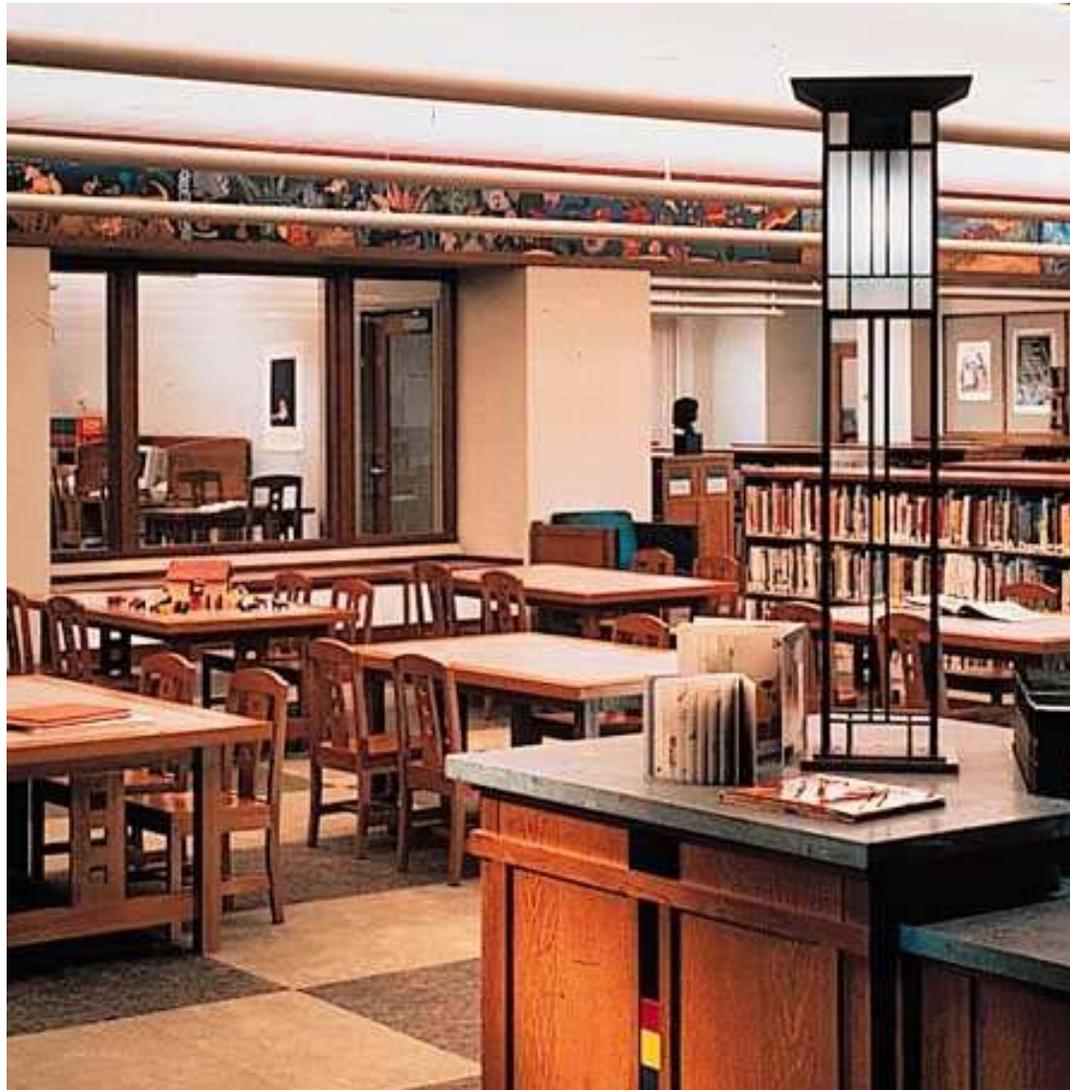
Harsh, directional light can make people feel tense and nervous.



***Indirect Lighting* allows people to see what they are doing without physical strain.**

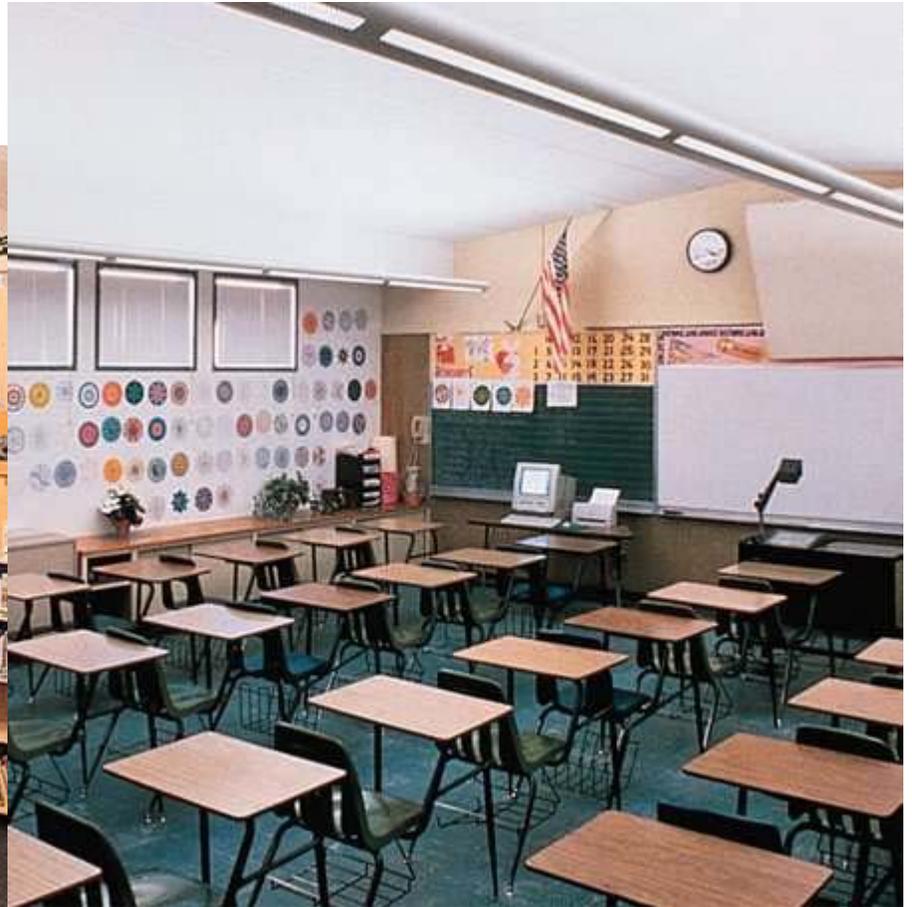
- Reduced glare
- Minimized Shadow & Contrast
- Balanced Lighting Levels





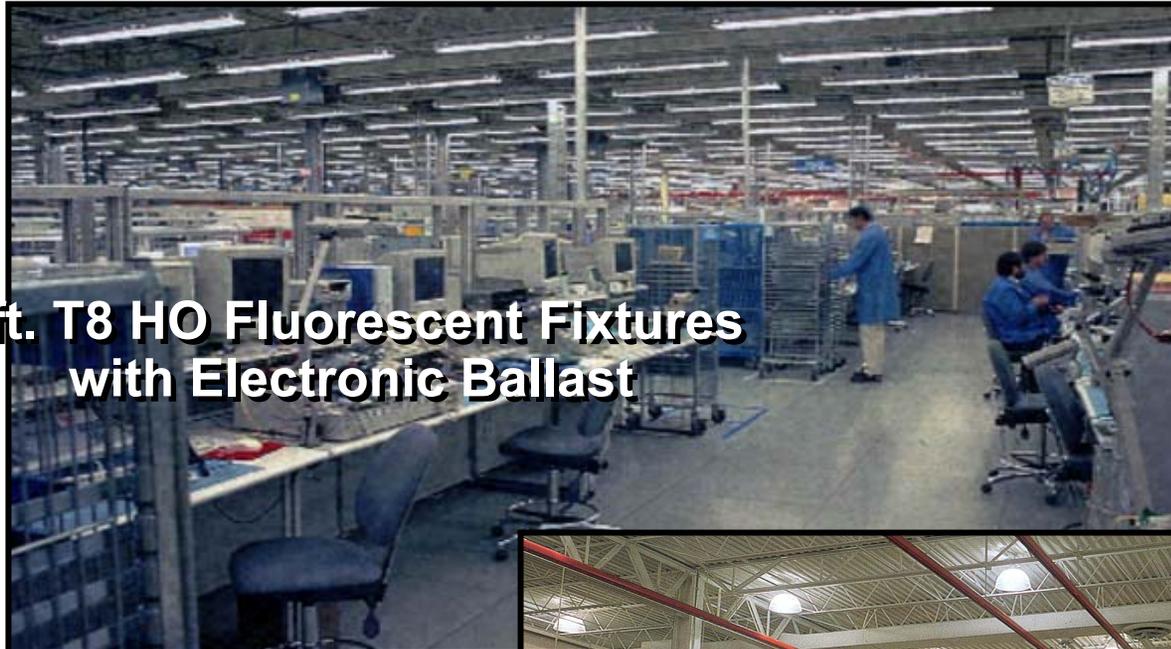


Direct/Indirect Fixtures





Thank You !



**3ft. T8 HO Fluorescent Fixtures
with Electronic Ballast**



High Bay Fluorescent Fixtures



PulseArc Metal Halide Fixtures