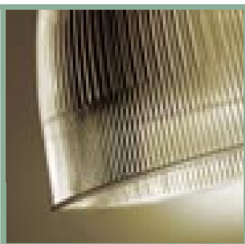
RUUD LIGHTING®

HIGH BAY LIGHTING COMPARISON GUIDE



You Can Count on Ruud

Ruud Lighting is a leading product innovator and manufacturer of both HID and linear fluorescent fixture technologies. We developed this brochure to help shed some needed light on what has grown to become a sometimes confusing decision-making process.

Inside you'll find a comprehensive look at the critical elements at play ranging from fixture, ballast and lamp types, to lumen maintenance and other performance considerations.

To help you put it all into perspective, we've also included examples of both new construction and retrofitting applications, which demonstrate how available options can affect performance and cost considerations.

In the end, we hope you will find the decision-making process a lot clearer, especially as you compare costs and energy usage against space performance needs. Of course, we are always here to personally assist you!
Call us toll free.

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Making the Right Choice for High Bay Lighting Applications

Lamp and fixture technologies have changed considerably over the past decade. Historically, high intensity discharge (HID) light sources, such as metal halide and high pressure sodium lamps, have long dominated larger, high-ceiling commercial/industrial lighting applications. Over that same time period, technological improvements coupled with governmental and industry demands for products delivering greater energy efficiencies and performance characteristics have led to major improvements. The results are impressive. Changes in lighting quality, energy efficiency, fixture performance and lamp life have taken hold for both HID and linear fluorescent lamps. And, whereas in the past, linear fluorescent lamps were typically overlooked for high bay lighting applications, the fact is, they now deliver significant performance and cost improvements that rival their HID counterparts.

There have never before been so many excellent choices in lamp and fixture solutions for large space, high bay applications. The challenge now is to take the information, apply it, and choose the best product for new construction and retrofit applications.

CONTENTS

Fixture Types

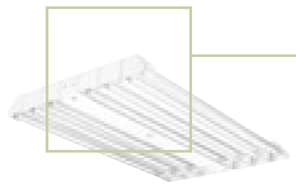
The primary function of a fixture is to efficiently direct light without causing glare or discomfort. Fixture types commonly used in commercial settings include fluorescent strips and troffers, recessed down lights, wall sconces, and many more. Here are four of the most commonly used in our examination of HID and linear fluorescent high bays.

Prismatic High Bay

This fixture produces horizontal, vertical and uplight illumination with a relatively low level of brightness. Its clear, prismatic acrylic reflector provides more than 90% efficiency and approximately 15% uplight. It was selected because of its superior efficiencies in moderate-to-clean environments.

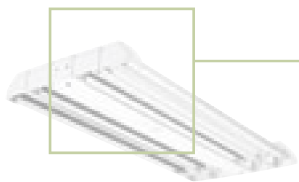
Aisle Light High Bay

The elliptical-shaped aluminum reflector illuminates warehouse aisles by distributing light in an elongated pattern. This pattern covers lower traffic areas while reducing both hot spots and distracting 'scallops of light' from racks located near each fixture. Uniform light grazes vertical surfaces and increases visibility, which promotes safety and productivity.



6-lamp 32W T8

The T8 fixture is available in a choice of high-efficiency, specular-aluminum reflectors, or white painted reflectors. Both can be used in combination with clear acrylic prismatic reflectors. For our application examples on pages 10-17 we used six specular-aluminum reflectors with the 6-lamp, T8 fixtures.



4-lamp 54W T5HO

The T5HO fixture is also available in a choice of high-efficiency, specular-aluminum reflectors or white painted reflectors. Both can be used in combination with clear acrylic prismatic reflectors. For our application examples on pages 10-17 we used four specular-aluminum reflectors with the 4-lamp, T5HO fixtures.

ESTABLISHING A BASELINE FOR LAMP COMPARISON

We begin our examination of lamps and ballasts by establishing an important baseline using a standard 400-watt metal halide lamp with a CWA ballast. While this system is the least energy efficient, historically it has enjoyed a large installed base. We would also like to point out that the combinations of lamps and ballasts listed here are not exhaustive, but represent those most commonly used in our sample applications. In considering ballast types, keep in mind that ballasts do affect the total wattage consumed by the fixture, as well as how the lamp performs over its life.

Lamps and Ballasts

CHART: LAMP - BALLAST COMBINATIONS

Metal Halide Ballasts CWA ballasts are the least efficient types available, but are the standard type for metal halide lamps. The slightly more efficient 277-volt reactor ballast for pulse start metal halide lamps is also available. This ballast improves lumen maintenance while reducing ballast losses in comparison to the standard CWA ballast. Electronic ballasts for pulse start metal halide lamps are microprocessor-based and help to reduce wattage consumption, lumen depreciation and color shift in pulse start metal halide lamps.

Linear Fluorescent Ballasts Instant start ballasts provide an instant voltage spark to start the linear fluorescent lamps immediately. In fact, we use high-output instant start ballasts with a ballast factor of 1.18 as the standard with our 32-watt T8 lamps. Doing so increases lamp lumens by 18%. We also use program start ballasts as standard equipment with our 54-watt T5HO lamps. This ballast preheats the lamp cathodes before applying the starting voltage.

	FIXTURE WATTS	INITIAL LUMENS	MEAN LUMENS	EOL LUMENS	RATED LAMP LIFE
400W Metal Halide w/ CWA (Baseline)	455	35,000	60%	45%	20,000
400W Pulse Start Metal Halide w/ 277V Reactor	435	40,000	75%	60%	20,000
320W Pulse Start Metal Halide w/ 277V Reactor	349	31,000	75%	60%	20,000
250W Pulse Start Metal Halide w/ 277V Reactor	275	22,600	75%	60%	20,000
400W Pulse Start Metal Halide w/ Electronic	430	40,000	86%	75%	20,000
320W Pulse Start Metal Halide w/ Electronic	345	31,000	86%	75%	20,000
320W Pulse Start Metal Halide w/ CWA	368	31,000	75%	60%	20,000
6-lamp 32W T8 Linear Fluorescent w/ Program Start	222	20,178	95%	90%	20,000
4-lamp 54W T5HO Linear Fluorescent w/ Program Start	240	20,000	95%	90%	20,000

Lamp Life and Lumens

CHART: LAMP LUMEN DEPRECIATION IN FIXTURE

The poorest performing lamp in our samples, based on lumen depreciation, is the standard metal halide (MH) lamp with a CWA ballast. At 8,000 hours (mean lumen output) it yields only 60% of its initial light output, and at 20,000 hours (end of rated life) it drops to only 45% of its initial light output.

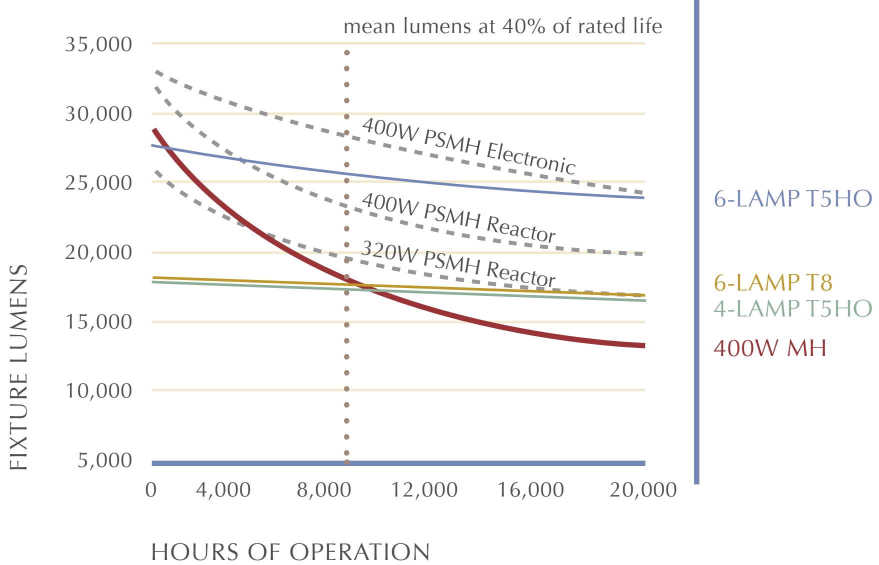
The 320-watt pulse start metal halide (PSMH) lamp with reactor ballast has similar light output at 8,000 hours and provides 25% more light output at rated life than the standard 400-watt metal halide, with approximately 100-watts of energy reduction. A pulse start metal halide with electronic ballast will increase the rated mean lumens to 86%.

The 6-lamp T8 and the 4-lamp T5HO fixture systems have similar light outputs, and each will achieve about 10% more light output at the end of rated life (EOL) versus the standard 400-watt metal halide, with approximately 50% energy reduction. While the larger size of linear fluorescent lamps is not always favored, in the lumen depreciation race, they are the champions. In fact, their mean lumens are 95% and their rated EOL lumens are 90%.

It should also be noted that the efficacy of T8 lamps, T5HO lamps and metal halide lamps is very close. That is, they all produce about the same amount of initial light output for the same energy input.

This information is based upon ambient room temperatures of 20°-25°C (68° - 77°F).

The industry standard for the mean lumen output is determined at 40% of its rated life (8,000 hours for a 20,000 hour rated lamp).



CONCLUSIONS

- Old standard 400W MH system has worst performance
- PSMH represents a great improvement over standard MH
- T8 and T5HO linear fluorescent systems are also excellent

CONCLUSION

- Fluorescent and MH lamp life is negatively affected by cold starts

Startups Shorten Lamp Life

CHART: HOW STARTING AFFECTS LAMP LIFE

Startups from cold, power-off conditions dramatically affect the lamp life of metal halide and linear fluorescent systems.

Rated lamp life is based on the number of starts for each lamp. HID lamps are based on 10-hours per start, and linear fluorescent lamps on 3-hours per start.

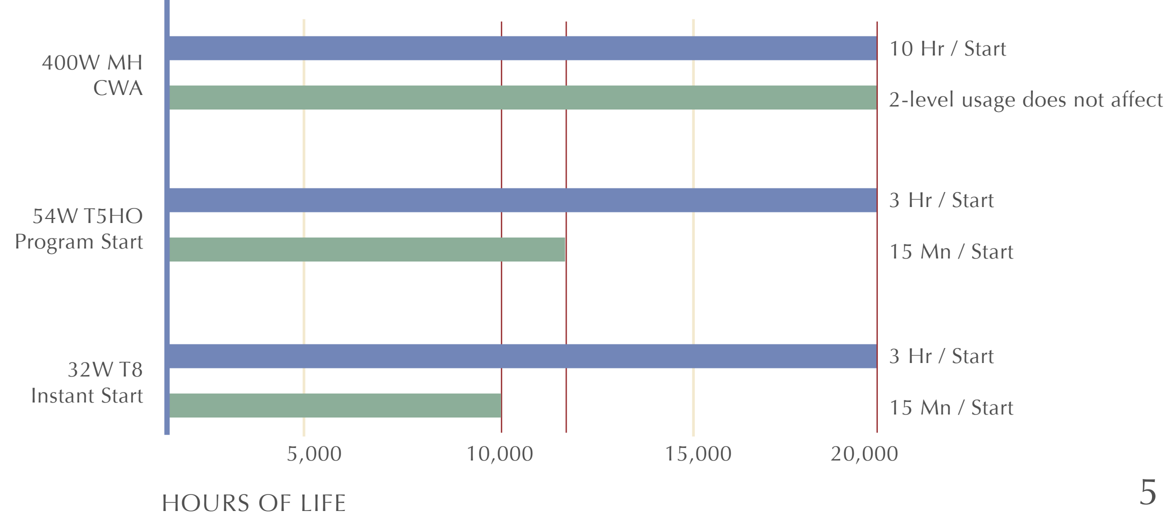
Excessive cold starts will shorten the rated life of all linear fluorescent and HID lamps.

Switching metal halide lamps from high to low output on a 2-level system does not affect rated life.

T5HO lamps are de-rated in life from 20,000-hours to 11,000-hours if the lamps are started every 15-minutes as opposed to the 3-hours per start at which their lives are determined.

T8 lamps are de-rated in life from 20,000-hours to 10,000-hours if the lamps are started every 15-minutes as opposed to the 3-hours per start at which their lives are determined.

All of these systems can be used in 2-level warehousing applications. Most warehouse aisle applications are occupied only 15% of the day. Therefore, the performance relative to lamp life obtained for each system will depend upon the number of starts as described above.



Fluorescent Lamp Characteristics

CHART: TEMPERATURE'S AFFECTS ON LAMP OUTPUT

Ambient temperature does not affect the output of a metal halide lamp or fixture.

Linear-fluorescent light output is very temperature sensitive. For example, a T8's peak output occurs at 25°C (77°F), and the T5HO's occurs at 35°C (95°F). It's important to note that light output on either side of this temperature range would be less than that obtained at the peak.

To achieve optimal light output, select the T5HO lamp for warmer than 25°C (77°F) temperatures, and the T8 lamp for less than or equal to 35°C (77°F) temperatures.

Fluorescent lamp light output data are measured at a 25°C (77°F) lamp ambient temperature, for both T8 and T5HO.

At 25°C (77° F) the T5HO's lamp output is only 4,460 lumens. This is 11% less than its optimum output at 35° C (95°F).

CONCLUSIONS

- MH lamp output is unaffected by ambient temperature
- Fluorescent light output is significantly affected by ambient temperature
- Fixture itself causes ambient temperature around lamps to increase
- T5HO lamps yield better performance in higher ambient temperatures
- T8 lamps yield better performance in cooler ambient temperatures

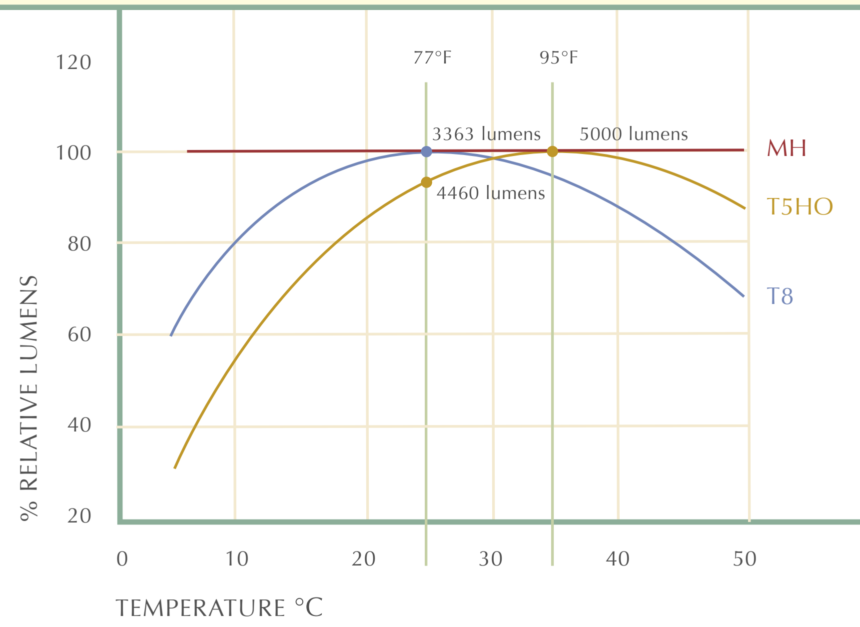


CHART: FIXTURE AFFECTS ON LIGHT OUTPUT

Once the lamp is placed inside the fixture the ambient temperature around the lamp will rise. Here are some things to keep in mind:

The fixture environment increases the ambient temperature of the T8 lamps by 5°C when installed in an open fixture. This results in a light output loss of approximately 4%.

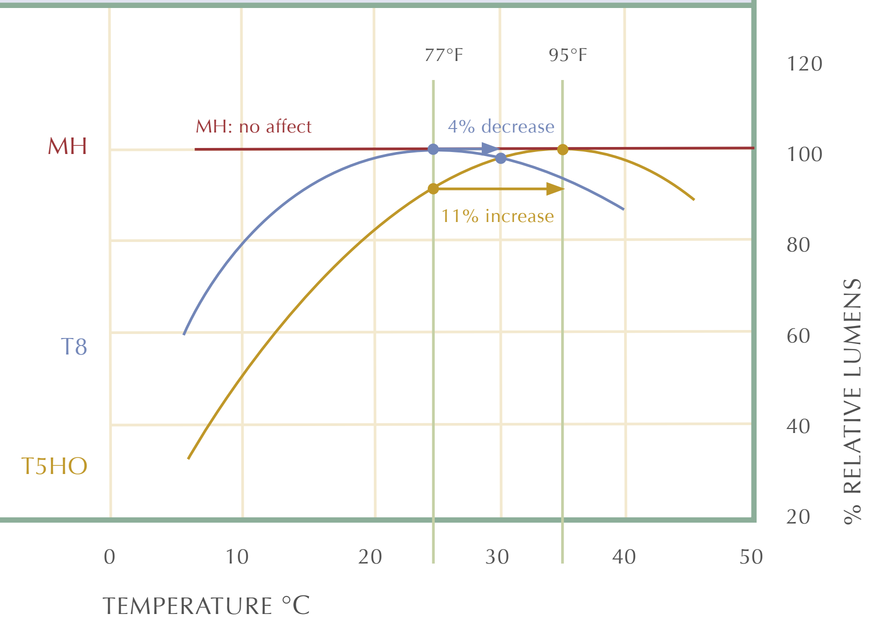
The fixture environment increases the ambient temperature of the T5HO lamps by 10°C when installed in an open fixture. This results in a light output increase of approximately 11%.

The T5HO lamp produces only 4,460 lumens at the calibrated 25°C (77°F) temperature. When installed in a fixture, lumen output increases to 5,000 lumens, and makes possible an overall fixture efficiency of greater than 100% when optical efficiency is 90% or greater. This effect is only possible with T5HO lamps.

When performing lighting calculations, you must use 4,460 lumens for each T5HO lamp and insert the proper fixture efficiency.

The T8 fixture's maximum light output is reached at 20°C (68°F) fixture ambient temperature. Its range for 90% or greater output is reached between approximately 10°C (50°F) and 30°C (86°F).

The T5HO fixture's maximum light output is reached at 25°C (77°F), while its range for 90% or greater output is reached between approximately 15°C (59°F) and 35°C (95°F).



In this section we examine four typical applications involving new construction, and retrofitting. The focus here is on high bay open areas and warehouse aisles. Each application example provides an examination of the working characteristics of metal halide and linear fluorescent, with chart references comparing required number of fixtures, initial lumens, mean lumens, initial cost, lumen maintenance, total costs, and annual energy savings found using the newer technologies. We compare everything against our established baseline lamp: the 400-watt metal halide lamp with CWA ballast.

Case Study Applications

New Installation: Open Area

APPLICATION ASSUMPTIONS

Initial Costs
Prices include fixture, estimated contractor markup and installation costs. Fixture count is determined by units needed to attain a 50 mean footcandle (mfc) average of illumination.

3-Year Differential Energy Cost Comparisons
Operating hours per year assumed to be 4200 and the cost of electricity at $.08/kWh. The numbers shown are the differences between the operating cost for the 400-watt metal halide with CWA ballast and the other systems.

Total 3-Year Differential Cost Comparisons
This combines the initial cost with the 3-year cost savings to derive a total differential cost for each system as compared to the 400-watt metal halide with CWA ballast system.

Other Assumptions
- 100,000 sq ft open area, 25' ceiling height
- Bottom of Fixture at 22'0"
- Reflectances: 50-50-20
- All fixtures assumed to be at 25°C ambient
- Practical fixture spacing dictates the number of fixtures used in each example to attain 50mfc average.

CONCLUSIONS

- 400W MH is most expensive system in spite of lowest individual fixture cost
- All systems, except 400W MH, provide excellent performance

It will take 290 standard, 400-watt metal halide fixtures with CWA ballasts to do the job with the assumptions shown. Even though this is the least expensive fixture, it does not provide the lowest initial cost for installation. In addition, it consumes more energy over the selected 3-year time horizon than any other system. Compared to the other systems, this is the most expensive on a total-cost basis.

The 400-watt and 320-watt pulse-start metal halide system with reactor ballast provides the lowest overall initial cost for the project primarily because of the reduced number of fixtures required. These also provide significant annual operating cost savings due to their lower energy consumption.

Adding an electronic ballast option to the 400-watt pulse start metal halide system increases the initial costs due to the higher cost of the ballast. The resulting improvements, however, in lumen depreciation result in fewer required fixtures, which leads to greater annual energy savings. On a total cost basis, they are still more expensive in the 3-year time period selected, but over a longer period could actually be the most cost-effective system.

Both the 6-lamp T8 fixture with instant start ballast and the 4-lamp T5HO fixture with program start ballast require only slightly more fixtures than the standard 400-watt metal halide system. The result is a very slight increase in initial costs. However, the linear fluorescent fixtures draw approximately one-half the energy while achieving the same designed light level. This result is made possible because of the excellent lumen-maintenance characteristics of the linear fluorescent systems. On a total cost basis, the three fluorescent systems are very cost competitive to the pulse start systems with reactor ballasts.

Different operating assumptions can change the results of these calculations. While this illustration is fundamentally correct, one should always perform an evaluation based upon the characteristics of the actual installation to obtain the most accurate comparisons.

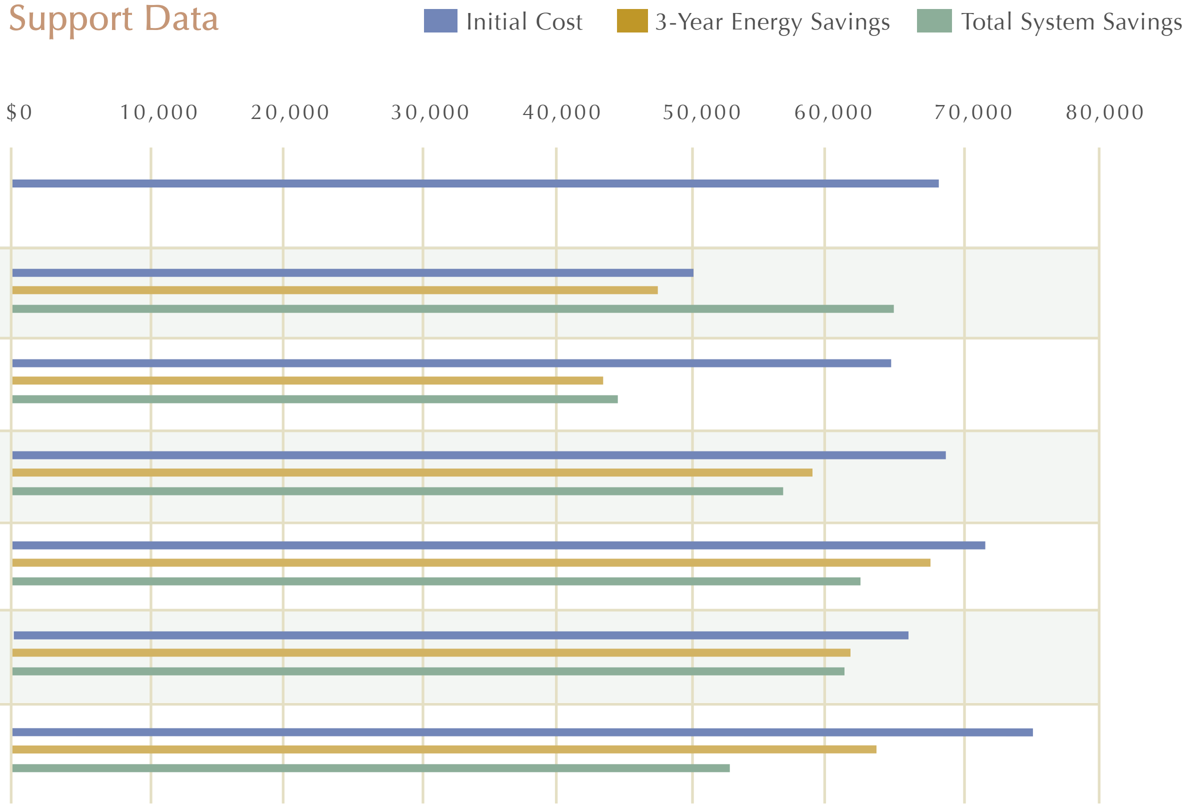
Finally – Any of these systems represent tremendous opportunities for cost savings over the standard 400-watt metal halide with CWA system. If this older system is installed, it could be replaced with any of the improved performance systems resulting in a substantial benefit to the user.

Fixtures Used for Comparison

* Lumens listed are system lumens which indicate the percent of lamp lumens exiting the fixture

LIGHTING SYSTEM	WATTS	% EFFICIENCY	* INITIAL LUMENS	* MEAN LUMENS	FIXTURES REQUIRED	TOTAL WATTS
Prismatic 400MH w/CWA	455	92.3	26,670	16,002	289	131,495
Prismatic 400PSMH w/Reactor	435	92.3	30,480	22,860	196	85,260
Prismatic 320PSMH w/Reactor	349	92.3	23,622	17,717	256	89,344
Prismatic 400PSMH w/Electronic	430	92.3	30,480	22,860	169	72,670
32W T8-6 Lamp w/Instant Start	222	88	17,757	16,869	289	64,158
54W T5HO-6 Lamp w/Program Start	360	105	27,000	26,760	196	70,560
54W T5HO-4 Lamp w/Program Start	240	105	18,000	17,840	289	69,360

Support Data



New Installation: Warehouse Area

CONCLUSIONS

- 400W MH is the worst system choice
- Aisle light optic with PSMH provides excellent performance and uses significantly fewer fixtures to achieve the specified light level
- T8 and T5HO fluorescent systems provide excellent performance
- 2-level option *always* saves incremental energy

APPLICATION ASSUMPTIONS

Initial Costs
Prices include fixture, estimated contractor markup and installation costs. Fixture count is determined by units needed to attain a 25 mean footcandle (mfc) average of illumination.

3-Year Differential Energy Cost Comparisons
Operating hours per year assumed to be 4200 and the cost of electricity at $.08/kWh. We also assume that all fixtures operate on high-level mode 15% of the time, and on low-level mode 85% with occupancy sensors. Linear fluorescent lamps, low-level mode consists of 50% of the fixtures switched off and the other 50% with half of the lamps switched off. The metal halide fixtures all run at 50% power in the low mode using occupancy sensors. The numbers shown are the differences between the operating cost for the 400-watt metal halide with CWA ballast and the other systems.

Total 3-Year Differential Cost Comparisons
This combines the initial cost with the 3-year cost savings to derive a total differential cost for each system as compared to the 400-watt metal halide system with CWA ballast system.

Other Assumptions
- 10′ by 500′ aisle, 30′ ceiling height
- 28′ racking above finished floor
- Bottom of Fixture at 28′0″
- Reflectances: 50-30-20
- All fixtures are assumed to be at 25°C ambient
- Practical fixture spacing dictates the number of fixtures used to attain 25 mfc average.

It will take 30 standard 400-watt metal halide fixtures with CWA ballasts to do the job given the assumptions shown. Again, even though this is the least expensive fixture, it is not the lowest initial cost for installation. Also, it consumes more energy over the 3-year time horizon selected than any other system. The end result is that this system is the most expensive system on a total cost basis compared to the others.

The 320-watt pulse start metal halide system with reactor ballast utilizes the same number of fixtures as the 400-watt metal halide with CWA system, but provides some energy savings over 3 years.

The warehouse example introduces the aisle light optic that was created just for this type of application. Aisle light fixtures will spread the light distribution in an elongated pattern, thereby reducing the quantity of fixtures needed. This also maintains excellent uniformity along the entire vertical surface of aisle racks. The 320-watt pulse start metal halide aisle light has the lowest initial cost. Also, its 3-year energy savings are among the best of the fixtures selected. The end result is that this is the most cost effective system over three years on a total-cost basis.

The addition of the electronic ballast to the 320-watt pulse start aisle light system does not reduce fixture count and does add appreciable cost. While not the lowest total cost over three years, it is still a very competitive system for this application.

Both the 6-lamp T8 fixture with instant start ballast and the 4-lamp T5HO fixture with program start ballast require approximately the same number of fixtures as the standard 400-watt metal halide system, resulting in a slight increase in initial cost. However, the linear fluorescent fixtures draw approximately one-half the energy. On a total-cost basis, the fluorescent systems do not provide as large of a savings as do the aisle light 320-watt pulse start system.

Both the T8 and the T5HO linear fluorescent lamps can be used with occupancy sensors, but will result in a reduction in rated lamp life. Due to the relatively short actual operating time in a given year (aisles occupied only 15% of the time), the actual useful life of the lamp in years of operation is still considerably long. The real advantage for linear fluorescent systems in occupancy sensor applications is the lower power consumption in the low mode.

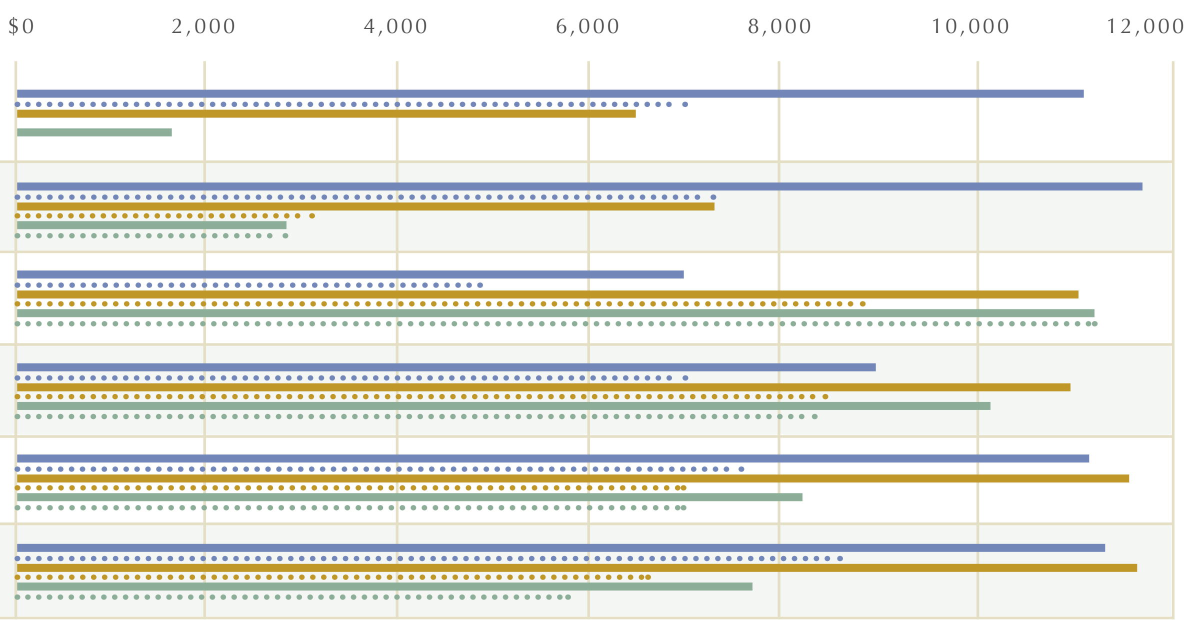
Occupancy sensors always add cost to the installation but will always result in increased energy savings – whether metal halide or linear fluorescent systems are used.

Fixtures Used for Comparison

* Lumens listed are system lumens which indicate the percent of lamp lumens exiting the fixture

LIGHTING SYSTEM	WATTS	% EFFICIENCY	* INITIAL LUMENS	* MEAN LUMENS	FIXTURES REQUIRED	TOTAL WATTS
Prismatic 400MH w/CWA	455	92.3	26,670	16,002	31	14,105
Prismatic 320PSMH w/CWA	368	92.3	23,622	17,717	31	11,408
Aisle Lt 320PSMH w/CWA	368	85.3	26,443	19,832	16	5,888
Aisle Lt 320PSMH w/Electronic	345	85.3	26,443	22,741	16	5,520
32W T8-6 Lamp w/Instant Start	222	88	17,757	16,869	31	6,882
54W T5HO-4 Lamp w/ Program Start	240	105	18,000	17,840	31	7,440

Support Data



APPLICATION ASSUMPTIONS

Initial Costs
Prices include fixture, estimated contractor markup and installation costs. Fixture count is determined by the number of units currently installed, (ex.30) All choices below maintain similar mean footcandle averages to the 400-watt metal halide with CWA ballast system.

1-Year Differential Energy Cost Comparisons
Operating hours per year assumed to be 4200 and the cost of electricity at $.08/kWh. The numbers shown are the differences between the operating cost for the 400-watt metal halide with CWA ballast and the other systems.

Other Assumptions
- 100,000 sq. ft. open area, 25’ ceiling height
- Bottom of Fixture at 22’0”
- Reflectances: 50-50-20
- All fixtures assumed to be at 25°C ambient
- Only lower wattage fixtures have been selected for the retrofit examples, as a primary objective in most retrofits is to lower operating costs. One-to-one fixture replacement of the 400-watt metal halide with CWA ballast system is also assumed.

Retrofit: Open Area

CONCLUSIONS

- PSMH systems provide excellent performance as a replacement for 400W MH
- T5HO or T8 fluorescent high bays will replace one-for-one the 400W MH fixtures, provide the same level of illumination, saving about one-half the energy cost

Given that retrofit jobs replace fixtures one-for-one, the resulting light levels generated must be evaluated as part of the decision making process.

Only lower wattage fixtures have been selected for this retrofit example, which will instantly result in lowered operating costs.

T8 and T5HO linear fluorescent systems can very effectively be used to replace the older standard metal halide in many retrofit applications since they provide similar mean light levels at about one-half the energy consumption.

The 6-lamp T8 and 4-lamp T5HO linear fluorescent systems are very effective when retrofitting older standard metal halide systems since both provide similar mean-light levels at about one-half the energy consumption. These two systems would clearly be the best choice for retrofitting a standard 400-watt metal halide with CWA ballast system.

While the 250-watt pulse start metal halide system would save more energy than the 320-watt system, it is important to note that its relative light levels would only be about 79% of those of the system being replaced. This would be an acceptable solution for applications where a reduction in light output was not a concern.

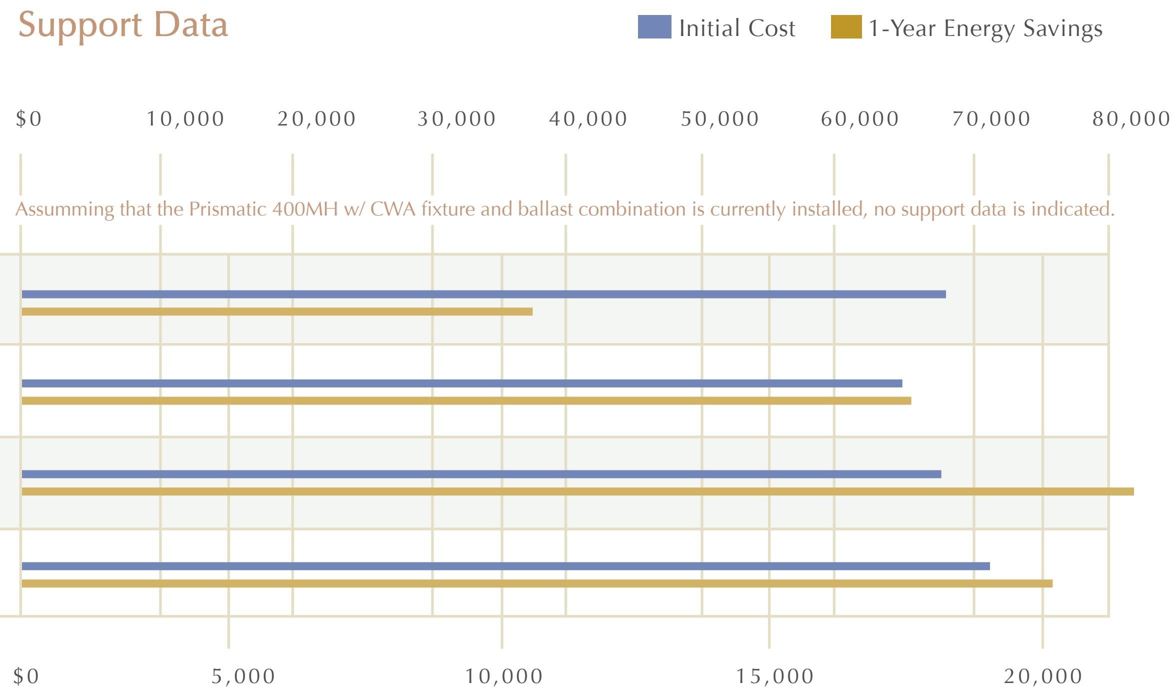
The 320-watt pulse start system provides improved light levels relative to the standard 400-watt metal halide with CWA ballast system, however, it does not provide as large an energy savings as the linear fluorescent systems.

Fixtures Used for Comparison

* Lumens listed are system lumens which indicate the percent of lamp lumens exiting the fixture

LIGHTING SYSTEM	WATTS	% EFFICIENCY	* INITIAL LUMENS	* MEAN LUMENS	FIXTURES REQUIRED	TOTAL WATTS
Prismatic 400MH w/CWA	455	92.3	26,670	16,002	289	131,495
Prismatic 320PSMH w/Reactor	349	92.3	23,622	17,717	289	100,861
Prismatic 250PSMH w/Reactor	275	92.3	17,221	12,916	289	79,475
32W T8-6 Lamp w/Instant Start	222	88	17,757	16,869	289	64,158
54W T5HO-4 Lamp w/ Program Start	240	105	18,000	17,840	289	69,360

Support Data



Retrofit: Warehouse Aisle

CONCLUSIONS

- Aisle light optic with PSMH offers best savings and performance
- T8 and T5HO fluorescent systems provide excellent performance
- 2-level option always saves incremental energy

APPLICATION ASSUMPTIONS

Initial Costs

Prices include fixture, estimated contractor markup and installation costs. Fixture count is determined by the number of units currently installed, (ex.30) All choices below maintain similar mean footcandle averages to the 400-watt metal halide with CWA ballast system.

1-Year Differential Energy Cost Comparisons

Operating hours per year assumed to be 4200 and the cost of electricity at $.08/kWh. We also assume that all fixtures operate on high-level mode 15% of the time, and on low-level mode 85% with occupancy sensors. Linear fluorescent lamps, low-level mode consists of 50% of the fixtures switched off and the other 50% with half of the lamps switched off. The metal halide fixtures all run at 50% power in the low mode using occupancy sensors. The numbers shown are the differences between the operating cost for the 400-watt metal halide with CWA ballast system and the other systems.

Other Assumptions

- 10′ by 500′ aisle, 30′ ceiling height
- 28′ racking above finished floor
- Bottom of Fixture at 28′0″
- Reflectances: 50-30-20
- All fixtures are assumed to be at 25°C ambient
- One-to-one fixture replacement of the 400-watt metal halide with CWA ballast system is assumed. Using the aisle light optic allows every other fixture to be replaced.

All of the choices, except the aisle light with the 250-watt pulse start metal halide lamp, provide improved mean lighting levels in the aisle.

Since the same number of fixtures is assumed, the initial cost difference is determined by the cost difference in the individual fixtures.

While a 2-level option always adds to initial cost, it will always save incremental energy.

All of the choices save at least 100 watts per fixture over the standard 400-watt metal halide system without the 2-level option.

Both the linear fluorescent lamp systems provide the best energy savings, especially using a 2-level system.

The aisle light fixture with 320-watt pulse start metal halide with CWA system allows every other fixture to be replaced reducing energy consumption by over half of the original.

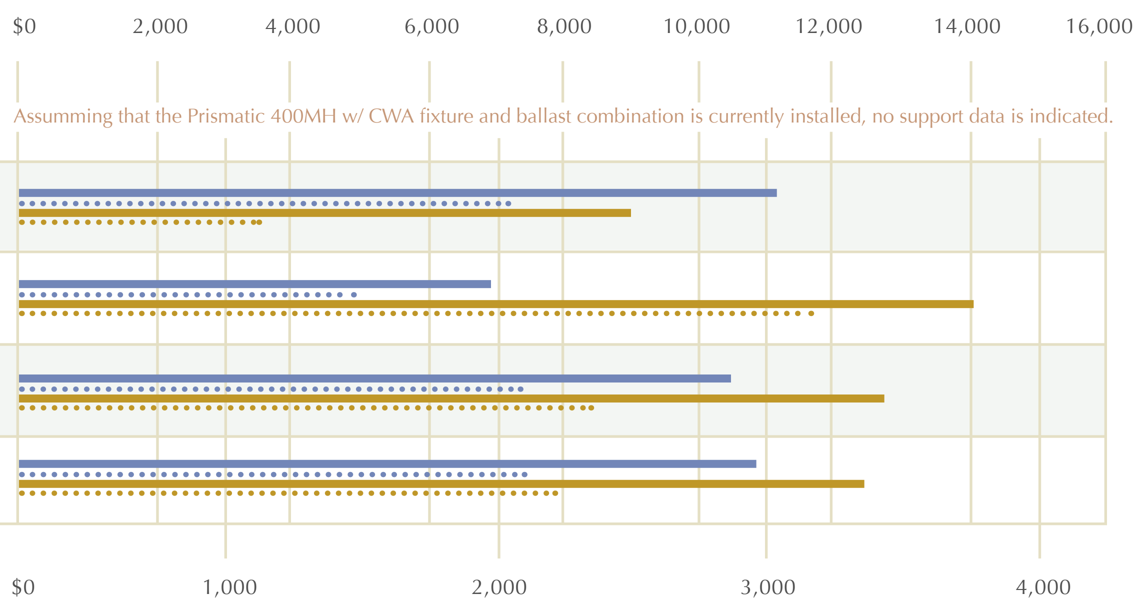
Fixtures Used for Comparison

* Lumens listed are system lumens which indicate the percent of lamp lumens exiting the fixture

LIGHTING SYSTEM	WATTS	% EFFICIENCY	* INITIAL LUMENS	* MEAN LUMENS	FIXTURES REQUIRED	TOTAL WATTS
Prismatic 400MH w/CWA	455	92.3	26,670	16,002	31	14,105
Prismatic 320PSMH w/CWA	368	92.3	23,622	17,717	31	11,408
Aisle Lt 320PSMH w/CWA	368	85.3	26,443	19,832	16	5,888
32W T8-6 Lamp w/Instant Start	222	88	17,757	16,869	31	6,882
54W T5HO-4 Lamp w/ Program Start	240	100	18,000	17,840	31	7,440

Support Data

Initial Cost   1-Year Energy Savings



PSMH with CWA ballast used in all 2-level applications. With 2 Level W/out 2 Level

Lighting for Larger Spaces

PHYSICAL APPLICATION CONSIDERATIONS

Clearly, the area and attributes of the physical space in which a lighting fixture will be used can exert a strong influence over ultimate system selection. This is especially true of retrofitting applications where an existing infrastructure may limit cost-effective options due to physical obstructions and other considerations. Here are some factors to consider to ensure the appropriate fixture and lamp selection for your project.

Ceiling Obstructions & Fixture Selection - Ceiling obstructions such as air ducts and sprinkler heads are important to consider when looking at fluorescent light fixtures, which are larger than their HID counterparts and therefore may represent an installation challenge. Cost considerations, especially the long-term avoided operation costs desired in retrofit applications, should take into account physical obstructions and the costs associated with existing infrastructure modifications.

Environmental Cleanliness - An environment high in airborne dust and dirt will cause any lighting fixture to lose its efficiency due to accumulation. In this regard, fixtures with up-light components, such as a prismatic high bay, will be more affected by dirt accumulation than one with only down light, such as an aluminum high bay. This is especially a concern with linear fluorescents, in which the entire length of the lamp can become coated, thus reducing light output. Regardless of luminaire type, all fixtures (HID and fluorescent) should be cleaned each time relamping is performed.

Ambient Temperature Affects - Ambient room temperatures can have a significant impact on the light output of fluorescent lamps, unlike HID sources, which are not affected by temperature variances. With this in mind, metal halide lighting provides a good fit in commercial freezer environments or non air-conditioned spaces, especially those found in very hot climates.

Color Temperature, Color Rendering (CRI) - Better visual acuity, perceived brightness, and lower energy costs continue to be critical factors in effective lighting environments. Research also has shown that substantial increases in worker productivity occur in well-lit, color-corrected environments. These characteristics are primarily resident in the light source. Fluorescent lamps, for example, offer a more diverse choice of color temperatures and color rendering than those found in metal halide.

End-of-Life Light Levels - Unfortunately, in most applications, end users do not perform planned lighting maintenance. As a result, light levels in these environments typically depreciate to well below the intended design levels over the life of the lamps. This is another area in which fluorescent lamps perform exceptionally well by offering greatly reduced lumen depreciation. This also results in improved (more consistent) light levels over the life of the job.

Planned Lighting Maintenance - HID fixtures typically have one lamp per fixture, while T8 and T5HO (fluorescent) fixtures are more often used in four or six-lamp configurations. The number of lamps used per linear fixture can affect the time required for cleaning and lamp changing during planned lighting maintenance events.

Power Interruptions - Metal halide lamps require between two to 15 minutes to startup and return to full output in the event of a power interruption, or if they are completely shut off. By comparison, fluorescent systems startup and return to full output nearly instantaneously.

Occupancy Control - If your space provides opportunities for occupancy sensor control of your lighting, you may want to consider a linear-fluorescent system. Their nearly instantaneous ability to attain full-light output when powered on makes them superior to metal halide lamps. As a result, they are especially useful in warehouses and distribution centers. With regards to metal halide systems, please note that in order to be of practical use, they must operate at 50% power in the 'low-mode' of a 2-level system. By contrast, linear fluorescent lamps can actually be at zero power in the low-mode, which results in greater opportunities for energy savings.

COST CONSIDERATIONS

Costs can be greatly affected by using a newer technology lighting system rather than relying solely on a least-cost fixture (in the case of a new installation), or the currently installed system (in the case of a retrofit). A more complete cost consideration requires examining the differential of total initial cost as well as projected three-year savings and lumen maintenance.

While first costs are important to every job, we recommend that they not be the only criteria for lamp and fixture selection. In fact, long-term avoided costs, especially those gained through energy efficiency, can play a significant role.

To that end, it is important to keep in mind that today's linear fluorescent systems have about the same efficacy as metal halide systems, yet provide superior lumen maintenance. And, since all lighting jobs are designed for mean lumen values (40% of rated life for fluorescent and HID), one has the opportunity to use less energy with fluorescent lighting while still providing the light levels of a standard metal halide layout.

The application examples in this brochure consider all of these costs and factors using three methods of analysis: initial cost comparison, annual energy savings, and total system savings.

UTILITY REBATES

The trend towards increasing the energy efficiency of lighting is here to stay. Faced with continual increases in electrical demand, utility companies are looking for ways to control their operations and infrastructure-growth costs. State public service organizations, which regulate their activities, also mandate that utilities actively promote energy conservation. As a result, utility rebates on qualifying energy-saving equipment can cut upwards of 50% or more off the first cost of lamp and fixture purchases. We highly recommend that you contact your local electric utility for more details.

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Glossary of Industry Terms

Ballast – Limits the current to a correct level for proper lamp operation.

Ballast Factor (BF) – The ratio of light output produced by a lamp operating on a ballast, versus the lamp's rated light output.

Color Rendering (CRI) – An international system used to rate a lamp's ability to render the color of an object. The higher the CRI (based upon a 1-100 scale), the richer the color appears.

Color Temperature – A number indicating the degree of warmness or coolness of a white light source. Measured in Kelvins (K). The higher the rating the cooler, or bluer, the color temperature. The lower the rating the warmer, or more yellow, the color temperature.

Electronic Ballast – A "smart" HID ballast with microprocessor-based technology designed to reduce both lumen depreciation and color shift of pulse start metal halide lamps.

End-of-Life (EOL) Lumens are calculated by lamp manufacturers for the estimated lumen output at end of rated life.

Fixture Efficacy – Lumens per watt, including lamp wattage, ballast losses and fixture efficiency.

Fixture Efficiency – The percentage of lamp lumens that exit out of a luminaire.

Foot Candle (fc) – A unit of light falling onto a surface. One foot candle is equal to one lumen per square foot.

Group re-lamping – Group re-lamping for metal halide lamps is recommended at 40% of rated life. Pulse start metal halide and linear fluorescent group relamping should occur at 60% of rated life.

High Intensity Discharge (HID) Lamp – A general term to refer to mercury, metal halide, pulse start metal halide and high pressure sodium lamps. HID lamps contain arc tubes that hold gases and metal salts, which operate at high pressures and temperatures. HID lamps require a ballast to regulate the current to the lamp. These lamps also take several minutes to warm-up in order to attain full-light output.

Initial Lumens refer to the amount of light output from a lamp when it is new. For a metal halide or pulse start metal halide lamp, these ratings are averages based on photometry at rated lamp watts after 100 hours of operation. Lumen depreciation refers to declining light output over time.

Instant Start Ballast – A type of ballast designed to start a fluorescent lamp as soon as the power is applied. These ballasts provide maximum energy savings for fluorescent lamps. Using high-output instant start ballasts with a ballast factor of 1.18 will increase the lamp manufacturer's lumen data by 18%.

Kilowatt (kW) – A measure of electrical power equal to 1000-watts.

Kilowatt Hour (kWh) – The measurement of electrical energy billed by electrical utilities for electricity use.

Lumen – Measurement of raw lamp light output.

Lumen Maintenance – A measurement of how well a lamp maintains its light output over time.

Mean Lumens refer to a calculated average lumen output over the lamp's life. These ratings are averages based on photometry at 40% of lamp life. For HID light sources, this is based on 10-hours per start. For linear fluorescent, this is based on 3-hours per start.

Program Start Ballast – A type of ballast designed to start a fluorescent lamp by heating the lamp cathodes before applying the starting voltage. Provides maximum lamp life regardless of the number starts.

Pulse Start Metal Halide Lamp – An HID metal halide lamp with good color rendering and less color shift over its life than a standard metal halide lamp.

Rated Lamp Life – The point in hours where 50% of lamps initially started will still operate. HID rated lamp life is based on 10-hours per start, and a linear fluorescent rated lamp life is based on 3-hours per start.

Reactor Ballast – A 277-volt HID ballast that produces a smooth waveform that reduces evaporation of tungsten from the lamp's electrodes thus improving lumen maintenance.

Questions? We're Here to Help.

We hope this brochure helped clarify the differences between two very popular lighting choices. As you can see, there's a lot more to consider than just first costs. Lumen maintenance, energy savings, total costs and more also come into play. And don't forget the purchasing advantages that can be gained through local utility rebates.

Our technical services department is available to provide you with free assistance Monday through Friday between the hours of 7:00 a.m. and 6:00 p.m., central time. We'll be happy to answer your questions, provide layout assistance and help you make the best choices for your application needs.

Also, ask about our available high bay lighting presentation: You Decide–We Provide. Available in Adobe pdf format, this is a helpful training tool on how to make better lighting choices. It also includes helpful speaker notes for use when making a sales or information presentation.

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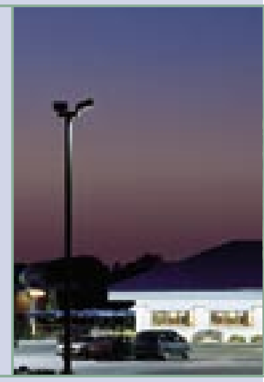
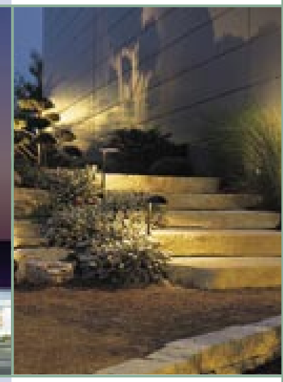

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