

DayLite Worldwide
Global Market Place
Government/Military
Commercial/Retail
Commercial/Industrial
Education
Residential

- vacuum deposition, also known as a "first surfaced" reflector.
- The external surface of the tube is coated with a corrosive resistance film, that will not peel or flake over time.
- Standard, proven, galvanized flashings ensure leak proof installation on your roof.
- The interior prismatic diffuser lens lights up to 150 sq. feet. And, is simple to remove for quick cleaning.
- Easy to install, simple to maintain and it carries a "life time" warranty.

Specifications

Measurements based on typical installation, that being 2 x 2' lengths (per kit) or 4' length of tube:

Designed to light up to 150 sq. ft area

Mid day, clear conditions, approx. 90,000 lux delivers 4320 luminous flux. Equivalent to five 100W light bulbs

Dome is classified CC2. Material - high impact, pure acrylic: ASTM D 1547 Type II, Federal spec. L-P507, Type II

Dome Gasket/Seal uses a Poron gasket with silicon seal - ASTM C794-92, ASTM B 1929-B 350°C[660°F]

Flashing and Storm Collar - standard 26g galvanized steel per American Metals Company

Daylite Tube - 0.020 PVD coated aluminum 99.9% specular reflectivity at 60° angle (emmissivity = 0.03) - ASTM E 1651-94, 179-81 & 430-78

Trim Ring - ABS plastic thermal fit

Lower Gasket -1/16th" CS Foam

Upper and lower prismatic Lens - 0.125" pure acrylic, with octagonal, multi-facet finish. Captures light through a full 170° angle ["fly-eye"]

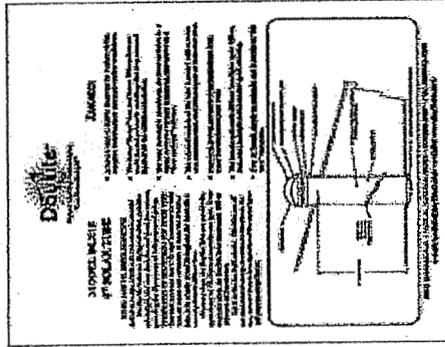
Parts List



Standard 8" Daylite Kit - Model DLX15
Consisting of:

- 2 ft. Tube w/dual lens & dome
- 2 ft. Tube extension (std.)
- Storm collar
- Roof flashing (std. 0 to 6/12 pitch)
- Sheet metal screws - for roof
- Metal tape
- Sealant (1 tube)
- Ceiling mounting ring w/screws & tabs
- Foam gasket
- Lower Lens - 8" bowl type (1.75" deep)
- Lower trim piece - std. color "white"

[Download 8" Specification Sheet](#)



Shipping box weight = Kg (11lbs)
 Dimensions = (22"x 11"x 29")

Accessories and options

- 4 ft. Tube extension
- Light Kit - 120VAC/75W
- Adjustable Elbow Joint (0° to 45°)
- S-Tile aluminum flashing
- SteepPitch flashing (7/12 to

- 12/12 pitch)
- Lower Lens - 8" flush type

Standard 12" Daylite Kit - Model DLX30

Consisting of:

- 2 ft. Tube w/dual lens & dome
- 2 ft. Tube extension (std.)
- Storm collar
- Roof flashing (std. 0 to 6/12 pitch)
- Sheet metal screws - for roof
- Metal tape
- Sealant (1 tube)
- Ceiling mounting ring w/screws & tabs
- Foam gasket
- Lower Lens - 12" bowl type (1.75" deep)
- Lower trim piece - std. color "white"

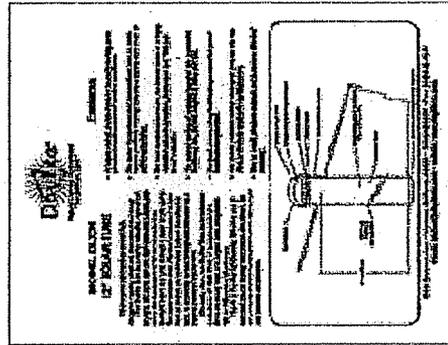
Shipping box weight = Kg (17lbs)
Dimensions = (26" x 14" x 29")

Accessories and options

- 4 ft. Tube extension
- Light Kit - 120VAC/75W
- Adjustable Elbow Joint (0° to 45°)
- S-Tile aluminum flashing
- Steep Pitch flashing (7/12 to 12/12 pitch)
- Lower Lens - 12" flush type

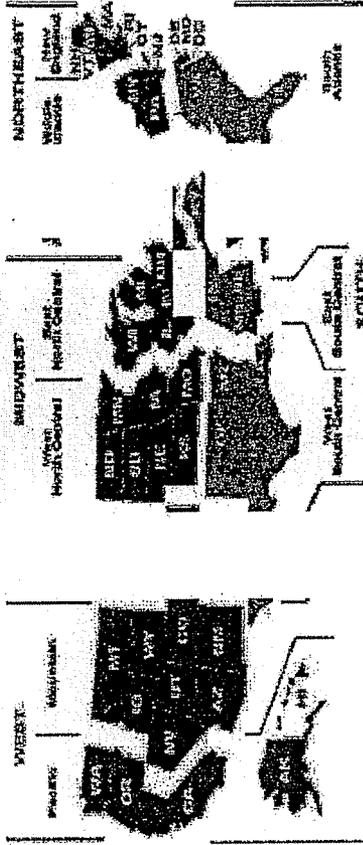


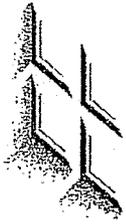
Download 12" Specification Sheet



Solar Breeze Brochure

Call us today at 888.DAYLITE or contact us via e-mail ...
On the map below click the area closest to you and you'll be linked to your
Daylite Team Member!





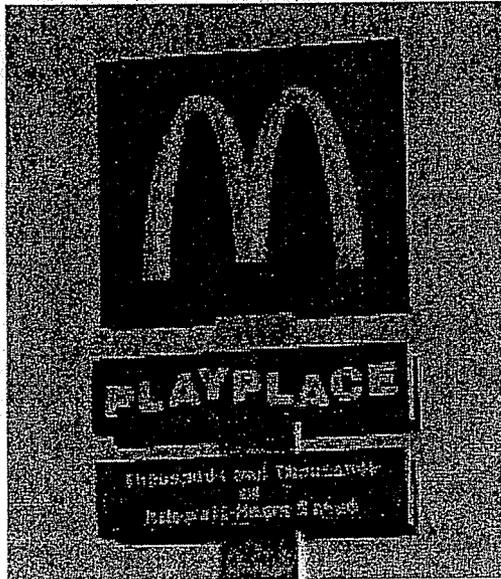
DAYLIGHTING *initiative*

Design tools and information from PG&E

Industrial Application

Retail Application

Restaurant Application



School Application

Museum Application

Office Application



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Electric Company.

WE DELIVER ENERGY.

PG&E'S DAYLIGHTING INITIATIVE

PG&E's daylighting initiative has two goals: to raise awareness of good daylighting practice within the design community and to improve the practice of daylighting design. This case study is one of a dozen case studies undertaken within the initiative. Together, they document a wide range of successful technical solutions demonstrated across a number of different commercial applications.

The Daylighting Initiative includes projects that will make better design tools available to the daylighting design community. The Desktop Radiance project, a collaborative effort of Lawrence Berkeley National Laboratory and PG&E, is bringing the powerful Radiance lighting simulation capabilities into the practical world of architectural CAD software. The Daylighting Initiative also includes a series of workshops and seminars at the Pacific Century Center in San Francisco. For more information visit the project's web site at www.pge.com/peg/daylight.

DAYLIGHTING AT McDONALD'S BAY POINT, CALIFORNIA

At its Bay Point restaurant just east of San Francisco, McDonald's incorporated simple, off-the-shelf daylighting technologies into the building's design. The technologies selected—tubular skylights, advanced glazing, daylighting sensors, and dimmable fluorescent ballasts—produced excellent results as well as some unexpected surprises.

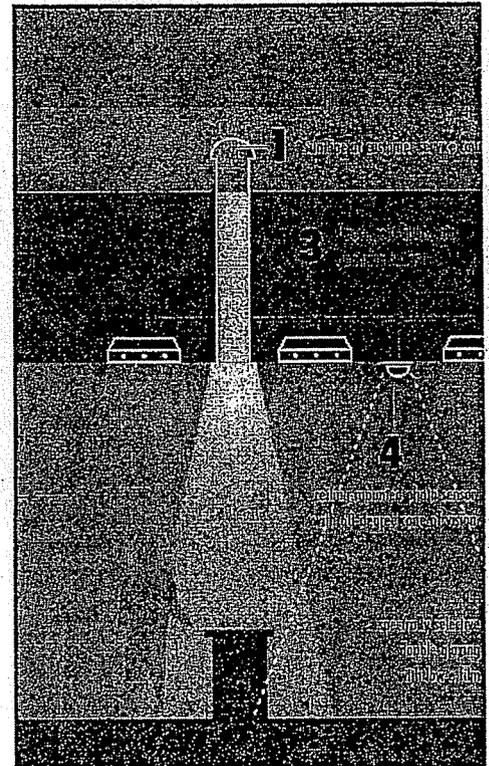
The daylighting features of this restaurant, as with all the measures incorporated into The Energy Efficient McDonald's (TEEM), meet simple, but rigorous, project criteria. They must:

- Save energy.
- Enhance the space for customers and employees.
- Be easy to maintain.
- Be simple to operate without management attention.

DAYLIGHTING FEATURES OF THE BAY POINT TEEM RESTAURANT

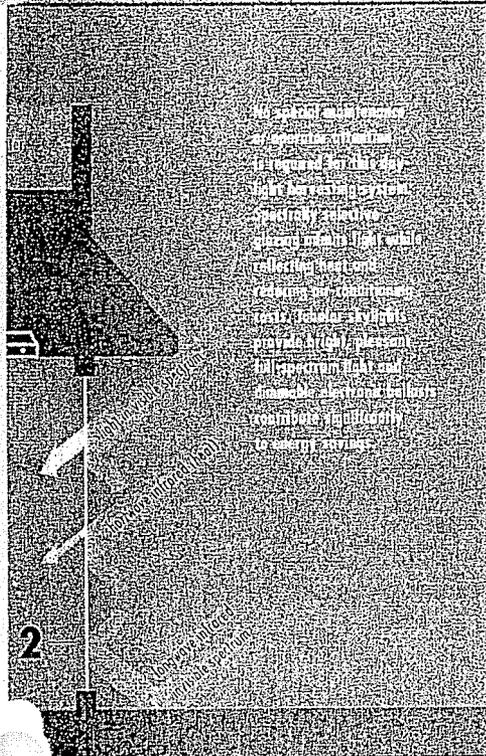
1 TUBULAR SKYLIGHTS With a diameter of just 13 inches, the tubular skylights were simple to incorporate into the design. They provide bright, pleasant, full-spectrum light at the counter area, throughout the Playplace, and in the restrooms. The "tubes" can be sized to any reasonable vertical length to accommodate various interstitial depths between the roof and the ceiling. The small cross-sectional area of this fixture minimizes disruption to the structural and mechanical infrastructure above the ceiling. This product incorporates a diffuser at the bottom of the tube, at ceiling level, giving an appearance much like an HID fixture.

DAYLIGHTING INITIATIVE



2 HIGH PERFORMANCE GLAZING How does a designer admit visible light into a space while restricting heat gain? Glazing products now available on the market provide a realistic solution to this common design problem in daylighting design. The solution is spectrally selective glazing. It is designed to admit the visible portion of the sun's electromagnetic spectrum while severely restricting the infrared and ultraviolet radiation. The glazing at TEEM Bay Point reduces heat transfer by 2-1/2 to 3 times that expected of clear double-paned glass while reducing light by only about one-third.

Glazing technologies such as these provide synergistic opportunities. At Bay Point, the low heat transmittance permits the use of downsized air conditioning with evaporative technologies. This greatly reduces air-conditioning costs and reliance on CFCs used in conventional vapor compression equipment cycles.



McDonald's and Energy
 as a special feature
 in equal parts. The
 lighting system
 provides a vibrant
 color palette that
 reflects the brand
 colors. The fixture
 also includes a
 photo sensor that
 allows the fixture
 to dim in response
 to ambient light.

[the] packaging graphics and food appearance are enhanced by the vibrant, full-spectrum illumination.

Tony Spata
 Building Systems Manager
 McDonald's

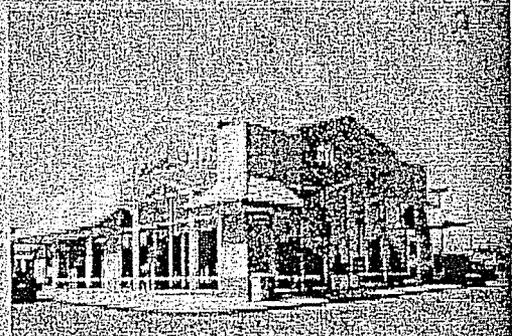
3 DIMMABLE ELECTRONIC BALLASTS WITH SIMPLE CONNECTIONS: As bright and pleasant as daylighting features may be, there can, of course, be no significant energy savings without control of the electric lighting system. At DEEM, Bay Point, the T8 fluorescent fixtures in the dining area are driven by dimmable electronic ballasts that permit continuous dimming down to 30 percent of light output and 30 percent energy input. Today, even further refinements in these ballasts have been made. They can dim light output down to 10 percent while saving up to 80 percent in energy.

The connection in this ballast is another dimmable innovation. The ballast receives its operate signal via control wiring that snaps in with a standard RJ-11 phone connector. It's that simple.

4 PHOTOSENSORS AND LIGHTING CONTROL SYSTEM: A simple, closed-loop control system dims the fluorescent fixtures in response to available daylight. There are two perimeter and three interior zones in the space. For each zone, a ceiling-mounted photosensor reads the illumination level within a 60-degree cone of vision. Each sensor connects directly to a group of several fluorescent fixtures by control wiring with RJ-11 connections. The sensor dims its group of fixtures in response to the available daylight from the skylights and windows. A central energy management system (EMS) or other interface device is not required for this system.

THE TEAM PROJECT

- A McDonald's corporate effort in four different U.S. sites to test advanced, off-the-shelf energy efficiency designs and measure actual world conditions.
- A collaborative project, McDonald's, the franchise owner, operates the local utility company, the U.S. Department of Energy, and equipment manufacturers.
- Comprehensive tools: The project included not only daylighting and other lighting measures, but HVAC and refrigeration measures as well.
- At Bay Point, the combined energy savings for all measures came in at \$16,220 a year. The successful ECH measures will be incorporated into standard plans for new McDonald's restaurants.
- To provide information on ECH rates to the resource manager at your firm.



RESULTS

The *Daily Energy Use* chart illustrates the effectiveness of the restaurant's daylight harvesting system—glazing, dimmable ballasts, and skylights—in the controlled area. The savings amounted to over 7,000 kWh per year or 34 percent savings for all space combined. In commercial applications of a similar nature, the costs of a similar dimming system can be reduced more to 10 percent.

One installed, none of the daylighting measures at PEGEM Bay Point required any special maintenance or operator attention.

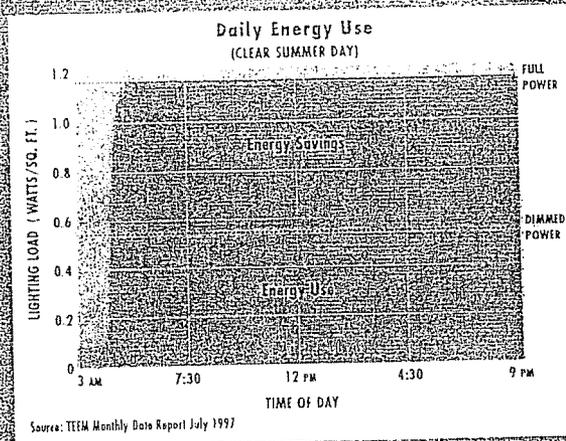
There were other less tangible benefits that may be even more important. Properly designed daylighting systems produce a bright, comfortable atmosphere well regarded by building occupants. Other details may emerge, as well, depending on the specific application. McDonald's, for example, was not really counting on the appealing effect achieved by locating the tubular skylights above the food service counter.

By all measures—esthetic, economic, and functional—daylighting improved the McDonald's Bay Point restaurant.

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Glazing, skylights, daylighting sensors, and dimmable ballasts all contribute to an effective daylight harvesting system that reduces energy use significantly. Over 7,000 kWh per year was saved in the controlled area or 34 percent energy savings for all spaces combined.

RESOURCES

PG&E does not endorse any particular products or services from any specific manufacturer or service provider. High efficiency products and services similar to those used in this project are available from multiple suppliers. For informational purposes, PG&E notes that the following companies provided equipment or services to the project.

Dimmable Ballasts & Daylighting Controls
Electronic Lighting Inc., Newark, California
www.elinet.com 1-800-395-5767

Tubular Skylights
The SunPipe Company, Northbrook, Illinois
1-800-844-4786

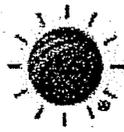
Spectrally Selective Glazing
Southwall Technologies, Palo Alto, California
www.southwall.com 1-800-365-8794

Contact: Nancy Rheas
nrhea@southwall.com

ADDITIONAL CONTACT INFORMATION

Pacific Energy Center, San Francisco, California
www.pge.com/pec/daylight 415-973-7206

McDonald's Corporation
Contact: Tony Spata, Building Systems Manager
tony.spata@mcd.com



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● **Products**

Brighten Up®
10" & 14" Solatubes

SolaMaster®
21" Solatubes

Solar Star®
Attic Fans

Accessories

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Products: SolaMaster Series Series 21" Solatubes

The 21" SolaMaster Series is ideal for a variety of commercial applications and suitable for larger residential areas

- Education facilities
- Industrial facilities
- Retail environments
- Office buildings
- Warehouses
- Healthcare facilities

Integrating the same high-performance engineering as our proven Brighten Up® Series, the 21" Solatube is the industry's first tubular skylight specifically designed to fit the existing suspended ceiling systems in commercial buildings.



The Solatube Advantage:

- **Compact, Modular Design**
The 21" Solatube can be easily integrated into most buildings without structural modifications. Its adjustable tubing allows incomparable installation flexibility and easily reconfigures to accommodate future interior layout changes.
- **Light Intercepting Transfer Device (LITD®)**
Solatube's patented LITD® increases daylight collection and harvesting for low sun angles, resulting in increased light output.
- **Spectralight® Infinity**
Our proprietary super-reflective tubing ensures maximum light transfer.
- **Easy Installation**
Each skylight can be typically installed in under an hour. Its small 22" diameter penetration fits between normal structural system layouts. No framing. No mess. No hassle.
- **Exceptional Energy Savings**
A single 21" Solatube can produce light output equivalent to two standard 3-lamp fluorescent light fixtures. When equipped with our electric light control options, dramatic energy savings can be realized as the photocontrols switch the heat-producing, energy-consuming electric lights off during daytime hours.
- **Flashings**
A full selection of durable Solatube flashings ensure fast, hassle-free installations on virtually any roof type and pitch. [Flashing Details](#)
- **Diffusers**



Choice of Diffuser Technologies provide a cost-effective option for providing comfortable, diffuse light into the workplace. While the prismatic design complements traditional lighting fixtures, the OptiView® High-Performance Fresnel Lens design provides a room with a view. [Diffuser Details](#)

SolaMaster 21" Options and Accessories	
Flashings Ceiling Mount Options	Diffusers Lighting Controls

Solatube Performance

To determine an initial estimate of Solatube products required to daylight a space, use the relative light output specifications for the Solatube products as compared to the light output of the electrical lighting fixtures used in the space being daylight.

Product	Relative Light Output (lumens)	Electric Lamp and Fixture
21" Open Ceiling Solatube (b) (SolaMaster Series)	13,900 Avg. Lumens (a) Up to 20,800	Approximately equal to the mean light output of 0.6 - 400W High Bay Metal Halide Fixtures. (c)
21" Suspended/Hard Ceiling Solatube (b) (SolaMaster Series)	13,500 Avg. Lumens (b) Up to 20,500	Approximately equal to usable light output of 2 fixtures, each using (3) F032T8 fluorescent lamps. (d)
14" Solatube (a) (Brighten Up Series)	6,000 Avg. Lumens (b) Up to 9,100	Approximately equal to usable light output of 1 fixture using (3) F032T8 fluorescent lamps. (d)
10" Solatube (a) (Brighten Up Series)	3,000 Avg. Lumens (b) Up to 4,600	Approximately equal to (3) 18W quad-tube compact fluorescent lamps. (d)

Handwritten notes:
 WAH
 279W
 3 Fluor
 12W
 86W
 162W (max)

a. Solatube relative light output based upon 30" tube run for the 21" Open Ceiling SolaMaster product. Maximum and average values achieved over the peak 2,400 annual daylight hours for San Diego, California TMY2 Weather Data.

b. Solatube relative light output based upon 6' tube run for 10" & 14" Brighten Up and 21" Suspended Ceiling SolaMaster products. Maximum and average values achieved over the peak 2,400 annual daylight hours for San Diego, California TMY2 Weather Data

c. Assuming a typical high-bay fixture efficiency of 90% and a mean lamp lumen output of 25,000 lumens.

d. Assuming a typical loss factor of 0.75, excluding additional efficiency losses.

**SolaMaster
21" Solatube
Material Specifications:**

Downloads

- Specifications
- Installation instructions
- [go to download page](#)

1. Dome is UV and impact resistant for



extended service life. Its low profile design is unobtrusive.

Impact modified, acrylic. Classified as CC2 material, .125" thick, with visible light transmission of 92% and ultra violet light transmission of .03%.

2. Light Intercepting Transfer Device (LITD®) increases daylight collection and harvesting for low sun angles, resulting in increased light output.

Spectralight® Infinity. For specifications see # 7 below.

3. Permeable Dome Seal locks out dust and bugs, but allows moisture to escape.

Black breathable weatherstrip material with 0.40" pile.

4. Dome Ring contains condensation gutter designed to channel out condensed moisture.

Durable white ABS, injection molded non-corrosive material.

5. One-Piece, 4"-, 8"- and 11"- high Seamless Flashing ensures a no-leak installation.

0.028 inches thick aluminized steel.

6. Spectralight Delta Angle Adaptors feature 30-degree elbows for easy installations. The 21" diameter tubes fit between 24" on center framing.

Spectralight® Infinity material, fabricated from aluminum sheet meeting ASTM B 209 requirements, alloy and temper required by the manufacturer to suit forming operations and finish requirements, 0.015" thick.

Finish: Reflective silver film provides over 99% total reflectance and up to 99% specular reflectance. Laminated with thermoset adhesive to provide permanent bond to substrate. Protected by PET film for long-lasting reflectance.

7. Extension Tubes are 24" in length, for installations up to 40'.

Spectralight® Infinity. Specifications are same as above.

8. 2'x 2' Transition Box fits a standard suspended ceiling system.

White 0.125" Acrylic (DR Plexiglass).

9. Square Diffuser Panel fits into the transition box and complements traditional light fixtures. UV and weather resistant diffuser seal provides an effective dust and bug seal.

**Find Out More About
Solatube Products**

Brighten Up Series
(10" & 14" Solatube)

SolaMaster Series
(21" Solatube)

Solar Star Attic Fan

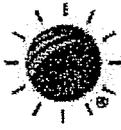
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Light News

Traditional or Tubular? Selecting the Right Skylight for Your Room

Q: What is a tubular skylight and how does it compare to a traditional box skylight?

A: Traditional skylights have their place, as do tubular skylights. There are a few key benefits of tubular skylights, however, including flexible location options, low cost of installation and better lighting performance.

Location

Tubular skylights can be installed in places where a traditional skylight wouldn't be an option, such as rooms without direct roof access or small areas like bathrooms, closets and hallways. The units are compact in design (as little as 10" in diameter) and feature adjustable tubing with angle adapters that allow for installation around attic obstructions.

Light Output

Tubular skylights are able to accomplish better lighting performance results than a similar size box skylight, because they don't use a skylight shaft (in which light is lost through absorption into the drywall tunnel). They capture light more effectively on the rooftop and efficiently transfer more of it down the reflective tube and into the room.

Additionally, a tubular skylight provides better light diffusion. Instead of lighting only the space directly below the skylight, a tubular skylight uses optics to spread the light out, often lighting the entire room.

Lighting Enhancements

Traditional skylights do not offer any optical enhancement devices to help increase performance. On the north side of a sloped roof, the light output from a regular skylight is significantly reduced without these devices.

The Solatube® tubular skylight, for example, features several proprietary enhancement devices, which work in concert to capture more light from all angles and reflect it down the tube for higher light output during early morning, late afternoon and in the winter months when the sun is low on the horizon.

The Solatube transfers the maximum amount of ambient light into a room with minimal light loss, allowing it to provide great performance even on cloudy or rainy days. In fact, it captures ambient light so well, on a full-moon night, you can actually see a nice glow.

Cost

The cost of a tubular skylight is more affordable than most traditional skylights. Remember, the cost of the traditional skylight is only a portion of the total materials cost. One must also add in the cost of framing members,

paint, drywall, etc. Then, labor becomes a very large portion of the cost because a contractor must frame out the skylight shaft, drywall it, tape it, then paint it.

Leaks

Traditional skylights have a reputation of leaking. Many times this is an issue of incorrect installation, but their square design invites problems. First, the flat up-slope side collects branches, leaves and other debris, which interferes with proper drainage. As the water dams up, it migrates under shingles or tiles to find an escape route, causing leaking.

The round design and one piece flashing system of the tubular skylight allows water and debris to flow past unobstructed. The entire unit is sealed to lock out any moisture.

Options

Tubular skylights can also be multi-functional. Tubular skylights like Solatube can be equipped with options like an integrated electric light (for night-time lighting) as well as a ventilation fan, providing a two- or three-in-one unit from a single ceiling fixture. Again, traditional skylights can't offer you these features.

For more information on Solatube tubular skylights, call (800) 966-SOLA (7652) or visit the Solatube website at Solatube.com. Media inquiries may be directed to (619) 291-1234.

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Light News

There Ain't No Cure for Summertime Energy Blues

Electric Lights Are A Good Place To Start Cutting; Natural Lighting Makes It Easier

The dog days of summer will soon be upon us. Temperatures will rise, and along with them those hefty summertime energy bills.

We all know how tough it is to keep energy bills in check during the year's hottest months, when standing in front of an open refrigerator starts to seem like a really good idea. But, there are some things that can be done around the house to cut back on energy consumption without impacting your comfort level.

A simple one can be taking a quick inventory of your daytime lighting requirements. Many of us have those rooms that never seem to be bright enough - the windowless bathroom, the North-facing kitchen, or that tree-shaded den that feels like twilight even at high noon. Turning on the electric lights, and often keeping them on all day, is usually seen as the only option; after all, you need to be able to live in those spaces. But you may be surprised how much those lights are costing you over the long haul. It has been estimated that one-quarter of the annual electricity use in the United States can be attributed to lighting.

Take one step outside and you'll see the potential for energy savings is right above your nose - the sun. There's more than enough free sunlight to go around, particularly in the summer months when the days are longer and the skies are clearer. Harnessing that sunlight and using it or high-quality, efficient interior lighting has never been easier and more financially feasible.

The newest generation of skylights from Solatube International Inc. makes opening your home to more natural light quick and painless. Available in 10", 14" and 21" units, Solatubes can be installed by a professional in about the time it takes to watch a re-run movie on cable and may even cost less than the repairman wants to fix the fridge you overheated.

Here's how it works: Solatube uses a unique reflective system to capture both direct and ambient light on the rooftop of the home. This light is then directed down a highly reflective tube to a diffuser at ceiling level.

The revolutionary design allows the product to provide exceptional natural lighting even on cloudy days, in the winter months, and in the early morning and late afternoons when the sun is low on the horizon. That means extra daylight each and every day, regardless of the time of year or the weather outside. So, your naturally-lit home won't fade when summer ends.

Another major concern for anyone who has ever owned a traditional box

skylight is the heat gain factor. After all, you don't want to be pumping your home full of expensive air conditioning if the area under the skylight is melting like pina colada sun-block on a sandy California beach.

Solatube's energy efficient, sealed design ensures the minimum amount of heat loss or gain between interior and outdoor environments. So, you're A/C won't work have to work overtime to compensate and the energy savings of retiring those daytime electric lights are all yours to enjoy!

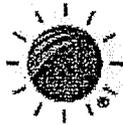
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Light News

Daylight Means Big Savings For Commercial Buildings

Natural Lighting Helps Boost Bottom Line By Shrinking Energy Bills

Thomas Edison may have changed the world with the invention of the electric light bulb, but that doesn't mean we can't work backwards. After all, sometimes you can't improve on the perfection of nature.

Daylight is arguably the highest quality light source. It presents the truest color rendition. It is less straining on the eyes. It has been linked with improved mental and physical health and even enhanced productivity. But, let's not forget the best part - it's free.

Using natural lighting techniques - or daylighting - in commercial buildings is not an original concept. However, creative, high-tech approaches are making the process more effective than ever, as well as more economical and convenient to implement.

With so many daylighting options available, businesses are reconsidering how they light their facilities. The commercial building industry is reevaluating options for its clients. Staggering energy figures are coming to light from intelligently planned daylighting projects, and the potential savings are impossible for anyone to ignore.

Consider the facts:

- According to the U.S. Department of Energy, artificial lighting accounts for as much as 40 to 50 percent of the energy consumption of commercial and institutional buildings.
- The U.S. Green Building Council reports that well-designed daylighting can reduce lighting usage by 50 to 80 percent.
- Lockheed Martin reported a 75 percent reduction in its electricity costs (approximately \$500,000 annually) after daylighting its Sunnyvale, Calif., facility.
- Researchers at the Lawrence Berkeley National Laboratory reported that a daylighting retrofit at the Palm Springs Chamber of Commerce resulted in a 47 percent reduction in annual electricity consumption.
- A Pacific Gas & Electric Company daylighting project at a McDonald's restaurant reduced energy use in the dining and lobby areas by 30 to 40 percent.
- According to the California Public Utilities Commission, an average grocery store could save about \$16,000 per year (or 32 cents per square foot) in operating costs by utilizing skylights. Additionally, a typical school could save \$7,500 per year (or 23 cents per square foot) and an industrial building could save about 12 cents per square foot.
- INC Bank in the Netherlands reported that its new headquarters (designed to favor natural lighting) used 92 percent less energy than

an adjacent bank constructed at the same time, saving the bank \$2.9 million a year.

Modern Daylighting Tools

Solatube International Inc., the innovator of the tubular skylight product which has been used in residential applications for more than a decade, recently launched its SolaMaster® Series, a whole new line of tubular skylights ideally suited for commercial interiors.

As a simple, cost-effective alternative to traditional box skylights, these compact units measure just 21" in diameter and feature a square ceiling diffuser that integrates into any office ceiling configuration. As with all Solatube products, the compact, adjustable tubing fits around ceiling plenum obstructions, and in most cases, no structural modifications are needed. The modular design provides flexibility for building owners and easily reconfigures to accommodate future interior layout changes.

The Proof Is In The Savings

At Solatube International's headquarters in Vista, Calif., a retrofit to include the company's 21" units resulted in an 86.1 percent reduction in lighting costs for the daylit portion of the office and a 68.2 percent reduction for the warehouse area.

For more information on Solatube tubular skylights, call (800) 966-SOLA (7652) or visit the Solatube website at Solatube.com. Media inquiries may be directed to (619) 291-1234.

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Miracle Skylight
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Light News

Natural Light Provides Key Marketing Advantages for Buildings

Daylit Spaces Command Higher Rates, Lease Faster, Attract and Keep Tenants Longer

Property owners and managers have a tremendous marketing advantage lurking right under their noses - or rather, right above their heads. It's the power of daylight.

Studies show that natural light has all kinds of benefits in commercial spaces - including dramatically reduced energy costs, improved worker productivity, decreased absenteeism, higher employee morale and job satisfaction, and improved mental and physical health. The list goes on and on.

While bright, naturally lit interiors are more attractive visually, they also can be appealing from a purely financial perspective as well.

Industry experts offer compelling evidence that buildings which maximize natural lighting technique lease or sell faster and for a higher price tag. Additionally, because daylit buildings are more energy-efficient and comfortable, tenants tend to stay in them longer. Marketing these buildings becomes that much simpler.

Consider the facts:

- According to the Electric Power Research Institute, daylit buildings can result in 10 to 20 percent higher rental income than those that use only artificial lights.
- According to the U.S. Department of Energy, artificial lighting accounts for as much as 40 to 50 percent of the energy consumption of commercial and institutional buildings. The U.S. Green Building Council reports that well-designed daylighting can reduce lighting usage by 50 to 80 percent.
- According to *Environmental Design & Construction*, energy-efficient building design can significantly increase the value of a property. Because the buildings cost less to operate and maintain, energy savings can go directly to the bottom line - the income of the property. Capitalizing this increased income can add \$5 to \$6 per square foot to the value of the building.
- According to the Housing and Building Technology Division of the National Conference of States on Building Codes and Standards, daylighting is one of the technologies that has the greatest impact on occupant comfort, health and productivity. Because people are willing to spend more for a comfortable building, owners can charge a premium.
- According to a survey conducted by the Building Owners and Managers Association and the Urban Land Institute in 1999 about what office tenants want, one of the top responses was more natural

light.

- *Energy User News* reports that quality daylighting systems offer improved comfort, reduced operating costs and a stronger connection to the outdoors, making them more marketable to tenants and valuable to building owners. Daylit properties are likely to rent faster and for higher rates. Additionally, when the owner is ready to sell the building, the investment in energy efficiency should bring added resale value.

Modern Daylighting Tools

Solatube International Inc., the innovator of the tubular skylight product which has been used in residential applications for more than a decade, recently launched its SolaMaster® Series, a whole new line of tubular skylights ideally suited for commercial interiors.

As a simple, cost-effective alternative to traditional box skylights, these compact units measure just 21" in diameter and feature a square ceiling diffuser that integrates into any office ceiling configuration. As with all Solatube products, the compact, adjustable tubing fits around ceiling plenum obstructions, and in most cases, no structural modifications are needed. The modular design provides flexibility for building owners and easily reconfigures to accommodate future interior layout changes.

Adding natural light is a simple way to make any property more marketable. The difference can be night and day.

For more information on Solatube tubular skylights, call (800) 966-SOLA (7652) or visit the Solatube website at Solatube.com. Media inquiries may be directed to (619) 291-1234.

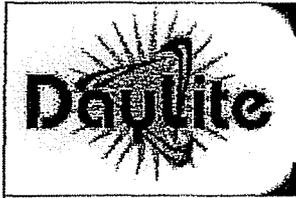
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The HiLite Company Authorized Dealer for DayLite Solar Tube and DayLite SkyLite San Diego



A Natural Lighting Corporation
"Let There Be Light!"

December 19, 2003

General Product Inf

Home

Services

Products

Giving you ...

The most advanced technology available ...

- The highest quality light
- Increased productivity
- Increased reliability
- The most cost effective energy efficient light source available
- Increased building value

The company and team committed to you...

HIGHEST QUALITY OF LIGHT...

Color - Color of light source is described by a combination of color temperature and color rendering index

1. Color Temperature describes how warm or cool light source appears. A warm color is a low number and a cool color is high
2. CRI – describes how accurately a light source renders colors. On a scale from -100, the higher the number the more true we say it renders color.

Contrast -

1. The difference in brightness between an object and its surround
2. allows us to see depth

Benefits -

1. Color – Accurately represents marketing materials
2. Color – Accurately represents products
3. Contrast – Safety – allows changes in elevations (stairs) or finishes visible
4. Contrast – Visual pleasure – foreground and background are allowed equal information

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INCREASED PRODUCTIVITY...

Heschong Mahone Group declares human productivity is dramatically affected by natural light

1. Studies conducted for retail sales concluded "all other things being equal, an average non-sky lit store in the chain would likely have 40% higher sales with the addition of skylights, with a probable range between 31% - 49%" AND "Employees in the half without daylighting continue to try to have their departments move to the daylight side"
2. Studies conducted for schools concluded "we found that students with the most daylighting in their classrooms progressed 20% faster on math tests and 26% on reading tests in one year than those with the least."

Psychologists use "Light Boxes" as a prescription to treat depression, stimulating serotonin levels in the brain, resulting in mood elevation

**ALL things being said about natural light lead to
PEOPLE JUST LIKE IT BETTER !!!**

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INCREASED RELIABILITY...

- Daylight is the most ancient and reliable source of light known.
- Harnessing daylight for internal purposes allows for our benefit of free light, everyday.
- No changing bulbs, ballasts, or recalculated energy consumption due to a rate hike.

Back to top

Energy Efficiency... Cost Efficiency...

- Reduced electric lighting consumption
- Reduced heating and cooling loads
- Reduced HVAC system size
- Reduced peak electric demand
- Reduced maintenance costs

Back to top

INCREASED BUILDING VALUE...

When you add these things together

- The highest quality light
- Increased productivity
- Increased reliability
- The most cost effective energy efficient light source available

Into one building it is likely to be far more interesting to an owner and a potential tenant resulting in higher square footage value.

 ***The HiLite Company***

Authorized Representative for the DayLite Company

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SunPipe® linked to global cooling?

Elgin, IL (March 13, 2001) -- At a time when global warming is being recognized as a serious threat to our climate, individuals often think they are powerless to do anything constructive to help alleviate the problem. "Not true," says Greg Miller, inventor of the SunPipe® and Owner of The Sun Pipe Company, Inc.

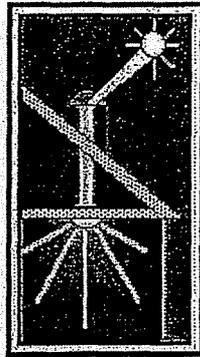
"The biblical principal of good stewardship can have a greater impact than any other single factor," says Miller, "just like when the biblical principal of quarantine was used to control and ultimately end Europe's black plague of the 1300's."

Global warming is the result of excessive pollution contaminating our atmosphere. Coal burning power plant emissions are a major factor, and power plants are being required to produce energy in a cleaner way. "However, power plants only exist to serve the energy demands of us, either in our private lives or at work," says Miller. "Accordingly, we have the primary responsibility to control our energy demand by being responsible for the manner in which we utilize energy."

"That's what good stewardship is all about," says Miller, "personal responsibility over those things we have control of. It's not about me trying to change the world, or even to tell others how they should do things. It's about me being responsible for what I do, not for what you do."

Consider our use of electricity. Electric lighting accounts for 25% of all energy produced in this country. By using daylight to illuminate interior spaces, the majority of the electric lighting load could be eliminated, according to Miller. "However, if daylighting is implemented improperly, it results in excessive solar heat gain, and we accomplish nothing more than a transfer of energy use from lighting to the air-conditioning system."

Miller's goal in introducing daylight pipes (also called solar tubes or tubular skylights) back in 1991 was to replace electric lighting with daylighting without using traditional skylights. According to the company, most skylights; a) eventually leak, b) let in huge amounts of heat (which drives up air-conditioning energy use), c) are expensive to install (usually over \$1000) and d) don't spread light throughout the room (often providing no more than a bright spot of light on the floor). Miller said that, to be a success, his product would need to reverse all these negatives by; a) not being prone to leaks, b) being thermally efficient, c) being simple and inexpensive to install and d) utilize a light diffuser to diffuse daylight evenly throughout an interior space." The result of Miller's efforts seems to be a very simple yet effective product.



SunPipe's simple design.

A simple design, the highly reflective hollow tube is installed between the ceiling of a room and the roof above it. Daylight shines into the solar tube above the roof and gets reflected down the tube to a light diffuser mounted to the ceiling of the room below. According to Miller, when the daylight hits the diffuser, it glows with the equivalence of up to 900, 1500 or even 3000 watts worth of light depending on the diameter of the tube (9", 13" and 21" respectively), the season, the time of day and the type of day (ie. cloudy or overcast).

The Sun Pipe Company provided the following information to substantiate their claim that a single SunPipe-13® can save over 600 pounds of CO2 emissions from a coal-burning power plant in as little as one year.

Claim: One SunPipe-13 reduces power plant CO2 emissions by over 600 Lbs per year.
Statistic: 60% of all SunPipe-13's are installed into kitchens and typically replace the burning of 300 watts worth of incandescent lamps.
Assumption: One SunPipe-13 replaces 300 watts worth of electric lamps for 5 hrs./day, 5 days/week.
Energy Savings Calculation:

300 Watts X 5 Hrs/day = 1,500 Watt Hrs/day
 1500 X 5 days/wk = 7500 Watt Hrs./wk
 7500 X 52 wks/yr. = 390,000 watt Hrs/Yr. /1000 = 390 kWh/yr.
 390 kWh / Yr. X 1.7 Lbs. CO2 / kWh = 663 Lbs CO2.

A) Coal Burning Plant:	Polution Produced Lbs. / kWh	Energy Saved kWh / Yr.	Emissions Saved Lbs. / Yr. / SunPipe-13
Carbon dioxide (Greenhouse)	1.7	390	663
Nitrogen oxides (Smog)	0.0068	390	2.652
Sunfer dioxide (Acid Rain)	0.013	390	5.07
B) Nuclear Plant:	Polution Produced Oz / kWh	Energy Saved kWh / Yr.	Emissions Saved Oz / Yr.
Spent Fuel (low level waste not incl.)	0.0012	390	0.468


The company claims to use 300 watts per hour energy savings per SunPipe® in the above example for the sake of conservatism. They also claim that a SunPipe® can actually save over 1000 Lbs of CO2 and over 1 Oz of nuclear waste per yr, but they didn't want the data to appear too unbelievable. Even at 600 Lbs/yr, multiply that by the thousands of SunPipes sold since 1991 and the reduction in CO2 emissions attributable to SunPipe® owners is impressive.

"Personal responsibility," says Miller, "means doing things the right way and not causing the release of unnecessary pollutants into our eco system. The typical SunPipe costs \$400 to \$600 installed and will prevent over 3 tons of CO2 from entering our air over the next 10 years. All this while providing healthy, natural interior illumination, far superior to any electric light in both color and intensity. It just makes good common sense to implement such technology."

Miller believes SunPipe® merits becoming a standard component of residential and industrial construction. And, since it reduces the need for electric lighting, it earns the distinctive role of being a truly "anti-global warming" product or, as Miller calls it, a "Global Cooling" product.

For further information call them toll free at 1-800-844-4786

[Back to SunPipe Home Page](#)
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How does Solar Flair's light output compare to electric lights or traditional skylights?

Light is measured in lumens and energy usage in watts. A standard 100 watt incandescent bulb produces 1200 lumens. A 40-watt, 48-inch fluorescent tube produces 2300 lumens.

* The 10-inch Solar Flair produces up to 3750 lumens

* The 14-inch Solar Flair produces up to 6500 lumens

The 10 inch Solar Flair compares to a 2' x 2' skylight and the 14-inch compares to a 2' x 4' skylight.

Rocky Mountain Institute: Approach to Energy

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From the Earth - Geothermal heat pump systems challenge conventional ideas about HVAC

<http://www.buildings.com/Articles/detail.asp?ArticleID=662>

Solar Gains - Reaping the energy-saving and productivity-boosting benefits of daylighting

<http://www.buildings.com/Articles/detail.asp?ArticleID=663>

Building Diagnostics - Building automation systems function first as diagnostic tools

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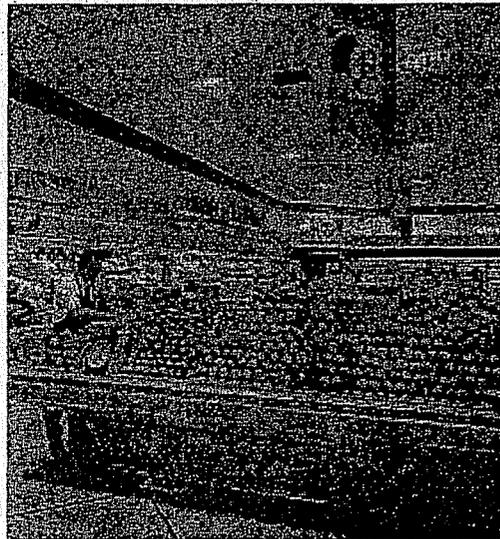
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Project: Stater Bros.
Building Type: Commercial/Retail

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Stater Bros. Markets, Inc. uses daylight to create an innovative energy-efficient shopping environment at their new grocery store in Chino Hills, California. The effective use of daylight not only serves to fully displace the need for electric lighting during the majority of daylight hours throughout the year, but also enhances the appearance of the products being sold. It truly creates a more natural and enjoyable environment for both the patrons and staff.



Objective

Provide significant annual energy and operating cost savings while also establishing a higher-quality retail environment through effective daylight harvesting.

Products Used

SolaMaster® Series
164 – 21" Solatube Units with OptiView® Lenses and 6-feet+ of tubing (530mm)

Solution

The Solatube tubular skylights are used to fully daylight the entire 43,235 square-foot sales floor (including produce, pharmacy, and checkout aisles) and back-of-house stocking spaces in the new Chino Hills store. Sophisticated panel-level photocontrols provide multiple controlled lighting zones utilizing a single photocell that is integrated into the Solatube daylighting system. The abundant daylight from the Solatube skylights accentuates the natural beauty of the high-quality produce and grocery products available in the store. The Solatubes are artfully placed to provide accent lighting for key architectural details and to brighten the perimeter walls of the store.



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Vista, CA 92083
Phone 760-597-4400
Fax 760-597-5181
www.solatube.com

Testimonial

"The most exciting aspect of this installation is that the projected energy savings resulting from the Solatubes will cut our annual lighting energy costs by nearly half. In addition to saving energy, the Solatubes will keep the store lighted in the event of a black-out situation, which is a real plus."

Mike McCasland

Property Development Manager
Stater Bros.

View this case study in [PDF](#) format

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Technology

Centralized Lighting Control

Allow automated control of lighting systems. Included in this technology are simple time clocks, package programmable relay panels, and complete building automation systems. This type of control is most often used with programming schedules to light only areas that are occupied based on typical occupant schedules and utilize wall switches or occupancy sensors to determine when occupants are in a space at a non-typical time and allow adjustments to the lighting accordingly. Increased savings are possible by incorporating photosensors with a centralized lighting control system to indicate when it is appropriate to decrease the lighting level in perimeter building areas. Energy savings are maximized by integrating other systems such as security systems that detect employee keycards and can turn on or off lighting in office areas accordingly. Limitations include high initial and maintenance costs and compatibility of components. This technology is easiest to implement in new construction, however retrofit is a possibility.

Estimated Energy Savings – kWh

Timers 10-20% of lighting energy, Building Automation systems with photoelectric controls 20-30%

Assumptions include: Lights on for an average of 4200 hours, even though 3,956 annual hours of operation (average of all commercial and industrial customers). 1.4 Watts per square foot, average lighting level in space to be controlled, 15% savings on simple timer systems and 25% on more sophisticated building automation and controls. Estimated savings averages 1.18 kWh per square foot per year.

Summer Peak Savings

Assumes at least 90% of lighting on during peak times. Assume peak savings is negligible.

Measure Life

12 years

Initial One-Time Cost

Simple time clocks are available for as little as \$49.00 for an electronic 20A programmable 7 day timer. Building automation systems can be in the hundred thousands of dollars. The simple timeclock installed for \$100 in a 150 square foot office will only cost about \$0.67/square foot. Large systems could cost several dollars per square foot. This analysis assumes an average cost of \$0.90 per square foot.

Any Recurring Costs

Requires regular maintenance and adjustments in scheduling due to changes in usage by occupants.

Suggested Incentive

We recommend a \$.10/square foot assumption be used. Could consider adding to incentives if systems create other opportunities for daylighting and/or multilevel lighting.

Requirements

System should be automated and must consider occupant schedules and override for safety.

Existing Energy Standards

There are currently no standards for this technology.

Source of Info

Lighting Research center --"Controlling lighting with building automation systems", ACEEE Guide to Energy Efficient Commercial Equipment, FEMP

Control Issues

By Alfred R. Borden IV, IALD

Reprinted courtesy of *Consulting-Specifying Engineer*, 05/01/2002.

It's safe to assume that most building owners would not let water run freely throughout their facilities, but most people don't necessarily understand that lighting without effective controls amounts to the same thing—a terrible mess. On the other hand, a lighting system regulated by well-designed controls is an efficient, cost-effective component of a building's operating systems.

In fact, a control system can be the most effective means of maximizing the benefits of good lighting, enabling facility managers to use only as much energy as is required.

Further, proper lighting controls can make a facility a friendlier place, as accessible, well-planned switches and dimmers give occupants options for creating the pattern and intensity of lighting that will make them most comfortable and productive.

Lighting control schemes, however, should always consider the impact on the people working in the space. In other words, lighting controls that do not take into account user needs become more of a hindrance than a help. Avoiding this kind of situation is the responsibility of the system designer and the building operator. Consequently, controls must be accessible and intelligible, as well as have reasonable local overrides so people are not "left in the dark."

No time like the present

The best time to make decisions about lighting controls in a facility is right now. Undoubtedly, it is much easier to do so during a preliminary design phase, but it is never too late to harvest the savings and operating benefits produced by properly applied lighting controls. The first step is to look at either how lighting is currently being utilized, or will be used.

Typically, lighting is provided for occupant safety, comfort and convenience, as well as to help create a building's image or identity. Each of these uses represents the beginning of a control strategy and the building can be divided into areas or zones according to lighting usage. A simple way to determine where these divisions are is to ask the following questions: Who will be using the area? What will they be doing there? What time will they be there? And for how long?

Interior spaces can be categorized as follows:

- Circulation areas—corridors, stairs and lobbies.
- Common facilities—dining areas, meeting rooms and fitness centers.
- Support spaces—mechanical rooms and storage rooms.
- Work areas—offices and laboratories.

Similarly, exterior lighting can be divided into usage areas such as parking lots or garages; walkways and building entry points; and landscape or accent lighting.

Next, consider that each area represents a different function. Some spaces contain areas that are frequently occupied, some are rarely occupied and some—such as the offices, labs or meeting rooms—are occupied only during specific hours. The activities performed in these areas vary, so it follows that their lighting requirements will also vary. Consequently, the lighting for each area should operate according to a schedule suited to its needs. Similarly, different intensities can be maintained throughout this schedule, according to the activities they must support.

In control

Once divisions are established, the next step is to examine available products. In the simplest analysis, lighting control systems come in two types: those that turn lights on and off, and those that vary intensity. On/off controls come in various forms. The most common types are: toggle switches, time clocks, photocells, relays and contactors. Time clocks provide scheduled control of lighting loads, and photocells react to changes in the ambient light level. Both continuously repeat their preset program of operation—barring an equipment failure—without any additional input. Switches, relays and contactors require an operator, either an individual who throws a switch or a control device—such as a microprocessor, photocell or occupancy sensor—to make the contact.

An occupancy sensor lighting controller is a light switch designed to detect motion within a space using either a field of ultrasonic sound or infrared light. Sensor types are made with a variety of field shapes and orientations designed for different shapes and sizes of rooms. Within the range of its field, an ultrasonic sensor detects fine movements and can even "see" over hard surfaces, such as partitions in restrooms and workstations. However, at the limits of this field such movements may not be detected. Also, an ultrasonic sensor can be fooled by air movement near a diffuser.

The other type, an infrared sensor, detects movement across the bands of light that it emits. Consequently, it only detects large movements within its line of sight. In all cases, infrared occupancy sensor systems must be "tuned" after installation. This involves adjusting sensitivity and time delay settings as is appropriate for the space. Most suppliers of occupancy sensors offer this post-installation service.

The spaces where occupancy sensors are most commonly used are conference rooms, private offices and restrooms. Areas that are usually occupied, such as large open offices, produce less savings. In any case, end users will ultimately see savings in their facility's kilowatt-hour energy costs but not necessarily in monthly peak kilowatt demand charges, because the sensors don't actually reduce the connected load of the lighting system.

Another question the owner must answer is: who will be allowed access to the switch? This answer can be determined by the lighting function. For example, safety lighting is too critical to be left to a human operator, so some form of automatic control is best. However, since this lighting can be on for long periods, the control strategy should include a method to limit its use. A timer or photo device can step down the light intensity in a parking garage by energizing fewer fixtures during daylight hours. Then, during periods of low usage, a timer, coupled with an occupancy sensor, can be used to drop off a portion of the walkway lights, or keep corridor and stair lighting off when unoccupied.

At the office

Office lighting is a different issue, as provisions must be made for direct occupant control. Although some areas operate on a regular schedule, off-hour use is common. Therefore, strict time control of the lighting is unacceptable. This is also true in common areas such as meeting rooms or reception areas. Toggle switches are the typical solution, but occupancy sensors may be the best choice.

Another useful device in areas with incandescent lighting is a dimmer. In the past, dimmers were only considered to be an amenity for high-end spaces. However, dimmers also offer an opportunity to conserve power usage. Modern dimmers are electronic and use semiconductors to vary the fixture input voltage, and hence light output. *This also varies the amount of power served to the fixture and reduces operating costs.* Reducing voltage to an incandescent source also slows the deterioration of the lamp filament and extends its life. Consequently, the total savings in kilowatt hours and lamp replacement can be dramatic. A 10% reduction below a lamp's rated line voltage will produce a nearly equal reduction in power consumption and reduce the light output by approximately 30%. However, this will also extend the lamp to nearly four times its rated life. Any space where incandescent lamps are used will benefit from dimmer installation.

Automated lighting

A programmable lighting controller interfaced with a building automation system (BAS) provides an excellent means for saving energy. This control strategy divides the facility into functional groups and programs the system to turn lights on and off according to the normal occupancy schedule for each group. Each lighting circuit is controlled by a relay that responds to the programmed directions. The controller can be fitted for local override if people enter the area off hours, and can account for changes in each area's schedule. The interface to the BAS can be used to report operating profiles and may offer the opportunity to optimize HVAC usage in each building area. (Go to "Deep Links" at www.csemag.com for a case study illustrating this technology.)

Another aspect of the lighting design, lighting circuits, should also be configured according to the control strategy. Controlling lighting on a per-circuit basis is less costly, so separate circuits should serve each control group. In other words, the corridor lighting should not share a circuit with the offices. Similarly, walkway lights should not be on the same circuit as landscape lights. Each functional piece of the facility offers a different opportunity to control lighting use, but mixing the circuiting may complicate a control device's wiring or limit future options.

Setting the standard

The growth of computer networking has had a great influence on lighting control systems. In the past, each electronic lighting control system stood alone in a building, especially when built by different manufacturers. Therefore, the conference room dimming system had no communication with the relay system that provided programmable on/off control of the office lighting. At best, they could both report their status to a centralized BAS. However, this has changed because most control manufacturers have started incorporating two communication standards into their systems.

Almost 15 years ago, the United States Institute for Theater Technology (USITT) developed a standard called DMX512—a method for digital data transmission between control systems and dimmers. The standard covers electrical characteristics, data format, data protocol, and the design of cables and connectors. It also allows control systems to talk to dimmers, relays and automated lights made by different manufacturers. The other standard comes from the computer industry—the RS232 data port. This is the serial nine-pin connection that sits at the back of a computer. RS232 is a transmission protocol that allows analog data communication between systems. Relay closures and sensor readings can all be translated into program instructions for the system so architectural control manufacturers can provide an RS232 connection.

Theatrical control manufacturers use DMX512 and, increasingly, the top manufacturers can provide both DMX512 and RS232. This means that it is possible to link all controls together and access each system from another, or from a computer. This increases the flexibility and efficiency of all systems. For example, the building automation computer can tell the relay system to turn on Preset Scene 4 in Conference Room 5 at 3 p.m. on Monday the 22nd. It can also make sure that all unnecessary lighting—including the conference room dimming systems—are turned off at the end of the work day.

Most recently, lighting control companies and ballast manufacturers have been working with new protocols that can provide digital control and monitor each lighting fixture in the building. Digital Addressable Lighting Interface (DALI) was developed in Germany and has been promoted worldwide. Several manufacturers have adopted DALI or similar standards as a means to provide a seamless interface between the components of an integrated lighting system. For example, in a fully developed system, each fluorescent lamp ballast is given a digital address. This means that each ballast can be accessed for on/off control or dimming through a standard computer network interface. The whole system can be mastered through a BAS and everyone in the building can control the lighting in their area through their own computer. Each addressable device also reports its status to the operating computer. This means that fixture locations are mapped in a building management system and tell the maintenance staff when they need to be serviced. In effect, lighting control becomes a building-wide system consideration, not just a stand-alone or specialty application.

At the same time, fully digital addressable lighting systems are not yet common and their cost and complexity make them an intimidating retrofit consideration. Very few companies provide all the components—ballasts, dimming modules, network interfaces—that comprise a system, and integrating

components made by different manufacturers is still not quite seamless. However, digitally addressable systems are the future of lighting control.

Another recent innovation in lighting control technology—automated lighting fixtures—has enabled show-lighting designers to add that extra visual thrill to their designs. Small motors with microprocessor controls let the designer program pans, tilts, color changes and moving projections into the fixture.

Until recently, using automated fixtures in a commercial building has been difficult. The theatrical fixtures have always required more tender loving care than the typical building maintenance staff is prepared to give. But now several manufacturers offer architectural versions of their automated fixtures. The fixture construction is sturdier, and they are rated for indoor and outdoor environments. Their programming is simpler and more reliable, and they use long-life metal halide lamps. The on-board fixture programming can be networked into the building system using a DMX512 protocol.

It is doubtful, at least in the foreseeable future, that automated lighting will be commonplace in the standard working environment. However, a few fixtures, properly placed, can create a dynamic identity for a facility.

Once all the lighting control issues have been identified—visibility requirements, operating schedules, life-cycle costs and user interfaces—end users can begin to develop a control program that suits their needs. The hardware can be as simple as local wall switches, or as complex as networked digital processors, but the return in energy savings and user comfort can be rapid and lasting.



Energy Advisor

Your guide to energy products
for commercial buildings

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Motors Office Equipment & Other Plug Loads Power Quality Equipment Refrigeration Water Heating

Lighting: Lighting Controls

What Are the Options?

How to Make the Best Choice

What's on the Horizon?

Lighting controls help to make commercial buildings more comfortable, productive, and energy efficient. These controls can turn lights off when they are not needed or dim light output so that no more light than necessary is produced. The two functions can be employed individually or in tandem to provide even greater benefits. The equipment needed to achieve these functions ranges from simple timers to intricate electronic dimming circuits.

The benefits of lighting controls can be significant. In one prominent example, Lockheed Martin cut energy use by 75 percent after applying daylighting and dimmable fluorescents extensively at one of its buildings in Sunnyvale, California. Elsewhere, TRW installed occupancy sensors in 8,000 rooms at its Space and Defense Park campus in Redondo Beach, California, and cut annual energy bills by \$1.3 million. Overall, lighting controls have been shown to reduce lighting energy consumption by 50 percent in existing buildings and at least 35 percent in new construction. Lighting controls can also reduce peak loads and provide a load-shedding capability.

What Are the Options?

ON-OFF CONTROLS

The simplest way to reduce lighting energy consumption is to turn the lights off when they are not in use. All electric lights feature manual switches for that task, but these are not used as often as they could be. To solve that problem, the lighting industry has developed a variety of devices, including timers and occupancy sensors.

Occupancy sensors. Occupancy sensors are most effective in spaces with a constant flow of foot traffic: for example, private offices, school classrooms, lecture halls, auditoriums, warehouses, restrooms, and conference rooms. Occupancy sensors are less likely to be effective in open-plan offices, where one or more people may be present throughout the day, or in reception areas, lobbies, retail spaces, or hospital rooms.

Three types of occupancy sensors are available: passive infrared (PIR), ultrasonic, and sensors that combine the two technologies.

PIR devices are the least expensive, most commonly used type of occupancy sensor. They detect the heat emitted by occupants and are triggered by changes in infrared levels when, for example, a person moves in or out of the sensor's field of view. PIR sensors are quite resistant to false triggering and are best used within a 15-foot radius.

Ultrasonic devices emit a high-frequency sound above decibel levels audible to humans and animals, and the sensors are programmed to detect a change in the frequency of the reflected sound. They cover a larger area than PIR sensors and are more sensitive. They are also more prone to false triggering. For example, ultrasonic sensors can be fooled by air currents produced by a person running by a door, moving curtains, or the on-off cycling of an HVAC system.

Hybrid devices that incorporate both PIR and ultrasonic sensors are also available. These take advantage of the PIR device's resistance to false triggering and the higher sensitivity of the ultrasonic sensor.

More details are available in the Energy Advisor [Occupancy Sensors](#).

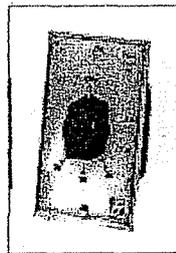
Timed switches. Timed switches operate based on either elapsed time after triggering or on programmed schedules using clock time. Elapsed time switches, also called timer switches, typically fit into, or over, a standard wall switch box and allow occupants to turn lights on for a period that is determined either by the occupant or by the installer (see **Figure 1**). Lights go off at the end of that interval unless the cycle has been restarted by the occupant or manually turned off sooner. Time intervals typically range from 10 minutes to 12 hours. Elapsed time switches are much simpler to specify than occupancy sensors, are less prone to user maladjustment, and are low in cost.

Elapsed-time switches may be mechanical or electronic. Mechanical units, typically set by the user, are basically spring-wound kitchen timers connected to a relay. These items are subject to mechanical failures if used in high-traffic areas. Time intervals on electronic switches are typically set by the installer using a hidden set screw. These electronic devices look like conventional toggle switches, so occupants are usually unaware of the presence of the device, which reduces vandalism and theft. Elapsed time switches are also an easy, economical means of complying with energy codes that call for automatic lighting controls.

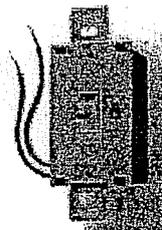
Clock switches control lights by turning them on and off at prearranged times, regardless of occupancy. They are most useful in locations where occupancy follows a well-defined pattern, such as a retail outlet. They are typically placed in electric closets that house lighting power panels. These devices cost relatively little to install and can control large loads with single sets of contactors. Equipment may consist of mechanical devices—with motors, springs, and relays—or sophisticated electronic systems that handle several time schedules simultaneously. Mechanical switches may require correction for daylight savings or after a power failure, unless battery backup is available. However, battery backup can triple the price of a mechanical clock switch. Electronic devices routinely include battery backup and can be easily programmed to adjust for shifts to and from daylight savings time or for holiday

Figure 1: Elapsed-time switches for lighting control

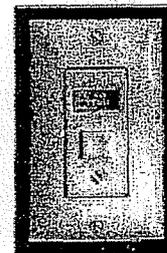
Elapsed-time switches are an inexpensive means of controlling lights in irregularly used spaces.



Spring-wound switch



Paragon ET
electronic
toggle switch



The Watt Stopper's
TS-200 electronic
push-button switch

Source: Paragon Electric Company, The Watt Stopper

schedules.

The latest clock switch includes a 10-year lithium battery and the capability to receive time signals from the National Institute of Standards and Technology to keep clocks current. For fluorescent lighting, make sure that electronic switches do not use a triac relay. Triacs may trickle a small amount of current to ballasts and lamps, even when they are off, and may damage the lamps.

Energy management systems. An energy management system (EMS) performs the same function for lighting as a clock switch, but with more sophistication and additional features. A typical EMS is designed to handle a variety of loads, including HVAC, but pure lighting management systems are also available. Systems are now becoming available that combine on-off and dimming capabilities in an EMS.

A common EMS feature is a sweep mode that automatically cycles lights on or off, one section or floor at a time, signaling occupants that lights will soon be shut off. Occupants can then override the shutdown in their area by pressing a local switch or by phoning in a code to the EMS.

DIMMING CONTROLS

Dimming controls are usually used to match lighting levels with human needs and to save energy. When combined with light sensors, dimming controls can correct for dirt buildup in fixtures and lamp lumen depreciation. Dimming controls are also used to modulate lamp output to account for incoming daylight. Dimming may be accomplished in either a step-wise or continuous fashion.

Step dimming. The most familiar form of step dimming is the three-way incandescent lamp. For non-incandescent lamps, two means of step dimming are available: banks of lamps may be put on different switching circuits, or ballasts designed specifically for step dimming may be applied.

The first of these two methods is often referred to as bi-level switching, even though more than two levels may actually be available. For example, in a system with three-lamp fluorescent fixtures, one switch may operate the center lamp in each fixture, while another operates the outer lamps. This arrangement makes three lighting levels possible (one lamp, two lamps, or three lamps lit), yet the term bi-level is still often used to describe such a system.

Step-dimming ballasts offer more light control and energy savings than nondimming ballasts but cost less than the more versatile continuous dimming ballasts. They typically offer two or three lighting levels. Step-dimming ballasts can be used with occupancy sensors so that the sensors are able to dim the lamps rather than turn them off, which can reduce on-off cycling and extend lamp life. These units also offer a viable way to reduce lighting levels during noncritical hours and to shed peak demand in common areas such as corridors.

Step-dimming ballasts are especially useful for high-intensity discharge (HID) lamps. HID lamps typically require long starting times, so they are not suited to being switched on and off by occupancy sensors. Better results can be obtained by switching the lamps between low power and full power.

Continuous dimming. Continuous dimming controls let users adjust lighting levels over a wide range of lighting output. They offer far more flexibility than step dimming and are

used in a wide variety of applications, including mood-setting and daylight dimming. Dimming can be accomplished on all lamp types found in commercial buildings: incandescent, fluorescent, and HID.

Incandescent lamps are the easiest to dim. The introduction of semiconductor-based dimming controls for these lamps means that dimming is also accompanied by a reduction in energy consumption. However, these dimmers cause the filament to run cooler, reducing color temperature and making the lamp appear more yellow. In addition, power does not vary linearly with light output, and lamp efficacy is reduced during dimming. However, voltage is also reduced, which increases the life of standard incandescent lamps but may reduce life in halogen bulbs.

Fluorescent lamps may be dimmed for two purposes: energy savings and architectural effect. Energy-saving dimmers typically dim down to 20 percent, while architectural dimmers may reduce light levels to 1 percent or less. Unlike incandescent dimming, fluorescent dimming does not extend lamp life, and long periods at very low light levels may shorten life. Dimming ballasts are often used to reduce artificial light output whenever sunlight is available. In one test, dimming ballasts helped cut peak demand by almost 40 percent (see **Figure 2**). Dimming can also be used in load-shedding strategies—better to have employees work under slightly lower light levels than be forced to send them home because of a power failure.

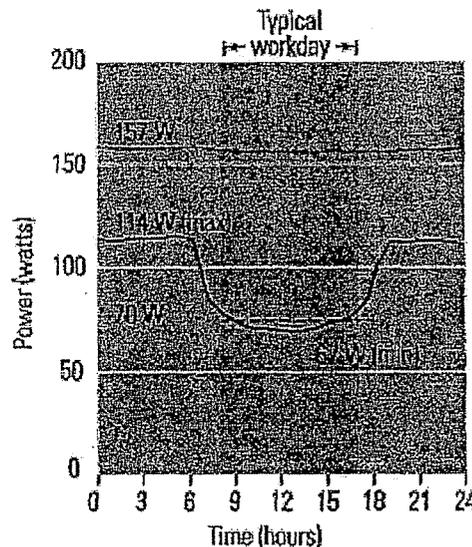
Dimming is accomplished through the use of either low-voltage control or power line control. Most ballasts are controlled by a separate, low-voltage circuit. This approach requires additional control wiring, but the ballasts are compatible with a wide variety of dimming controls. For example, low-voltage controlled ballasts can easily be connected to energy management systems that offer 0- to 10-volt output channels. Power line controlled ballasts can dim fluorescent lamps with standard incandescent wall dimmers installed directly on the line-voltage switch leg—no extra wires necessary. The ballasts are not compatible with all dimmers, however, so ballast and dimmer should be checked for compatibility.

In recent years, it has become easier to dim compact fluorescent lamps as well as full-size fluorescents. New screw-based, dimmable compact fluorescent lamps (CFLs) provide dimming capabilities down to the range of 10 to 20 percent, and early reports claim that these products work well with most existing incandescent dimmers. These lamps

Figure 2: Power levels for dimming and nondimming systems

In a test at the Florida Solar Energy Center, dimming cut average workday power consumption for lighting from 157 watts (W) to 70 W.

- Dimming system: electronic dimming ballasts, open paracube troffer, specular reflector, T8 lamps
- Nondimming system: magnetic ballast, painted troffer, prismatic lens, T12 lamps



Source: Florida Solar Energy Center

cost just a few U.S. dollars more than standard CFLs. New hardwired CFL dimming products are coming to market as well, providing opportunities of dimming lights to even lower levels.

Personal dimming controls that allow individuals to control light levels in their own work areas are also becoming more widely available. Such dimming controls have been shown to cut energy use and increase worker satisfaction levels.

HID dimming is more limited, because it is often accompanied by color shifting, reduced color rendering index, increased flicker, adverse impact on lamp life, and inadvertent lamp shutdown during line voltage variations. New electronic dimming ballasts for metal lamps promise to solve some of these problems and make HID dimming more feasible.

HID and fluorescent lights may also be dimmed with panel level controllers that lower circuit voltage upstream of the ballasts. This approach is best applied in overlit situations with large banks of lights that are switched simultaneously, such as in retail stores, supermarkets, and large, open-plan offices. Dimming levels are usually limited to 25 percent or less.

COMBINED SYSTEMS

Building operators can achieve the highest levels of energy savings through the combination of dimming and on-off strategies. However, the total savings achieved by implementing both strategies will be less than the sum of the savings gained by implementation of each individual strategy. The reason for this is simple. Take for example, a system that combines occupancy sensing and dimming. Dimming cannot save energy when occupancy sensors have already shut off a lamp, and the occupancy sensors save less energy when they turn off lights that otherwise would have been dimmed.

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How to Make the Best Choice

Select the type of control based on the usage of the space. Consider occupancy sensors and timers if the space use is unpredictable. Typical examples might be warehouse aisles and hotels or any space that is unoccupied, in an unpredictable fashion, for more than 30 percent of the time. Consider timed switches if space use is predictable and not part of a 24-hour operation. Photoswitches and timed switches work well for exterior lighting used on facades, signs, and in parking areas. If daylight is available, consider dimming ballasts with photosensors or multilevel switches. In spaces where there is a need to vary light levels, either during the day or after hours, manual dimmers or multilevel switching will work well.

Select the right type of control for the expected load profile. For a space with predictable 9-to-5 work hours and limited weekend use, select controls that will reduce peak demand. In that scenario, occupancy sensors and photosensors will help reduce demand in tenant spaces, and timed switches can be used in public areas. In a facility with extended hours of occupancy, occupancy sensors and manual dimming or multilevel switching can help to reduce unpredictable use. In spaces that are always open, use photosensors in conjunction with dimming ballasts to cut daytime energy use, and use manual dimming and multilevel switching to cut energy use at night. Manual controls work best in spaces such as gymnasiums or conference rooms that are lit for specific events. Manual dimming and multilevel switching are the best energy-saving options in those situations.

Evaluate cost-effectiveness. Users will achieve varying levels of energy savings based on the types of spaces in which they implement occupancy sensors, as shown in the [table for occupancy sensors](#). More precise estimates require random surveys of occupant patterns or the use of dataloggers to record current usage. For daylighting, actual scale models or full-scale mockups are sometimes used to estimate the savings potential. Once building operators estimate potential savings, they can use the incremental cost of the controls to calculate a simple payback period.

Test system compatibility. All the components in a lighting control system—including ballasts, controller, photocells, occupancy sensors, and switches—must be compatible. Achieving this can be tricky when each item may come from a different manufacturer. A small-scale test will help sort out compatibility issues before a large installation is specified.

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What's on the Horizon?

Look for new products in the near future that incorporate the Digital Addressable Lighting Interface (DALI). DALI is a digital communications standard that a growing number of manufacturers are embracing. It is a nonproprietary standard that defines interfaces for digital communication between a controller and the various electronic components of a lighting system. The DALI concept was designed to close the gap between 0- to 10-volt systems—which are low in cost but lack flexibility—and complex building management systems, which provide lots of functionality but require costly equipment and a high level of system knowledge on the part of the user.

DALI supports the concept of individually addressable ballasts, which can be assigned to a control group after installation. These ballasts transmit their individual, digitally encoded identification number to a controller, which then assigns them to a control group and communicates the group's dimming or on-off instructions. If the configuration of the space changes, ballasts can easily be reassigned to another group without rewiring.

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RESEARCH &
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Technology

Multilevel Lighting Control

Systems allow occupants or building control systems the ability to vary the amount of lighting in a space using multilevel switching to create different lighting schemes based on the task illumination requirements. Examples are: Conference rooms, auditoriums, classrooms and other multipurpose rooms where lighting needs may be at different levels for meetings, presentations, etc. Fluorescent fixtures with 3 lamps may contain 2 ballasts to control inboard and outboard lamps to vary the amount of illumination generated by the fixture. Occupants can operate fixtures at 3 levels – 1 lamp, 2 lamps or all 3 lamps. Other examples are multiple fixture types, such as in a conference or multimedia room where occupants may choose to operate perimeter lights, accent lights or task lights separately from ambient lighting for multiple levels of lighting.

Another area where multilevel lighting might be used is in warehouse areas that are frequently unoccupied or are illuminated by skylights. In this situation, lighting with multilevel (high/low) capability can be switched to low output based on input from an occupancy or daylight sensor. A consideration for multilevel HID is that in many cases, the lamp loses efficacy at reduced power – for example at the high setting a 400W MH is operating at 100% input wattage and 100% lamp lumens, but at 50% power the lamp lumens are at approximately 23-30%. An option to operate lamps at 50% light level is also available, but the energy savings are not as great (approx 30% energy reduction).

Estimated Energy Savings – kWh

Savings varies by application and user preferences. Classrooms can take advantage of available daylight and switch lighting rows next to windows off to achieve savings (approx. 20-30% at perimeter). Savings for HID bi-level can be estimated at approximately 24% compared to single level HID fixtures. These savings are likely optimistic compared to the universe of potential applications. Average savings is estimated at 15%. Based on 4200 burn hours per year savings should be about .9 kWh per square foot.

Summer Peak Savings

Assume peak demand impact is negligible.

Measure Life

12 years

Initial One-Time Cost

One time cost on new construction can be fairly minimal. Costs on retrofit will vary significantly with sophistication of the project. Assume \$1/square foot for lack of substantial detail.

Any Recurring Costs

Commissioning to ensure proper performance of sensors if used.

Suggested Incentive

Minimal incentive based on savings potential and applications. Assumed to be \$.05/square foot. Savings more reliable if multilevel lighting is part of a lighting automation or controlled daylighting strategy.

Requirements

Should be used with daylight or occupancy sensors to automate and maximize savings.

Existing Energy Standards

There are currently no Energy Star standards for this technology.

Source of Info

PG&E, LRC, manufacturer websites.

LBNL-44281
LG-215

The Usefulness of Bi-Level Switching

Original Technical Note: November, 1998
Revised: August, 1999

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November 1998

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We used the measured energy data for each of the 30 offices to compute the average number of hours a day that the occupants set their lights to 1/3, 2/3 and FULL light level. Only weekdays in which the offices were substantially occupied are included in the sample. The data for the seven month period between May and December, 1998 is presented in the figure below. Note that while most occupants use full lighting, four (13%) use mostly 2/3 lighting and seven (23%) use only 1/3. Thus the bi-level switches are used effectively (i.e., the occupant call for less-than-full lighting) by a significant number of occupants of this sample. Even those occupants who primarily use full lighting sometimes use only one switch for the entire day.

The inset pie chart shows the percentage of total lighting hours in this sample that the lighting was at the different light levels. 45% of the lighting hours were at less than full lighting with 28% using only 1/3 lighting.

Finally, we estimate the energy savings attributable to the use of bi-level switching for this office sample. The mean number of lighting hours per day is 9.1 hr/day. But there are only 6.9 hr/day of "full-equivalent" lighting because a significant fraction of the total lighting hours is at reduced level. This represents energy savings of 24%.

For more information, contact FMRubinstein@lbl.gov:

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This work was supported by the General Services Administration, Pacific Rim Region; the Pacific, Gas & Electric Co.; and the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs and Office of Federal Energy Management Programs of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

A THERMIE PROGRAMME ACTION



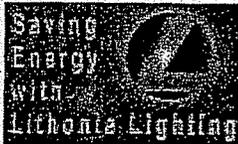
TECHNOLOGY SUMMARY LEAFLET

Energy Efficient Lighting in Industry



European Commission
Directorate-General for Energy (DG XVII)

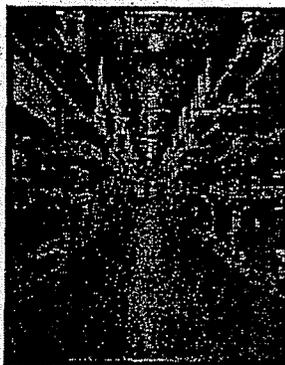
RUE



Multi-Level
H.I.D.
Lighting



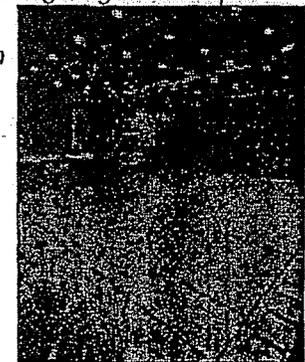
[Start Calculator](#)



Energy Savings for HID Lighting through a multi-level control system. With energy costs on the rise, there is a need for a better control of energy usage. Efficient, well-designed lighting systems offer a tremendous opportunity to reduce energy consumption while maintaining productivity. The *KiloWatch* system from Lithonia Lighting combines the high efficiencies and energy savings of High Intensity Discharge lighting with proven control technology, **allowing you to have light when you need it...and save energy when you don't.** *KiloWatch* systems can reduce lighting power cost by up to 40%.

Many environments are occupied only a portion of any given day. During the balance of the time, only minimum lighting levels are required for safety. In a typical **warehouse environment** (applications similar to picture on the left), loading docks and shipping/receiving have the highest activity, but are contained in a small percentage of the total square footage. The balance of the warehouse usually contains aisles with rack storage locations that may require occupancy only a couple of times a day. When there is no occupancy in the aisles, the lighting level should not be a concern; therefore, use of a sensor system with a 50% power reduction will maximize energy savings. When a worker enters the space, *KiloWatch* automatically switches the light level to full brightness, this level of illumination is only required possibly 20% of the time. Then when worker leaves the space, *KiloWatch* switches the light level to low, possibly 80% of the time. The energy-saving *KiloWatch* system allows you to maintain a minimum lighting level at reduced power consumption when areas are not in use, then gives almost instantaneous full lighting when required.

The expectations of a **high school gymnasium** (applications similar to picture on the right) are no longer just basketball, they are now multi-purpose facilities that include gymnastics, wrestling and even baseball practice during the off season. With the wide array of activities and more hours of operation, a multi-purpose system is excellent for this changing environment. Physical education classes or recreational basketball requires half the illumination that the varsity basketball team would need to practice or for game play. A traditional lighting system would be designed to the higher foot-candle requirement. This level of illumination is only required possibly 30% of the time. The use of the *KiloWatch* system allows the luminaire to be switched to a 50% lumen reduction and still maintain the proper lighting for other activities.



KiloWatch is the solution to providing proper lighting for the work environment while conserving energy and saving money.

The simple design of *KiloWatch* permits easy installation and many years of energy-efficient operation. A manually switched system places the control of light levels at your fingertips, while the second system utilizes sensing devices. Motion detectors, photocells and other devices are incorporated to control the light output automatically. Sensing devices allow for maximum energy savings.

- ▶ Typical **manual** applications include : general activity areas, institutional areas such as prisons, family life centers, general offices, schools/gymnasiums and manufacturing facilities. This system allows for high/low levels to be manually controlled from single or multiple pole switches. A control

component is used in conjunction with the system for lamp stabilization for a period of 15 minutes when initially energized daily.

- ▶ Typical sensor applications include : Warehouse aisle lighting, shipping docks, storage areas, refrigerated areas, parking garages, and airport baggage claim areas. This system incorporates the use of infrared sensors which automatically switch the lighting from low level to high level when motion is detected and back to low when there is no occupancy. This return to low delay function of infrared motion sensor can be field adjusted from 1 to 20 minutes. A time delay of 15 minutes is built into the sensor to allow for lamp stabilization at high when the system is initially energized daily.

Further information on the KiloWatch system and ordering information, see the [KW Guide](#). A great educational tool on ordering proper fixture and component nomenclature, plus details on manual and sensor systems with RELOC modular wiring systems.

Pulse Start systems are compatible with *KiloWatch*, it is recommended taking advantage of Pulse Start systems where applicable for greatest energy savings. Please see [Pulse Start Calculator](#) for further information. Pulse Start systems are designated in chart below **Wattage/Source** with a SCWA ballast.

Lithonia's *KiloWatch* dual-level system is designed around ease of installation, simplistic operation, and proven technology.

Regardless of control method used, manual switch or sensor, the luminaire electrical components are identical. Lithonia uses standard ballast, capacitors, and when required, ignitors. The control is accomplished by adding a second capacitor and switching it in or out of the circuit with a 120V or 277V AC control relay, installed in the luminaire. The control relay is part of the luminaire that is directly connected to the wall switch in a manual system or the control sensor system by a separate 120V or 277V AC control circuit.

In our continual efforts for energy savings product we have added an **integral sensor system** (specification sheet) designed to control a single HID fixture. The control is accomplished by adding a second capacitor and switching it in or out of the circuit with a solid state control relay, installed in the luminaire. There is a armored cable connected to the side of a pendent splice box on fixture that connects the relay to the sensor, which mounts to the reflector. No extra system wiring is needed for installation purposes. The integral sensor system will maximize the possible energy savings in a sensor application.

[For further information in regard to KiloWatch systems, such as specification sheets-click here](#)

Indoor HID Options and Accessories Application Guide.

This guide shows which applications each of our options and accessories are typically used in. (Word Document)



The **KiloWatch calculator** allows you to compare full power output versus a 50% power output for various lamps (a 50% lumen output version is also available). To fully appreciate the energy savings potential of the KiloWatch system, one must understand the energy consumption of a standard lighting system. Subtracting the energy consumption of the KiloWatch system from a standard system reveals the total energy savings using the KiloWatch multi-level lighting system. All inputted watts are based on the most recent published information from ballast manufacture. Up to date details specific to input wattage should be verified with ballast manufacture.

The [KiloWatch Calculator Excel \(Version '97\)](#) allows users to download program onto computer, moreover calculates simple payback on estimated initial capital cost.

Wattage/Source	Standard System Performance		50% Power Reduction at Low	
	Input Wattage	% Lamp Lumens	Input Wattage	% Lamp Performance
175 Metal Halide (CWA)	213	100%	115	35%
175 Metal Halide (SCWA)	220	100%	119	35%
250 Metal Halide (CWA)	295	100%	168	38%
250 Metal Halide (SCWA)	288	100%	164	38%
320 Metal Halide (SCWA)	370	100%	190	30%
350 Metal Halide (SCWA)	400	100%	212	35%
400 Metal Halide (CWA)	458	100%	231	23%
400 Metal Halide (SCWA)	455	100%	234	30%
450 Metal Halide (SCWA)	506	100%	275	30%
1000 Metal Halide (CWA)	1080	100%	542	28%
250 High Pressure Sodium (CWA)	295	100%	173	23%
400 High Pressure Sodium (CWA)	464	100%	198	22%
1000 High Pressure Sodium (CWA)	1100	100%	565	37%
Wattage/Source	Standard System Performance		50% Lumen Reduction at Low	
	Input Wattage	% Lamp Lumens	Input Wattage	% Lamp Performance
175 Metal Halide (CWA)	213	100%	158	50%
175 Metal Halide (SCWA)	220	100%	163	50%
250 Metal Halide (CWA)	295	100%	208	50%
250 Metal Halide (SCWA)	288	100%	203	50%
320 Metal Halide (SCWA)	370	100%	243	50%
350 Metal Halide (SCWA)	400	100%	255	50%
400 Metal Halide (CWA)	458	100%	322	50%
400 Metal Halide (SCWA)	455	100%	312	50%
450 Metal Halide (SCWA)	506	100%	329	50%
1000 Metal Halide (CWA)	1080	100%	705	50%
250 High Pressure Sodium (CWA)	295	100%	188	50%
400 High Pressure Sodium (CWA)	464	100%	350	50%
1000 High Pressure Sodium (CWA)	1100	100%	680	50%

Start Calculator



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CODE CHANGE PROPOSAL
Bi-Level Lighting Control Credits
 JUNE 27, 2002

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Overview

Description

This code and standards enhancement initiative will encourage the use of occupancy sensors, timers and specialized switching strategies in conjunction with bi-level lighting controls in intermittently occupied areas, such as hotels and motel corridors, warehouse and library stack areas and small office areas. We are proposing to introduce these new applications as control credits. The credits take the form of a Power Adjustment Factor, Power Adjustment Factors are energy neutral – they are simply a way of encouraging application of a new technology.

The three space types identified as eligible for PAFs are corridors, library and warehouse stack areas and small office spaces.

Corridors are typically lit at 100% levels for 24 hours per day. This credit would provide encouragement to reduce light levels by 50% when the space is unoccupied.

Lighting in library and warehouse stack areas is typically on during normal operating hours. Yet these spaces are largely unoccupied and would benefit from reduced lighting levels during unoccupied times.

Small offices have bi-level switching and in some cases will have occupancy sensors but may not be capturing maximum energy savings. This credit would allow an automatic ON function based upon occupancy sensing for the first 50% or less of the lights. The occupant would activate the remaining 50% or more of the lights manually. The OFF function would be automatic. Manual off will also be available, to turn the lights off manually. Alternatively, the users may choose to use a Manual ON approach for the first level of light, wherein the switch would require the occupant to turn on the lights at 50% or less level. These controls would serve to encourage lighting at the 50% level to be the default condition for a space.

Environmental Impact

There are no adverse environmental impacts identified.

Type of Change

Requirement	This change would modify Power Adjustment Factors shown in section 146 Table 1-L.
Compliance Option	The revised Table 1-L would provide an additional compliance credit for those using the prescriptive area category method, tailored method or the performance method.
Modeling	The performance method would need to accommodate the PAFs.

Relationship to Other Measures

This measure has no significant interactions with other measures, except to allow a slight increase in installed lighting power density, and would need to be coordinated with the proposed changes to other requirements for lighting control devices, such as the multi-level lighting description and the proposed credit for dimmable fluorescent ballast and controls.

Methodology

This section describes the methodology followed in developing the proposed PAFs.

Space Type Screening

First, space type candidates were identified. Targets included all intermittently-occupied spaces where lights are normally on 24 hours per day, spaces where occupancy is very infrequent, and where lights are controlled in large banks due to space use. Candidates included corridors, storage areas, stairways, warehouse spaces, parking garages, and library stacks. Parking garages and exterior of hotel/motels were eliminated from consideration because these spaces are being addressed in the proposed outdoor lighting standards.

Private offices were given consideration for a special type of control because, although automatic shut-off and bi-level control is currently required, providing a switching incentive for the occupant to use no lights or 50% or less of level control has a large energy savings potential. In addition, the presence of an occupancy sensor guarantees savings when the space is unoccupied, even during normal business hours. The manual ON or bi-level automatic ON feature prevents the automatic activation of 100% light levels.

Second, an equation was created to answer the following question: How many hours of "normally on" operation would have to be curtailed by the control in order to make the device cost effective to install? In cases where the hours were substantial, the space was dropped from consideration. Stairwells were dropped from consideration for this reason.

Although no cost-effectiveness analysis is required because the proposal is for a control credit, this simple screening was done so that only appropriate spaces would be included in the proposed code language.

Power Adjustment Factor Quantification

The proposed Power Adjustment Factors were created by estimating percentage of time the space would be unoccupied (and therefore automatically controlled), or that the space is occupied and the occupant chooses lower light levels and applying that percentage to the percentage of light controlled per luminaire. The resulting fraction represents the savings potential.

Results

The results revealed that the following space types are worthy of a PAF: interior corridors in hotels, motels and high-rise residential occupancies, library and warehouse 'stack areas' and small private offices. The space types and necessary shut-off hours are shown below. Necessary shut-off hours means the number of hours per day during which the control must shut off the lights, in order for the control to be cost effective according to CBC economic criteria.

Space type screening results

Space Type	Shut off Hours Necessary	Should space be considered for PAF credit?
Corridors	4 - 6 hours per day	YES
Library Stacks/ Warehouse Stacks	3 - 5 hours per day	YES
Stairwells	15-22 hours per day	NO
Small Offices	3 - 4 hours per day	YES

Power Adjustment Factor Calculation

The Power Adjustment Factor calculations are shown for the individual spaces in the recommendations section.

Recommendations

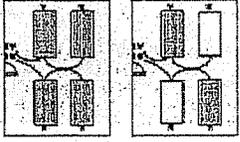
Provide a credit in the form of a Power Adjustment Factor for the following space types:

Small offices (<250 sq. ft) and Classrooms

Recommendation: Provide a 20% Power Adjustment Factor for an occupancy sensor with bi-level "manual ON" functionality or a bi-level automatic ON functionality. The normal condition of this occupancy sensor would be no light. The switch must require separate actions in order to provide 100% light.

Rationale: This provides three distinct advantages: 1) The occupancy sensing function captures more energy savings in small rooms than large sweep automatic shut-off controls do 2) the bi-level capabilities of the switch encourage 50% lighting by discouraging the behavior whereby occupants automatically flip both toggle switches up when entering the room, and 3) for those who currently use bi-level capabilities in their existing switching pattern, the manual ON or the automatic ON functions preserve this light, whereas a standard occupancy sensor may not.

Figure 2 Switching Sequence



Studies show that lighting is a matter of personal preference and when given options, people will often decrease light levels or work with their lights off when provided with good indirect light or adequate daylight. In spaces with this type of control, the occupant would still have three light levels to choose from, but rather than have a readily accessible switch or an occupancy sensor that would allow the occupant to default to 100% light, achieving the 100% light level would require a separate action. The images in Figure 2 show one of the control strategies for the recommended sensor. The first level of control ("A" fixtures or

Interior Corridors of Hotels, Motels and High Rise Residential

Recommendation: Provide a 25% Power Adjustment Factor for automatic bi-level switching in these locations

Rationale: In these spaces, currently exempt from bi-level switching and night-wire requirements, there is a significant portion of time where the space is unoccupied. With the recommended control when the space is occupied, full lighting is available. When the space is unoccupied, no more than 50% of the lighting is available. There are two measures of safety to preserve egress. First, there is never a circumstance where the corridor is not lit. In the event the control fails, it will fail ON. The proposed definition of multi-level lighting requires that lighting reduction be uniform. Second, the sensors will trigger full power to the system when the space is occupied.

Basis for the Credit: Our research revealed that any given corridor may be unoccupied for at least 75% of the time. During the day the corridor was assumed to be unoccupied for 25% of the time. The table below shows expected occupancy patterns and the savings fraction. The savings fraction is 1 because only the luminaires controlled are eligible for the PAF. These savings assumptions are based on the alternate luminaire type of switching. If alternate lamp switching is used, then the PAF would apply to all luminaires and therefore the savings fraction would be 50%. We accommodate this difference by first determining what the PAF would be based on luminaire switching, then note in the code that when alternate lamp or dimming is used, the PAF would be reduced by 50%.

For corridor and stack areas, the recommended PAF is 50% of the potential savings. This is recommended for three reasons: 1) Occupancy rates vary widely in these types of spaces 2) A 25% Power Adjustment Factor is sufficient to provide incentive for the desired change, 3) reducing the PAF with respect to the potential savings it may provide yields a further measure of security against the possibility of increased energy use building wide.

PAF Calculation for Corridors

Day	Occupied	75%	0.40	0.00	Fraction	Savings	Weighted
Occupied	0.00	0.75	0.10	0.00	0.40	0.30	0.12
Unoccupied	0.10	0.25	0.10	0.00	1.00	0.10	0.10
Night							
Occupied	0.00	0.75	0.40	0.00	1.00	0.40	0.40
Unoccupied	0.10	0.25	0.40	0.00	1.00	0.40	0.40
Potential Savings per watt controlled							0.50
Recommended PAF							0.25

Table 4 Savings Fraction and PAF Calculation for Corridors

Recommendation: Provide a 25% Power Adjustment Factor for library spaces that utilize any type of occupancy sensor or timer that sensor controls two or fewer rows of stacks. Provide a 15% Power Adjustment Factor for warehouse aisles that utilize any type of occupancy sensor or timer when that sensor controls two or fewer rows of stacks.

Rationale: In these spaces, providing a more flexible automatic switching scheme could save energy. Rather than sweep off entire spaces, smaller areas could benefit from the installation of an occupancy sensor or a timer. Either a 50% reduction or a 100% reduction would qualify the space for the credit.

Commercial and Industrial Storage, Library Stacks

PAF Calculation for Stacks

Occupied	0.50	0.50	0.00	Fraction	Savings	Weighting
Unoccupied	0.50	0.50	0.00	1.00	0.50	0.50
Potential Savings per watt controlled						0.50
Recommended PAF						0.25

Table 5 Savings Fraction and PAF Calculation for Stacks

Basis for the credit: An assumption was made that during normal hours of operation, stacks in libraries are only occupied 50% of the time. In warehouse aisles, it is assumed that they are occupied 70% of the time. The recommended PAF's provide a credit for the luminaires under control, not for the entire space. The potential savings fraction is 1, therefore, because savings are calculated using the alternate luminaire strategy for control.

PAF Calculation for Warehouse Spaces

Occupied	0.70	0.00	0.30	Fraction	Savings	Weighting
Unoccupied	0.30	0.00	1.00	0.30	0.30	0.30
Potential Savings per watt controlled						0.30
Recommended PAF						0.15

Table 6 Savings Fraction and PAF Calculation for Warehouse Spaces



Lighting controls: a new technology?

Gallina, Carla

Electrical Construction & Maintenance, Jul 1, 1995

Besides new lighting control products entering the marketplace, marketing efforts by these product manufacturers are on the rise.

After we squeeze every watt out of lamps, ballasts, luminaries, and light levels, where else can energy savings be found? The answer is literally at our finger tips: turn the lights OFF. With all of the development and attention paid to reducing energy in lighting systems, the fact still remains that turning lights OFF is the most cost effective means of capital savings and energy conservation available. However, doing so requires human activity that, like a weatherman, is not always reliable.

Switching strategies

OK, so what are these lighting controls that are going to save owners energy dollars? Let's take a look at the most simple: the snap switch. Snap switches (single pole, 3-way, and 4-way) can be used individually to switch all of the lamps in a room, or they can be used in tandem to provide multi-level switching control. Dual control lighting, designed in one of two ways, provides the opportunity to reduce light levels and subsequently lighting energy loads in a space when full light output of the lighting system is not required.

Zone switching Zone switching allows control of luminaires in front room-back room, side-by-side, or special task configurations. The advantage of zone switching is most apparent in large spaces such as multitask labs, open offices, multi-congregational sanctuaries, and multipurpose gymnasiums where lighting can be switched off in the zones where tasks are not performed. The disadvantage of zone switching is that it limits movement. Tasks cannot occur in more than one zone sequentially without switching lights as an individual moves from one task zone to the next.

Split switching Split switching or ~~board on board~~ switching is used in place of zone switching to provide ~~three levels of even illumination~~ where three lamp fluorescent luminaries are used. The advantage of split switching is that light levels can be reduced while still maintaining even lighting throughout the room. Three levels of light (one lamp on, two lamps on, or all three lamps on) provide considerable flexibility for daylight spaces or for spaces with tasks that require several different light levels but do not require full range dimming.

Split switching can also be incorporated into 2- and 4-lamp luminaire configurations. However, only two light levels can be achieved from these applications. In 4-lamp luminaries, the options are two lamps ON, or four lamps ON. Technically, you could switch all four lamps individually, providing four light levels if that degree of flexibility is justified. However, ballasting and balancing the light output may make this an undesirable choice. It may seem obvious, but it's important to note that 2-or 4-lamp split switching can reduce the energy consumed by half when full light output is not required.

Compact fluorescent downlights have become a major player for 2-lamp switching schemes. While 2-lamp electronic dimming ballasts for compact fluorescent lamps are becoming increasingly available and in popular use, 2-lamp switching of downlights provides a cost effective alternative to dimming, where full range dimming is not required.

In our designs, we use split switching almost exclusively in classrooms and offices where multiple levels of lighting are typically required. We also use split switching in healthcare facilities with overnight patient rooms. Corridors with high daytime light levels can typically be reduced by half for night time use. Sleeping patients and reduced caregiver activity make this a good energy saving alternative with a very low initial cost. (See advanced lighting control strategies on page 57.)

Dimming controls

The second most simplistic method of lighting control and energy savings is to turn the lights down. Control technologies are currently available to dim incandescent and discharge lamps. While dimming is a very common practice for incandescent control, fluorescent dimming is beginning to be pursued seriously by several fluorescent ballast and control manufacturers. You should note that while energy can be saved in dimming systems, the energy saved by dimming incandescent lamps or discharge lamps is not proportional (below 40%) to light level reductions; more light will be lost than energy saved. In other words, the lumens-per-watt ratio (efficacy) of the system decreases as the energy consumption via dimming decreases, but not at the same rate. (See [ILLUSTRATION FOR FIGURE 1 OMITTED] on page 57 and [ILLUSTRATION FOR FIGURE 2 OMITTED].) In addition to system efficacy, the cost effectiveness (i.e. energy saved per dollar spent for dimming discharge lamps) should be scrutinized carefully where energy saving is the primary requirement for the space. Where full range dimming is required, the cost of dimming discharge lamps versus the cost of dimming incandescent lamps versus meeting energy requirements is left to the professional judgment of the lighting specifier. In an increasing number of cases, the choice is very difficult and should be evaluated very carefully.

Incandescent dimming. In spaces where incandescent lighting is appropriate, so are dimming controls. Incandescent dimming, as simple as it is, is not without its technological changes. Early dimming controls were variable resistors that, from an energy point of view, wasted as much energy as they saved. Autotransformer (magnetic core and coil) dimmers replaced resistor technology by reducing voltage to the lamp, thereby reducing the total energy required for operation. Solid state dimming, typically found in today's applications, uses transistors or thyristors as switching elements to control the power input to the lamp. Solid state dimming comes in many packages, from single pole dimmer switches to larger multiscene preset controls.

While incandescent lighting in spaces is severely limited by most energy codes, applications for its use still exist. The primary, large-scale use of incandescent lighting is in performance and theological spaces where changing light levels and limited audible noise is essential. Consider religious sanctuaries, as an example. Often, they contain large voluminous spaces with ceilings at 30 ft or more above a finished floor. Here, dimming controls are essential to the basic requirements of the space.

Energy codes aside, we typically design sanctuaries for 20% more light than recommended. The reason is simple: the dimming systems (in most cases multiscene presets) are essential to the function of the space and, therefore, will be specified with or without a high illuminance lighting design. By over designing the light level, a 10% energy/dimming high-end cutoff can be programmed into the control system. The high-end cutoff will not allow light levels to be switched higher than 90% of full lumen output and can not be altered except by the facility lighting control manager. The 10% energy reduction will reduce light level by 20% but increase lamp life by 300%. That means that the life of a quartz

lamp, rated for 2000 hrs, will be extended to an average of 6000 hrs, which is significant for a space that operates an average of 15 hrs per week and where relatively expensive lamps are difficult to replace.

The dimming of discharge (fluorescent and high intensity discharge or HID) lamps is more complex than dimming incandescent lamps. However, dimming controls for discharge lamps, and fluorescent lamps in particular, have been available for quite some time. The dimming of discharge lamps requires dimming ballasts working in conjunction with dimming controls.

Fluorescent lamp dimming. In the case of compact fluorescents, even the lamps must be specified (four-pin instead of two-pin) specifically to work with the dimming system.

The fluorescent lamp is a negative-resistive load that requires a ballast to control the electrical input for starting and maintaining operation. Dimming controls designed to reduce voltage input, as in the case of incandescent dimming, will extinguish the arc in addition to reducing lamp life.

Fluorescent lamps can be dimmed from controls designed for standard magnetic ballasts, magnetic dimming ballasts, and electronic dimming ballasts. Like a low voltage incandescent lighting system, a fluorescent dimming control must be matched to the technology for which it is specified. Standard magnetic fluorescent dimmers provide full range dimming to 40% of rated lumen output.

Magnetic dimming ballasts, available for only 30W and 40W lamps, can provide full range dimming to 10% of rated lumen output.

Electronic ballasts for dimming compact fluorescent lamps can provide full range dimming to 5% of rated lumen output.

Electronic dimming ballasts for long fluorescent lamps can provide full range dimming to 1% of rated lumen output. To date, only one manufacturer of long fluorescent dimming ballasts and controls offers reliable full range dimming to 1% of rated lumen output. Several new manufacturers of fluorescent dimming ballasts and controls have recently entered the market, and several more are expected to be on the market by year end.

Fluorescent dimming to date is not a low cost specification item; it's not for every space and it's certainly not for every budget. As noted above, only one low wattage electronic ballast has proven its reliability in the market. Few would argue that the technology, reliability, and manufacturer's support is worth the price if fluorescent lighting and dimming is appropriate for the space. Unlike incandescent dimming, where the controls and luminaries are so inexpensive that over designing the light levels can justify dimming both in energy savings and in maintenance, the initial and long term costs of fluorescent dimming must be carefully evaluated. Spaces where we have found justification for full range fluorescent dimming are in medical exam rooms, conference rooms, and in daylight spaces where lumen maintenance and photocell controls are likely to be employed.

HID lamp dimming. While HID dimming controls are currently on the market, the technology is still developing and the cost effectiveness of full range dimming remains questionable. HID dimming and control systems must compensate for lamp sensitivities such as warm up time, color shift, and lumen degradation, which are standard operating issues. Because of warmup time, HID lamps are slow to respond to dimming. Lag time from low illuminance to high illuminance can take as long as 10 min. Instantaneous response can be attained by some dimming controls, but in a very limited illuminance range.

The color shift of HID lamps varies between lamp types. Low wattage, clear metal-halide (M-H) lamps can begin a color shift to blue-green in the range of 80% of full lumen output. High wattage, clear, M-H lamps will begin to shift at about 60%. High pressure sodium (HPS) will begin a significant monochromatic shift to yellow at about 50% of rated lumen output. Indeed, lamp manufacturers may void the lamp warranty if the dimming and control system specified is known to threaten lamp life and/or induce unrecoverable color shifts.

Multilevel switching, often referred to as "Hi/Lo," is another form of energy and illuminance control for HID lamps. Typical systems will operate HID lamps at full light output and energy consumption and at a reduced light output and energy consumption. The primary advantage to this type of system lies in low traffic spaces where occupancy sensors can switch lights to low to conserve energy when the space is unoccupied, and switch them to high when a person arrives. Bi-level systems are also appropriate for atriums, where photocells can be used to reduce the light level when a significant lighting contribution from daylight is present. We have used bi-level switching in multiuse high school gymnasiums to meet energy codes and maintain high illuminance levels for competition basketball.

The most recent development by one of the oldest manufacturers of multilevel ballasts and controls is a tri-level switching system.

Multilevel lighting controls suffer the same problems as full range dimming: Lamps switch from high to low instantaneously, but switch back only to about 85% of full lumen output instantaneously. Also, in a multilevel lighting system, lamps must always be started in the high mode; only after the lamps are warmed up to full lumen output can they be switched to low. The lamp takes between 5 and 10 min to warm-up to full bright.

Most manufacturers limit noticeable color shift by designing multilevel systems that do not allow the low setting to be below the color shift point of the particular HID lamp. As with dimming ballasts and controls, lamp manufacturers may void warranties on products that threaten lamp life and color.

Low voltage lighting

Low voltage lighting specifications for accent lighting are increasing due to the relatively low input watts and high lumen output of the low voltage source (for example, a 50W halogen lamp rated for 950 lumens versus a common 50W A19 incandescent lamp rated for 750 lumens).

Low voltage lighting systems require low voltage dimmers and care must be taken to specify like systems. There are two types of low voltage transformers and, as a result, there are two types of low voltage dimmers. A magnetic low voltage transformer is an inductive load; it requires a dimmer that sees an inductive load. An electronic low voltage transformer is a capacitive load; it requires a dimmer that will see a capacitive load.

While line voltage lamps can be added to either system, the line voltage lamp, which is a resistive load, must be placed ahead of either the magnetic or the electronic transformer in the system.

Intermediate control technologies

Intermediate lighting controls include systems that incorporate timers or sensors to switch or dim lamps without human action. These controls include time clock controls, occupancy sensors, and daylight sensors. They can be used separately or in tandem in a space. Consider, for example, an office with significant daylight and a mobile occupancy. Occupancy sensors and daylight sensors can be combined

to switch the lights OFF if the daylight illuminance level exceeds a preset illuminance level. The remaining lights can be switched OFF or ON by the occupancy sensor as people move through the space. A time clock could also be added to this scene by switching OFF the power supply to the room at a prescribed time. The primary disadvantage of this type of multisensor control is loss of control by the occupants; however, this can be resolved with advanced controls.

Photocells and timers

Including photocells and timers in a lighting design is an inexpensive way to ensure that lights are turned OFF when they are not required. Timers can be used to switch the lights OFF over a full floor or in an entire building before or after daily occupancy. Photocells will switch lights OFF if the daylight component of the interior lighting is great enough and switch lights ON when the daylight subsides.

Photocells. The types of spaces most often designed with photocell controls are atriums and sun rooms. However, any space with concentrated daylight present throughout the day is a candidate. Consider, for example, an office with predominantly east facing glazing. This space may not require electric lighting during the morning hours, but may require electric light in the late afternoon.

Lumen maintenance system. Photocell technology combined with dimming technology provides owners with an advanced lumen maintenance system, resulting in cost savings from reduced energy and maintenance.

What's a lumen maintenance system? It's basically a system that takes into account the natural lumen depreciation of a lamp, fluorescent lamps in particular. For example, if you assume a 30% loss due to lamp lumen depreciation, you can design a control system to account for this eventual loss. The initial lumen output of the lamp will be reduced by 30% and energy will increase during the life of the lamp to consistently maintain the 30% light loss. However, full energy will be consumed only at the end of lamp life, when the lamp has reached its rated lumen depreciation. Therefore, a significant amount of energy will be saved through out the life of the lamp, without a change in the light levels designed for the space.

Occupancy sensors

There are three kinds of occupancy sensors available: infrared, ultrasonic, and infrared/ultrasonic. They may be wall or ceiling mounted as individual units, or they can be specified as integral to a lighting switch. They are readily available from a variety of sources.

Occupancy sensors are notorious for switching lights OFF when rooms are occupied and switching lights ON from motion that is extraneous to the room or occupancy.

Sensors have varying range capabilities, in addition to sensing sensitivities. You should take care to select the right product for any given space. You also should be careful to select the right application for occupancy sensors. In spaces where fluorescent lamps are switched OFF and ON frequently, lamp life may be significantly reduced. (Remember, lamp life is rated at 3-hr starts.) While the lamp will gain usable life because it's switched OFF, you must decide if the OFF time will compensate for the reduced rated lamp life.

Occupancy sensors are best for small, infrequently used spaces such as rest rooms, conference rooms, storage rooms, copy rooms, and private offices.

A recent development in occupancy sensors is a personal occupancy sensor. This device (by one manufacturer) provides a 15A power strip containing six receptacles. Four of the receptacles are tied to a small personal motion sensing device. When the sensor does not detect motion for a preset period of time, the four receptacles shut down power until occupancy or motion is detected once again. Task lights, radios, or video display terminals can be connected to the sensed receptacles while computers and clocks can be connected to the unsensed receptacles.

Advanced lighting controls

The most advanced control systems used today combine the technologies already discussed with microprocessors and low voltage relays to create some very powerful lighting controls.

The original low voltage systems started with momentary contact switches that controlled relays. By adding motor masters to control whole banks of relays, an entire floor of lighting could be switched OFF.

Now, an advanced lighting control can control each relay separately. The more relays employed in the system, the more control you have.

Advanced lighting control systems typically contain internal timeclock functions and can take input from occupancy sensors, interior and exterior daylight sensors, and momentary contact switches. The newest products will also take input from dimmers, which can control line voltage and low voltage incandescent lamps, fluorescent lamps, and hi/lo switching HID's. The dimming and control adds a very powerful dimension to advanced lighting control systems by replacing numerous components and independent systems with one advanced control system.

While the concept of lighting controls is not new, the controls themselves are the next logical place to look for developments in energy conservation. In addition to new lighting control products entering the market place, marketing efforts by lighting control manufacturers are on the rise. However, the new wave of control sophistication is not without drawbacks. Ballast and lamp manufacturers are faced with the task of once again taking a closer look at technologies that can operate effectively with switching, dimming, and other energy reducing controls for discharge lamps used today.

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Advances in Technologies to be aware of:

Throughout the C/I Technology Assessment process for Cinergy the group that Morgan Marketing Partners put together has discussed a variety of new technologies. We wanted to share a bit more detail on some of these technologies as you look toward future program changes and offerings.

Electronic ballasts for High wattage Metal Halide (320W PSMH, 350W PSMH and 400W):

Benefits include:

- Lower ballast losses compared to magnetic. (ex. 400W Mag bal 60W loss, 320W PSMH elect bal 20W loss) improves overall energy savings.
- Better lumen maintenance – even in PSMH (13-15%) need to be replaced less often, better maintained light level means less fixtures needed to maintain light levels.
- Dimmable down to 50% power/25% light output, multilevel capability
- Eliminates ballast noise

T-8 Technologies

“Super” and “Premium” T8s are the new buzz words floating around the Northwest. What exactly are these T8s? The basic definition is 3100 or higher initial lumens and 2915 or greater mean lumens with a Color Rendering Index (CRI) of at least 85 and a rated life of 20,000 hours or greater.

GE-Starcoat HL, Osram/Sylvania-Octron 800 XPS and Philips-Advantage T8 are the lamps from the major manufacturers that comply. As a quick comparison the 70 series lamps produce around 84.5 mean lumens per watt, the 80 series lamps produce around 87.5 mean lumens per watt and the super/premium lamps produce around 92 mean lumens per watt. This is a 9% increase in light output with the same wattage. The purpose of using these lamps is to produce the most light per lamp with the least lumen depreciation.

Some energy conservation organizations, such as the Energy Trust of Oregon (www.energytrust.org), offer greater monetary incentives for using the Super/Premium T8 systems over standard lamps.

Energy-Saving T8 lamps are designed to provide similar lighting performance to the full-wattage lamp, but using a watt or two less energy per lamp. GE-Watt Miser Ultra, Osram/Sylvania Supersaver and Philips Energy Advantage lamps use 28W-30W to produce approximately 2900 lumens. Some of these lamps are intended exclusively for use on instant-start ballasts and have less than 20,000 hours of rated life.

Long-Life T8 lamps are engineered to lower relamping costs by extending the rated burn hours beyond the typical 20,000 hour level. Also, some new lamps are designed to



provide 20,000 hours of life whether the ballast is rapid start or instant start. Many longer-life lamps are rated at 24,000 hours, and some are rated as high as 30,000 hours.

When you see a linear fluorescent lamp rated at higher burn hours make sure the rating is based on a standard 3 hour operation cycle. Some less reputable lamp manufacturers claim long life ratings, but base those claims on 10-, 12- or 24 hour burning cycles. The industry standard for testing fluorescent lamp life uses a 3 hour operation cycle.

Dimmable Ballast

Dimmable ballasts have been available for linear fluorescent and compact fluorescent lamps for several years and are beginning to drop in price substantially. Screw in fluorescent lamps can typically be dimmed to 10%, and CFL & linear fluorescent ballasts will allow dimming to 5% (Lutron advertises 1% for CFL ballasts). Controls for individual occupants to control the lighting in their space via remote control are readily available, but can be costly to install. Dimmable ballasts may still be as much as twice the price of standard ballasts, but offer considerably more flexibility in design. Daylighting controls and building management systems can be designed to take full advantage of dimming capability to provide load shedding that may go virtually unnoticed, unlike stepped dimming.

Development of Electronic HID ballasts has led to the ability to control exterior and interior lighting in response to available daylight and occupancy. Holophane's Prismatron is advertised as having the capability of constant dimming to 25% light output at 50% power (without step dimming or time delay at various levels).

Dimmable controls for LED are now emerging as more LED luminaires are developed and new uses are discovered.

Use of LED strip & channel lights in place of neon

A variety of strip and tube style LED lamps that are designed to replace neon light sources in channel letters and decorative strip lighting with possible savings of 60-90% are now available. Because of the monochromatic nature of LED light and the fact that all lumens emerge at the front of the sign or channel (rather than 360 degrees as in neon), there is very little wasted light – so by specifying the exact color of the strip, tube or channel all light produced is transmitted. Rated life is up to 100,000 hours (red) and LED's operate efficiently at cold or hot temperatures (below 212 F). Another benefit to LED strip lighting is durability, Neon is very customized and must be fabricated locally. Many LED strip products can be pre-fabricated and shipped or be cut to fit on site.

- Applications include
 - Retrofit of existing signs as well as new signs
 - Decorative accent strip lighting – Indoor and Outdoor

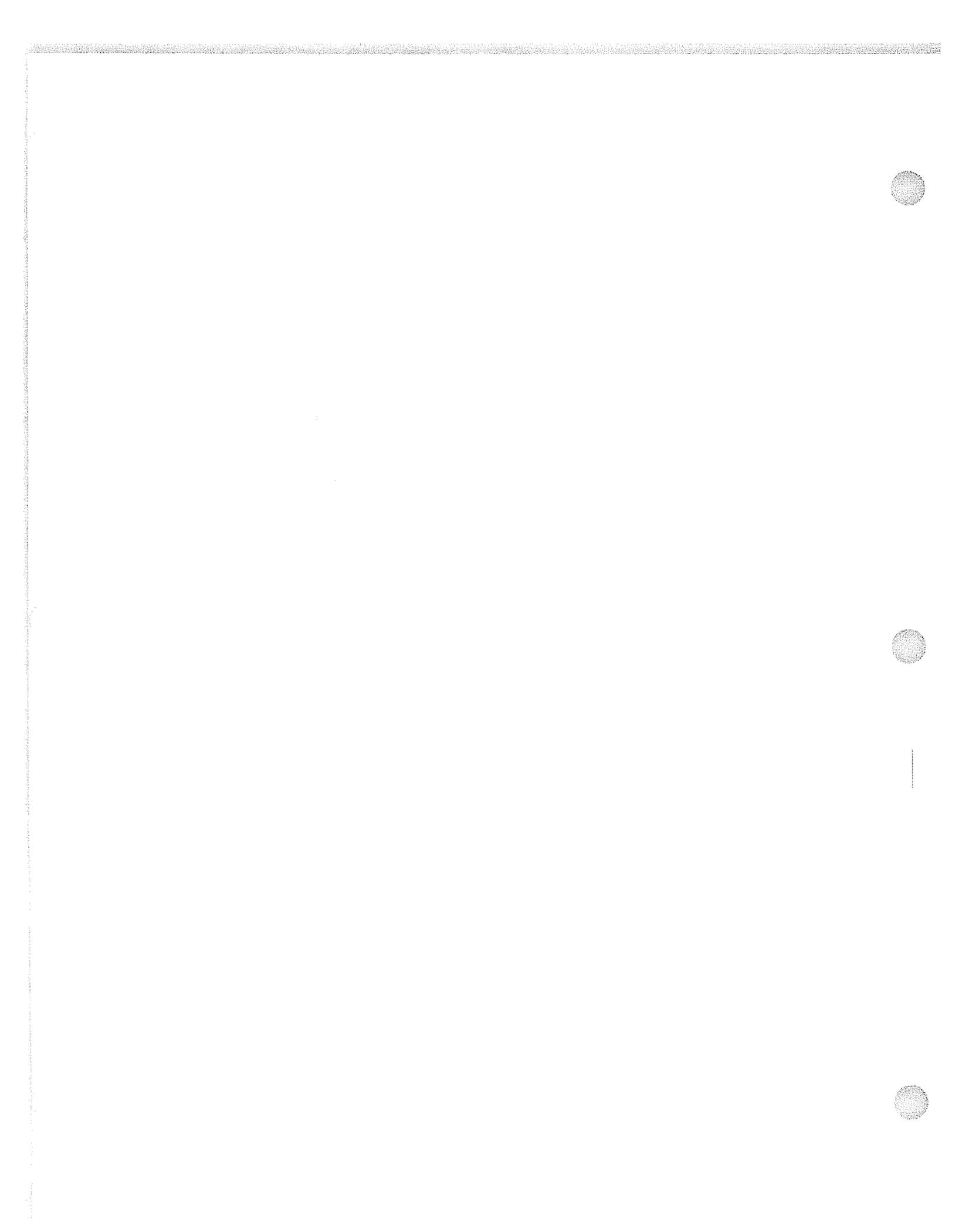


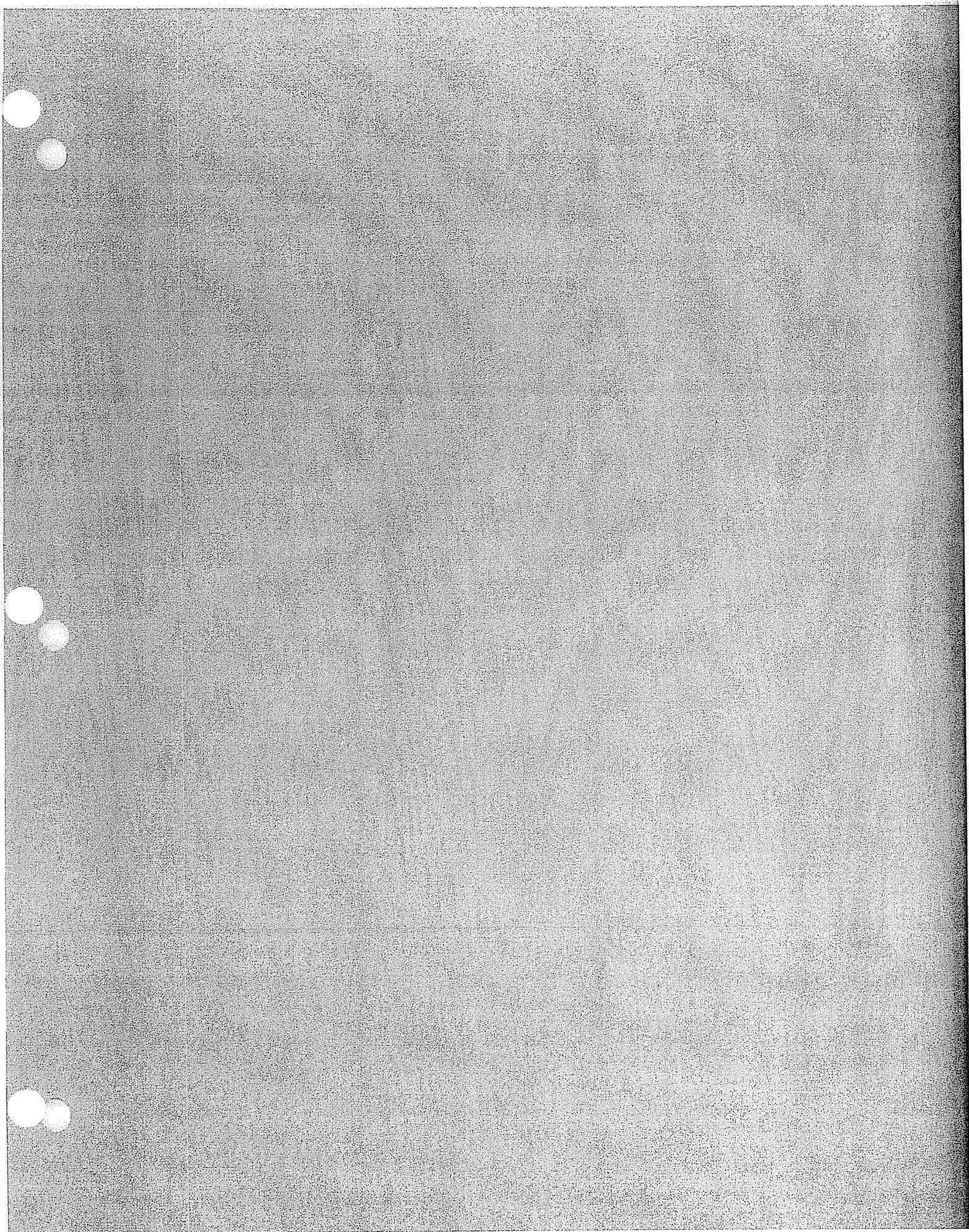
Electroluminescent Lighting

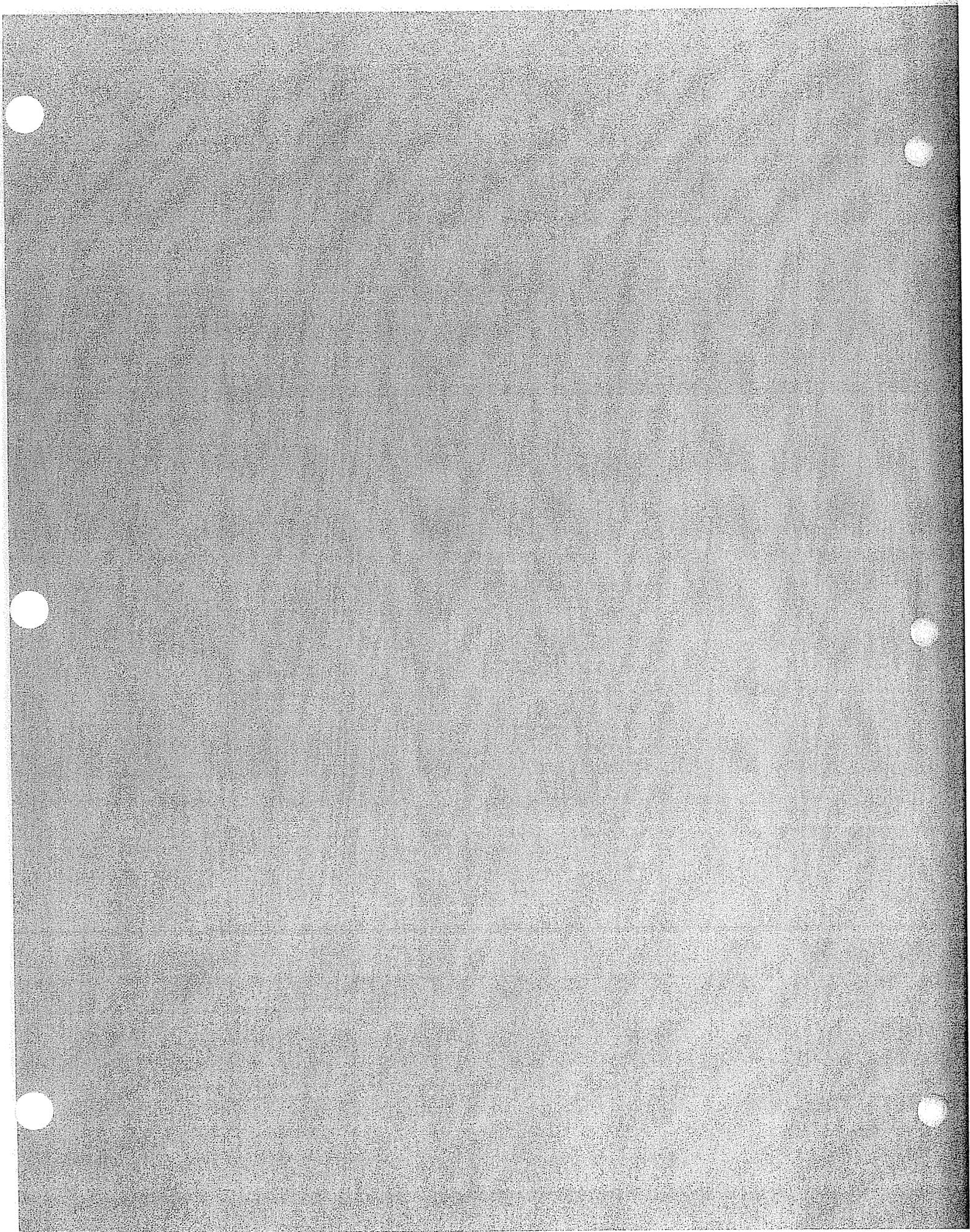
This is actually an old technology, where light is produced, with very little heat, by current passing through the material. It has been revived recently as new polymers and other materials have developed to make it more cost effective than in the past. The overall cost effectiveness may still be questionable.

Products such as light "wire" are concentrated in the automotive and novelty arena and show some promise as accent lighting in commercial spaces, specifically hospitality and restaurant applications to replace neon. Available in ribbon or wire configurations in a variety of bright colors.

Flat Panel "Sheet" products are also being used in automotive, specifically for dashboard lighting, and are also available in panel type configuration for use in back lighting signage. This may also prove useful in medical applications for back lighting equipment display panels and radiology films. Sylvania has a product called Planon that is marketed to industrial and medical end uses for display applications. Lifetime is similar to LED, roughly 100,000 hours, but indications are that it is not evolving as quickly as LED and is more expensive to produce products that have similar applications.









**Energy Efficiency and Renewable Energy
Federal Energy Management Program**

Federal Supply Sources:

- Defense Logistics Agency (DLA)
Phone: (800) DLA-BULB
dscp103.dscp.dla.mil/gi/general/light1.htm
- General Services Administration (GSA)
Phone: (817) 978-8640
www.fss.gsa.gov

For More Information:

- DOE's Federal Energy Management Program (FEMP) Help Desk and World Wide Web site have up-to-date information on energy-efficient federal procurement, including the latest versions of these recommendations.
Phone: (800) 363-3732
www.eren.doe.gov/femp/procurement
- FEMP's *Federal Lighting Guide* and other resources provide helpful guidance on lighting projects.
Phone: (800) 363-3732
www.eren.doe.gov/femp/resources/lighting.html
- National Electrical Manufacturers Association (NEMA) publishes Standards Publication LE-5B, *Procedure for Determining Luminaire Efficacy Ratings for High Intensity Discharge Industrial Luminaires*, as well as other information on industrial lighting.
Phone: (800) 854-7179
www.nema.org
- Green Seal's July, 2000 "Choose Green Report" provides valuable information on selecting HID luminaires.
Phone: (202) 872-6400
www.greenseal.org
- Illuminating Engineering Society of North America (IESNA) publishes guidelines and other information on industrial lighting.
Phone: (212) 248-5000
www.iesna.org
- Lawrence Berkeley National Laboratory provided supporting analysis for this recommendation.
Phone: (202) 646-7950

How to Buy Energy-Efficient Industrial HID Luminaires

Why Agencies Should Buy Efficient Products

- Executive Order 13123 and FAR section 23.704 direct agencies to purchase products in the upper 25% of energy efficiency, including all models that qualify for the EPA/DOE ENERGY STAR® product labeling program.
- Agencies that use these guidelines to buy efficient products can realize substantial operating cost savings and help prevent pollution.
- As the world's largest consumer, the federal government can help "pull" the entire U.S. market towards greater energy efficiency, while saving taxpayer dollars.

Efficiency Recommendations

Upward Efficiency ^a	Lamp Wattage	Closed Fixture (HC) LER ^b		Open Fixture (HO) LER ^b	
		Recommended	Best Available	Recommended	Best Available
Metal Halide Lamps					
0%	150 - 399	41 or higher	64	(insuff. data)	63
	400 - 999	53 or higher	67	59 or higher	69
	≥ 1000	77 or higher	83	(insuff. data)	110
1% - 10%	150 - 399	56 or higher	70	(insuff. data)	53
	400 - 999	62 or higher	67	64 or higher	70
	≥ 1000	(insuff. data)	99	88 or higher	108
11% - 20%	150 - 399	57 or higher	69	(insuff. data)	67
	400 - 999	65 or higher	73	69 or higher	75
	≥ 1000	(insuff. data)	87	(insuff. data)	118
> 20%	150 - 399	62 or higher	73	77 or higher	90
	400 - 999	65 or higher	74	(insuff. data)	75
	≥ 1000	(insuff. data)	96	(insuff. data)	96
High Pressure Sodium Lamps					
0%	150 - 399	58 or higher	76	68 or higher	76
	400 - 999	63 or higher	87	84 or higher	96
	≥ 1000	(insuff. data)	94	(insuff. data)	95
1% - 10%	150 - 399	64 or higher	78	63 or higher	84
	400 - 999	82 or higher	101	89 or higher	111
	≥ 1000	(insuff. data)	92	109 or higher	121
11% - 20%	150 - 399	(insuff. data)	89	78 or higher	87
	400 - 999	(insuff. data)	91	94 or higher	100
	≥ 1000	(insuff. data)	79	(insuff. data)	122
> 20%	150 - 399	75 or higher	80	77 or higher	90
	400 - 999	(insuff. data)	102	(insuff. data)	103
	≥ 1000	(insuff. data)	116	(insuff. data)	121

a) Upward efficiency is the portion of light directed up. Both high-bay and low-bay luminaires are available with opaque reflectors, which direct all or most of the light downward, and with transparent refractors, which direct some light up.

b) LER, or luminaire efficacy rating, describes the efficiency of a luminaire in terms of rated light output (in lumens) per watt of electricity use. A lumen is a standard measure of light output.



The first part of the document discusses the importance of maintaining accurate records. It emphasizes that proper record-keeping is essential for ensuring the integrity and reliability of the data collected. This section also outlines the various methods used to collect and analyze the data, highlighting the challenges faced during the process.

The second part of the document provides a detailed description of the experimental setup. It includes information about the equipment used, the procedures followed, and the conditions under which the data was collected. This section is crucial for understanding the context and limitations of the study.

The third part of the document presents the results of the study. It includes a series of tables and graphs that illustrate the data collected. The results show a clear trend, indicating that the data collected is consistent with the theoretical model proposed. This finding is significant as it provides strong evidence for the validity of the model.

RESULTS AND DISCUSSION

The results of the study are presented in a series of tables and graphs. The first table shows the data collected for the first set of experiments, while the second table shows the data for the second set. The graphs illustrate the relationship between the variables studied, showing a clear correlation between the two.

The discussion section of the document provides a detailed analysis of the results. It compares the data collected with the theoretical model and discusses the implications of the findings. The results show that the data collected is consistent with the theoretical model, providing strong evidence for its validity. This finding is significant as it provides a clear understanding of the relationship between the variables studied.

The conclusion of the study is that the data collected is consistent with the theoretical model, providing strong evidence for its validity. This finding is significant as it provides a clear understanding of the relationship between the variables studied. The study also highlights the importance of maintaining accurate records and the need for further research in this area.

In conclusion, the study has shown that the data collected is consistent with the theoretical model, providing strong evidence for its validity. This finding is significant as it provides a clear understanding of the relationship between the variables studied. The study also highlights the importance of maintaining accurate records and the need for further research in this area.

The federal supply sources for HID (high intensity discharge) luminaires are the Defense Logistics Agency (DLA) and the General Services Administration (GSA). DLA sells HID luminaires through its *Energy Efficient Lighting* catalog, available on its Web site. GSA offers them on Schedule 62-II, as well as through its on-line shopping network, *GSA Advantage!* Select or specify models that meet the recommended LER for that luminaire type.

Buyers should select or specify luminaires with Luminaire Efficacy Ratings (LERs) that meet the recommended levels, based on industry standard tests. However, the LER rating may not be available for some manufacturers' products. If an LER rating is not available, it can be estimated from other photometric data using this formula:

$$\text{LER} = \left(\frac{\text{Total Rated Lamp Lumens} \times \text{Ballast Factor} \times \text{Luminaire Efficiency}}{\text{Input Watts}} \right)$$

Rated lamp lumens, ballast factor, and luminaire efficiency (see "Definitions," right) may be found in manufacturers' photometric reports and in some catalogs. Many industrial HID luminaires provide multiple socket positions to accommodate different lamps and provide narrow or wide light distribution. Narrower light distribution tends to lower LER.

Two types of HID lamps are typically used in industrial applications: metal halide (MH) lamps and high-pressure sodium (HPS) lamps. HPS lamps generally have higher efficiency and longer life, but usually do not provide as good color rendition as MH lamps. HPS lamps are more commonly used at higher wattages. Mercury vapor and low-pressure sodium (LPS) lamps are not commonly used in industrial applications because of their poor color rendition. Mercury vapor lamps are much less efficient than other HID's.

"Pulse-start" metal halide lamps and compatible energy-efficient ballasts provide both reduced input watts (25% savings) and increased light output compared to standard MH lamps, approaching the efficiency of HPS lamps. Pulse-start lamps also provide much faster re-strike times, improved color rendering and color stability, and longer lifetimes.

Capacitive switching with special HID ballasts can provide bi-level lighting control for use with occupancy sensors in warehouses, garages, or other areas with intermittent occupancy. Because of the delay in re-strike time, it is generally not practical to shut off HID lights completely except during extended periods of non-occupancy.

Where to Find Energy-Efficient Industrial HID Luminaires

Definitions

Ballast Factor (BF) is the ratio of the light output of lamp(s) operated by a ballast to the light output of the same lamp(s) operated at rated current and voltage.

Luminaire Efficiency (LE) is the light output, in lumens, divided by the total rated lamp lumens.

Buyer Tips

Technology Options

Definitions

"Pulse-start" metal halide lamps use a special ignition system that allows a faster "re-strike" (light-up) time.

Industrial HID Luminaire Cost-Effectiveness Example (Closed Fixture HPS Lamp, 150-400 watts, 1-10% Upward Effic.)

Performance	Base Model	Recommended Level	Best Available
Luminaire Efficacy Rating (LER)	40	64	78
Luminaire Light Output	11,800 lumens	15,700 lumens	13,300 lumens
Power Input	295 watts	245 watts	170 watts
Annual Energy Use	1060 kWh	880 kWh	610 kWh
Annual Energy Cost	\$64	\$53	\$37
Lifetime Energy Cost	\$670	\$560	\$390
Lifetime Energy Cost Savings	-	\$110	\$280

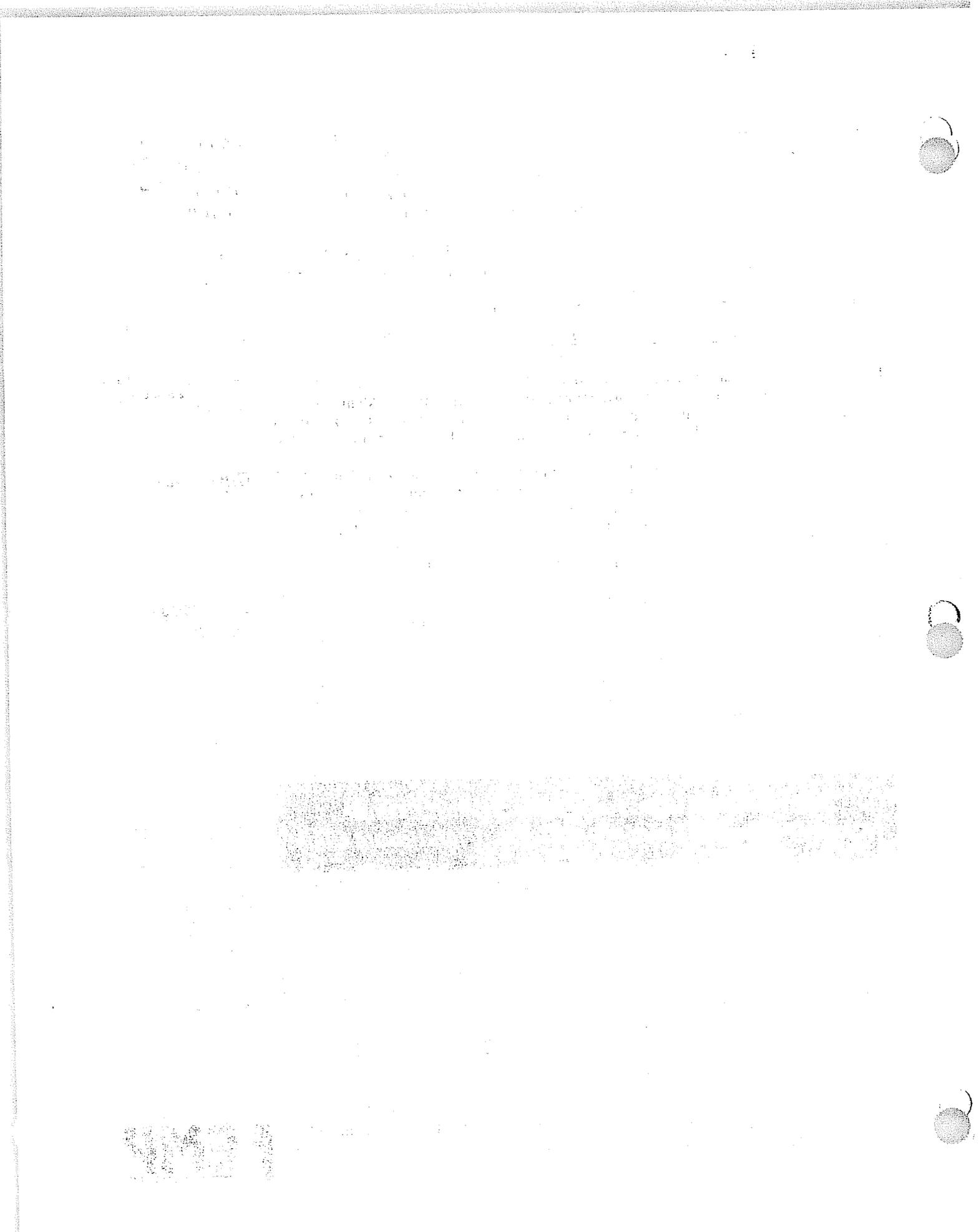
Annual Energy Use is based on 3,600 operating hours per year.

Lifetime Energy Cost is the sum of the discounted value of annual energy costs based on average usage and an assumed luminaire life of 15 years. The assumed electricity price is 6¢ per kWh. Future electricity price trends and a discount rate of 3.4% are based on federal guidelines (effective from April, 2000 to March, 2001).

Using the Cost-Effectiveness Table

In the example above, the luminaire at the Recommended Level, with an LER of 64, is cost-effective if its price does not exceed the price of the Base Model by more than \$110. The Best Available luminaire, with a 78 LER, is cost-effective if its price does not exceed the price of the Base Model by more than \$280.





National Lighting Collaborative

Order a free copy of NEMA Standards Publication LE5

WHAT IS LER?

Manufacturers, distributors, specifiers, and lighting designers have a new tool to compare the energy efficiency of fluorescent luminaires. The Luminaire Efficacy Rating, or LER, is part of a voluntary program being implemented by the lighting industry. Watch for LER information on product literature.

The Energy Policy Act of 1992 (EPAAct) called for a voluntary national testing and information program for "widely used luminaires with the potential for significant energy savings." Responsibility for creation of the program was given to the lighting community: National Electrical Manufacturers Association (NEMA), American Lighting Association (ALA), and other interested organizations. The U.S. Department of Energy's (DoE) role was to provide financial and technical assistance, and to evaluate whether the program met EPAAct's objectives. If it did not, EPAAct prescribed government regulatory action.

Consensus-building has been a key element in the stakeholders' working group, the National Lighting Collaborative (NLC). The Collaborative, established April 14, 1992, represents a broad spectrum of opinion on lighting issues drawn from industry, government, designer, and energy conservation member organizations. In the words of Ms. Christine Ervin, DoE's Assistant Secretary for Energy Efficiency and Renewable Energy, "Voluntary partnerships such as those forged by the Collaborative play an important role in helping America to become more energy efficient, to achieve our environmental goals, and to stimulate sound economic growth."

The resulting program is based on NEMA Standards Publication No. LE5, "Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaires." The program received provisional approval from DoE on March 15, 1996. The program is expected to gain momentum as more manufacturers test and rate their luminaires and publicize the results, and as designers and specifiers use the LER information in their purchase decisions.

Currently, the program covers ten categories of fluorescent luminaires used in the commercial and industrial sectors. Other luminaire types will be added to the information program as additional NEMA standards are developed and reviewed by the Collaborative.

HOW IS "LER" CALCULATED?

LER is a single figure that expresses luminaire efficacy, the luminaire's light output divided by the input power. The formula is:

$$\text{LER} = \left[\text{luminaire efficiency (EFF)} \times \text{total rated lamp lumens (TLL)} \times \text{ballast factor (BF)} \right] \text{ divided by } \left[\text{luminaire watts input} \right]$$

Note that the effects of all components of the luminaire system are included in the LER. Simply stated, this is similar to the 'miles per gallon' rating for automobiles. "LER gets to the core of what energy efficiency is all about -- to get more energy service using less energy," says Francis Rubenstein, Staff Scientist, Lawrence Berkeley Laboratory.

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 433

LECTURE 1

1.1

1.2

1.3

1.4

1.5



The LE5 document specifies the major fluorescent luminaire categories covered and the standard industry test procedures. It is recommended that luminaire testing and rating be performed with F40T12/ES lamps and energy-efficient magnetic ballasts, and F32T8 lamps with electronic ballasts as well.

In addition to LER, LE5 also contains a calculation for the relative energy costs of each rated luminaire. This estimates "cost of light," the yearly lighting energy cost per 1000 lumens of light output using identical assumptions for operating hours and electricity price. Because application and operating conditions vary widely, this number is intended for comparison purposes rather than prediction of actual energy usage.

WHAT DOES "LER" MEAN TO MANUFACTURERS?

Manufacturers have stated that using the new system will add competitive advantage to their products and expect the testing and rating procedures to spread rapidly through the industry. LER and cost ratings are being added to product literature and used as marketing tools. The LE5 document contains a sample format for reporting LER to promote consistency throughout the industry. Manufacturers are encouraged to communicate their progress in testing and rating luminaires to NEMA. The U.S. Bureau of Census MA36L Current Industrial Report has been modified beginning in 1995 to collect luminaire shipment information as a partial means to evaluate the impact and use of the LER. Continued participation is encouraged to maintain the voluntary nature of the program.

WHAT DOES "LER" MEAN TO SPECIFIERS?

The LER and the "cost of light" provide guidance on comparative energy-efficiency and costs of fluorescent luminaire options. It can be added to specifications to ensure efficiency levels and used to educate clients. LER should be used along with other application-specific criteria in selecting the proper luminaire.

HOW DO WE USE "LER"?

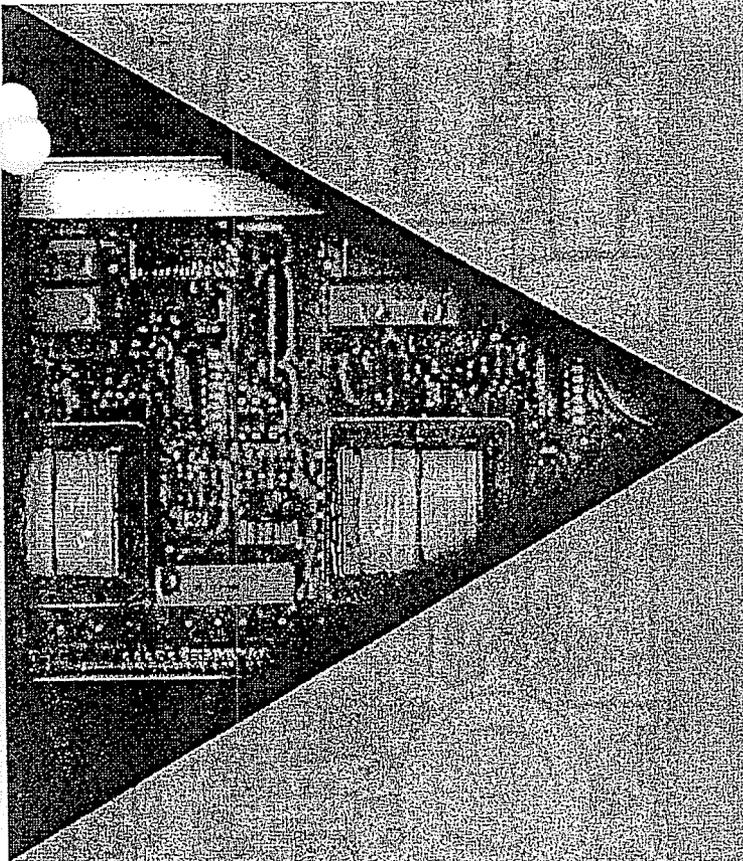
Comparing the LER of two luminaires is not quite as simple as comparing two automobiles' miles per gallon ratings. LE5 distinguishes between the major categories of fluorescent luminaires. Each rating contains a two letter code indicating source and product category, such as FL. "F" stands for fluorescent and "L" represents the lensed product category. Only luminaires within a product category should be compared. By the nature of their different applications, a lensed fixture and a strip fixture (for example) would fall into different LER ranges.

HOLD A PLACE OF METRICS OF QUALITY

The International Association of Lighting Designers (IALD) and the Illuminating Engineering Society of North America (IESNA) are working towards the development of numerical metrics for quality of lighting. These metrics will someday be used as a tool to expand common practice in lighting specification beyond the realm of the horizontal foot-candle. In the future, the LER will be expanded to provide information on quality in addition to efficiency. In the meantime, LER should be used to complement application criteria in fluorescent luminaire selection. Used with common sense and care, LER will be a powerful tool for bringing energy-efficiency into the complex equation of lighting purchase and specification decisions.

ADDITIONAL INFORMATION ON THE LER PROGRAM:

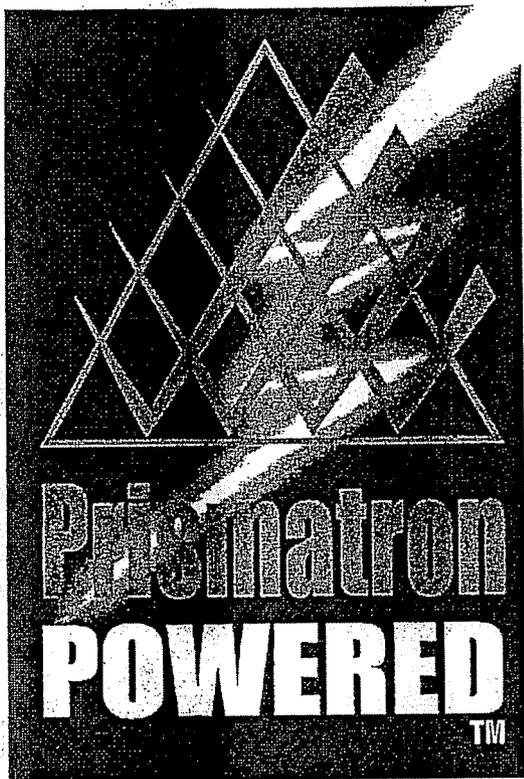
Kyle Pitsor, Chair; National Lighting Collaborative, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209
Phone: 703-841-3274; Fax: 703-841-3374



Prismatron

**Holophane's
HID Electronic
Ballast**

**HOLOPHANE**

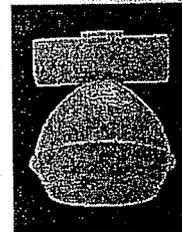
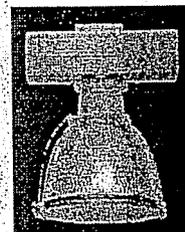
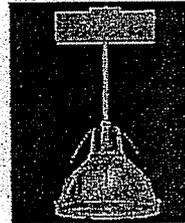
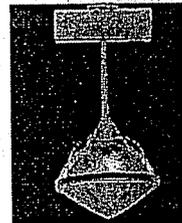
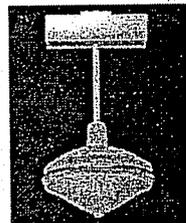
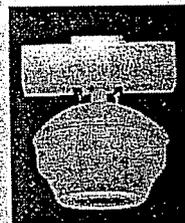
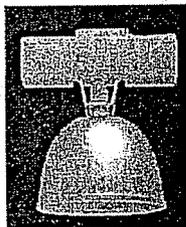


Holophane's Electronic Ballast Technology

Key Product Feature Summary

Product Highlights:

- 277/240/208 VAC, 50/60 Hz Supply Power
- 400/350/320W MH and Pulse Start MH
- High Frequency Lamp Operation (>100 kHz)
- Continuous Dimming Option
- Operates Two Lamps (tandem)
- Improved Lamp Lumen Maintenance
✓ Lamp company warranted
- Low Watts Loss
- FCC certified for electromagnetic and radio frequency interference requirements
- 3 Year Warranty



Prismatron™ is available with the following luminaires:

In order, from left to right:

- Prismalume®
- PrismPack® V
- PrismAire® II
- PrismAire® II Enclosed
- CentaGlo®
- PrismGlo®
- 02454
- PGRL
- Prismalume® Enclosed
- PrismPack® Enclosed
- Enduralume®

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Keynes MK1 1JG, England / Holophane, S.A. de
C.V., Apartado Postal No. 986, Naucalpan de
Juárez, 53000 Edo. de México

Visit our web site at www.holophane.com

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ADVANCE

DynaVision™

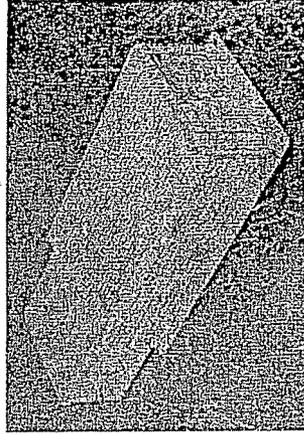
For 320/350/400 Watt
Pulse-Start Metal Halide Lamps

*"Leaping beyond
the next generation
in HID ballast technology..."*

Electronic HID Ballasts

Introducing breakthrough electronic HID performance

DynaVision™



Since the advent of HID lighting, Advance has taken a prime leadership role in developing the technology that helped spur HID's remarkable growth. Most recently, pulse-start technology for metal halide systems was made possible by Advance's ballast innovations.

Now, breakthrough technology from Advance is igniting a brand new revolution in metal halide — with DynaVision™ Electronic Ballasts.

DynaVision is a completely new kind of HID ballast — with microprocessor-based technology that delivers a genuine, quantum leap in metal halide performance. DynaVision's extraordinary, unprecedented lumen maintenance capabilities mean huge opportunities for operating cost reductions, both through energy savings and lower maintenance requirements. In addition, DynaVision also helps turn color shift, lamp blackening and lack of control into long-gone problems of the past.

In applications where fluorescent options such as T5/HO are beginning to provide an alternative to HID, DynaVision reasserts metal halide's value in a big way. Thanks to Advance, users looking for a positive cost/benefit equation now have more choices — and more ways to enjoy the rewards of better lighting.

DynaVision: The latest example of Advance's leadership in HID and fluorescent lighting. Proof of Advance's dedication to delivering energy-efficient, cost-effective solutions. From pulse-start metal halide to controllable T5/HO fluorescent, lighting value is driven by Advance — now more than ever.

So follow along, as we introduce you to the revolutionary HID possibilities now created by DynaVision.

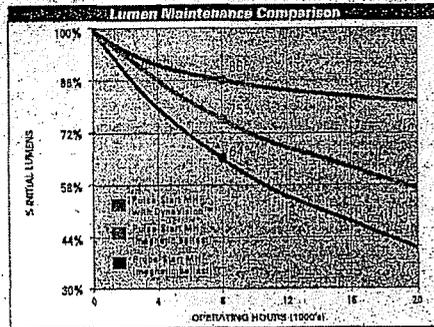
Revolutionary technology delivers revolutionary value.

With the introduction of the DynaVision™ (Dyna) ballast, the industry has established totally new benchmarks for performance and cost savings.

The key to understanding the dynamic, multifaceted value of DynaVision is something called "lumen maintenance," or the lamp/ballast system's ability to minimize light output depreciation over the life of the lamp.

Conventional HID systems — magnetic ballasts driving probe-start metal halide lamps — typically experience a 50-60% fall-off in light output over the published life of the lamp. This fall-off can lead to excessive maintenance costs due to the need for frequent re-lamping, and inefficient energy usage throughout the life of the system.

DynaVision changes the rules by delivering a 30-50% improvement in lumen maintenance over these conventional systems. By maintaining higher light levels across the entire published life of the lamp, DynaVision systems deliver significant value to the end user, in three key ways:



Value Proposition #1 30-50% improved lumen maintenance leads to up to 50% less lamp maintenance

PLUS Value Proposition #2 56% more lumens enables the use of up to 36% fewer fixtures.

PLUS Value Proposition #3 36% fewer fixtures leads to 4.1% energy savings — annually!

EQUALS 10-year overall cost of ownership reduced up to 36%

Let's make a deal. Look at each of these exciting value propositions.

DynaVision™

#1 Improved Lumen Maintenance = Less Lamp Maintenance

Most lighting systems are designed on the basis of mean of "average" light output of the lamp. For metal halide lamps, this mean light output, as measured in lumens, is defined at 40% of the lamp's rated life. Since most medium wattage MH lamps are rated at 20,000 hours life, mean lumens are advertised at 8,000 hours of lamp life.

As lumens fall off after the 8,000 hr. design point, the lighting level for many applications may become unacceptable, resulting in the need for re-lamping significantly prior to reaching the 20,000 hr. rated life of the lamp.

Because of DynaVision's relatively flat lumen depreciation characteristic, (i.e., better lumen maintenance), early

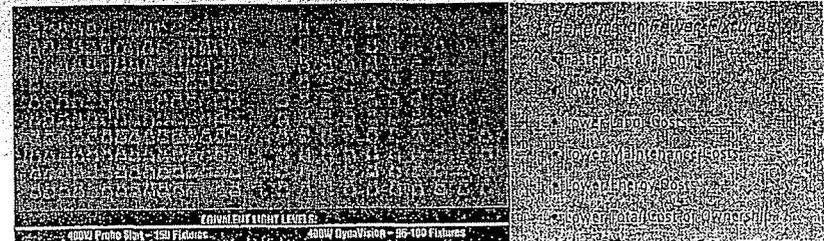
re-lamping is unnecessary, resulting in a most cost-effective lighting system. In the example below, consider identical installations with 400 fixtures: one with magnetic ballasts where lamps are replaced at 12,000 hours, and a second where lamp life is extended to 18,000 hours with DynaVision.

In this example, DynaVision would save on average \$10 per fixture, per year, just in reduced maintenance costs! The assumption was made that equal number of fixtures were used. Next, consider the total consequences of producing more light, longer, with fewer fixtures... and discover the true advantage of DynaVision (Value Proposition #2)..

	Conventional Magnetic Pulse-Start	DynaVision
Number of fixtures	400	400
Annual burn hours	5,000	5,000
Lamps replaced at (hrs.)	12,000	18,000
Lamp cost per each re-lamping	\$10,000 (@ \$25/lamp)	\$10,000 (@ \$25/lamp)
Fixture cleaning and lamp replacement labor	\$10,000 (@ \$25/fixture)	\$10,000 (@ \$25/fixture)
Number of replacements in 10 years	4	2
Total 10-year cost of lamp changes	\$80,000	\$40,000

10-Year Lamp Maintenance Savings = \$40,000!

#2 More Maintained Lumens = Fewer Fixtures



A 400W DynaVision system produces up to 56% more mean lumens over conventional probe start systems using the same wattage lamps. Taking advantage of this performance benefit, the overall fixture count can be reduced by up to 36% without sacrificing light levels.

Plus, fewer fixtures also have a dramatic impact on both energy and maintenance costs, leading to significantly lower overall operating costs.

PRISMATRON™ TECHNOLOGY

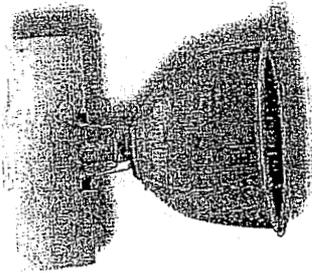
Prismatron Powered lighting systems from Holophane deliver improvements in energy efficiency with:

- Improved Lamp Lumen Depreciation, Lower Ballast Losses, and Continuous Dimming Option
- Improved lamp lumen depreciation

In studies conducted by Holophane and General Electric, HO lamp Product Management, the Prismatron electronic ballast was determined to reduce lamp lumen depreciation over the life of the lamp when compared to published performance. As a result Prismatron is the first HD electronic ballast that delivers improved lamp performance. A statement from GE, HD Lamp Product Management on page 4 describes the warranty. Lumen depreciation curves from the studies and the warranty comparing lamps operated on magnetic ballasts to lamps operated on the Prismatron ballast are shown on page 5.

- Increased lamp light output

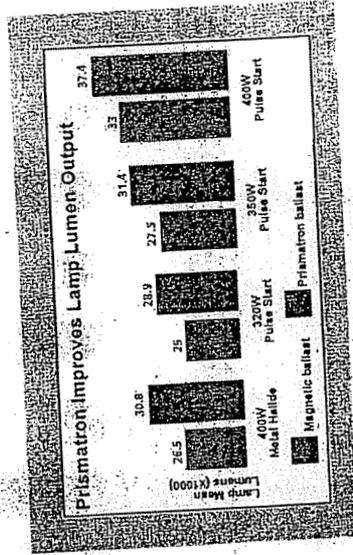
Prismatron ballast technology increases light output over the life of the lamp by improving lamp lumen depreciation. Conventional metal halide and pulse start metal halide lamps operating on Prismatron improve mean lamp lumen maintenance from 65% to 75% of initial output and to 75% to 85% of initial output, respectively when compared to



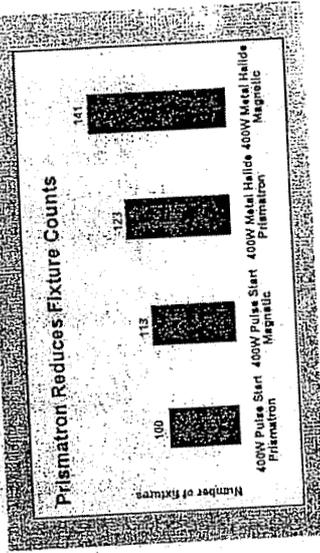
HID-Electronic MH Ballast

- Suitable for single lamp or tandem applications
- Full range dimming capability
- Emergency standby capability
- Standard control configurations
- "Hold high" relay for lamp protection
- Daylight Harvesting™ capabilities

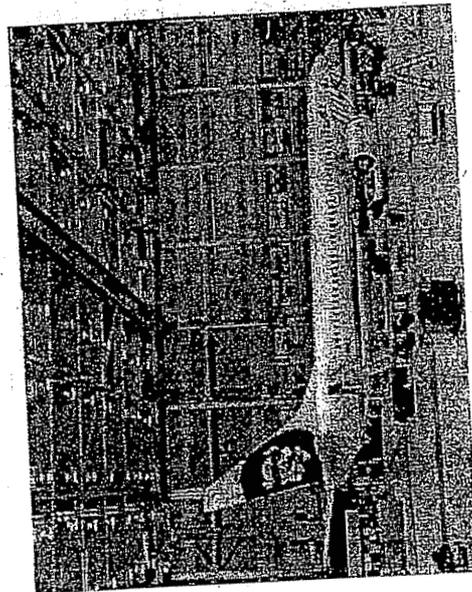
A proven and reliable electronic HD ballast technology for 400, 350 and 320 watt HID metal halide and pulse start lamps, exclusively from Holophane, the leader in HID ballast technology. Prismatron is the first HD electronic ballast that delivers lamp manufacturer warranted improved lamp performance!



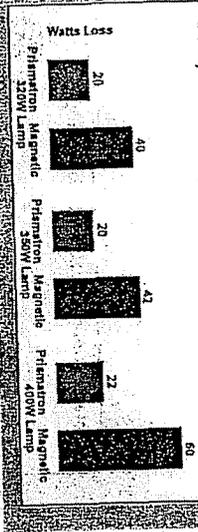
More Lumens
Prismatron ballast technology improves lamp lumen depreciation in pulse start and standard metal halide lamps. Mean lumen output is increased by 15% on standard metal halide lamps and by 13% on pulse start lamps.



Fewer Luminaires
Improvement in mean lamp light output means that fewer fixtures are required to deliver equivalent light levels. Fewer lighting fixtures results in less energy consumed by the lighting system. Compared to a bank of magnetically ballasted metal halide systems a Prismatron powered pulse start lamp based lighting system can reduce fixture counts by 30%.

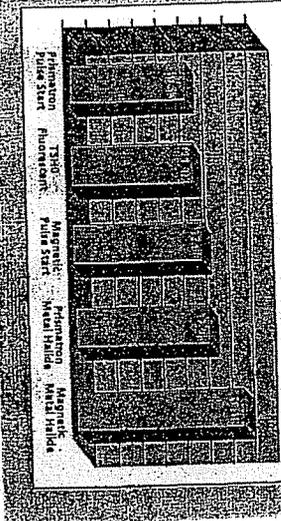


Prismatron Has Lower Watts Loss Compared to Magnetic Ballasts



Lower Watts Loss
Prismatron electronic ballast from Holophane reduces losses compared to conventional magnetic ballasts. 95% of the energy going to the lamp is used by the lamp in generating light output. Typical magnetic ballasts consume 10% to 20% of the energy per lamp. In a 400 watt lamp, that's a savings of 38 watts on a 400W lamp. \$121 saved per 400W lamp. That's a savings of 38 watts on a 400W lamp.

Reduced Annual Energy Expense



Energy Savings:
Typical annual energy expense for equivalent lighting systems illustrate the energy savings when using the Prismatron electronic ballast from Holophane.

PRISMATRON™ TECHNOLOGY

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HOLOPHANE®

PRISMATRON™ TECHNOLOGY



HID Product Management - Metal Halide Products
General Electric Company
9751 Road One 4412
Cincinnati, OH 45240
Tel. 216-565-2440
Fax. 216-266-2310

Date: January 17, 2002

Holophane / GE
HID Electronic Ballast System

GE Lighting and Holophane have recently concluded long term testing of GE Multi-Vapor lamps operating on Holophane's Prismatron electronic ballasts aimed at verifying system performance in typical metal halide applications. These tests included standard 400 w M59 type lamps as well as PulseArc lamps.

Based on the test results, GE Lighting is pleased to announce that the basic Metal Halide Lamp warranty will be extended to cover standard PulseArc and CWH lamps when operated on the new Prismatron electronic ballast system developed by Holophane.

Specifically:

- Lamps of the Holophane Prismatron electronic ballasts are compatible with regard to starting and operation similar to standard M59 electromagnetic systems.
- Comparable life rating to standard M59 electromagnetic ballasts - 20,000 hrs median life (or 11 hour on, 1 hr off cycle) for PulseArc products, 30,000 hrs when operated on a 120 hrs on and 1 hr off cycle)
- Comparable color uniformity and color quality, initial and over life.
- Lamp Lumen depreciation is greatly improved on Holophane's Prismatron electronic ballast system.
- For standard Multi-Vapor lamps warranty will be based on nominal lumen maintenance factor of 75% vs. typical 65% on electromagnetic M59 systems
- For PulseArc or Multi-Vapor lamps, warranty will be based on nominal lumen maintenance factor of 85% vs. typical 75% on electromagnetic Pulse Start or M59 systems.

Based on the extensive testing completed on 400 watt lamps, GE Lighting will extend its lamp warranty to cover other wattages on the new Prismatron electronic ballast system from Holophane on a case by case basis.

Attached are typical Lumen Maintenance curves comparing standard electromagnetic performance vs. the new Holophane Prismatron electronic ballast system.

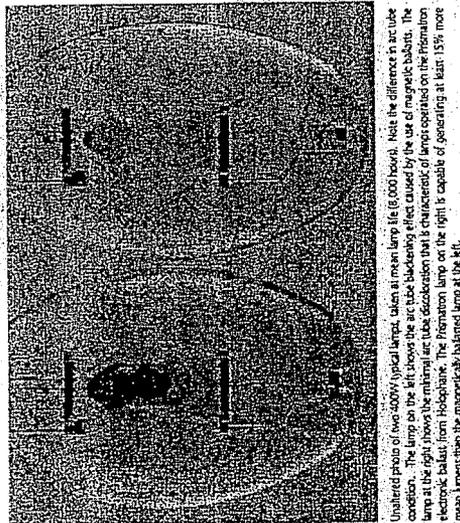
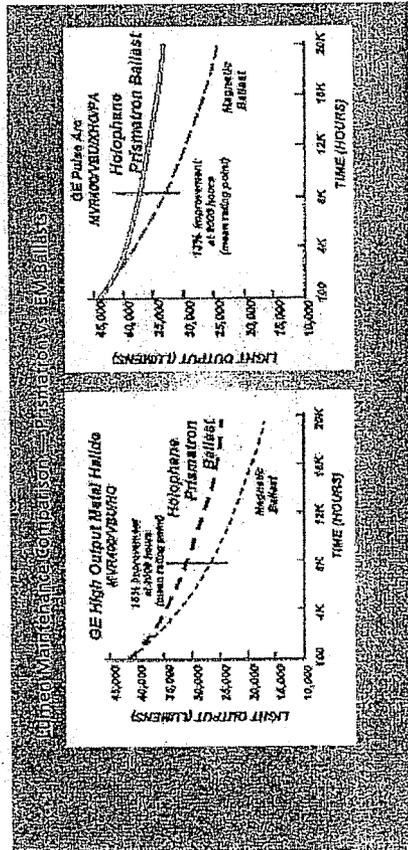
Carlino J. Lanza
HID Product Management

GE HID Lamp Endorsement

HOLOPHANE®

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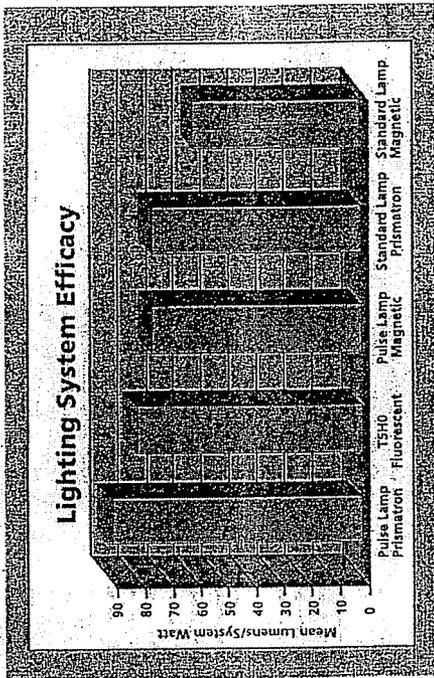
Higher light levels, fewer light fixtures, less operating costs.



Unshaded photo of two 400W typical lamps, taken at mean lamp life (8,000 hours). Note the difference in arc tube condition. The lamp on the left shows the arc tube blackening effect caused by the use of magnetic ballasts. The lamp on the right shows the arc tube condition that is characteristic of lamps operated on the Prismastron electronic ballast from Holophane. The Prismastron lamp on the right is capable of generating at least 15% more mean lumens than the magnetically ballasted lamp on the left.

- Additional Prismastron Features:**
- Available in Holophane Luminaires UL listed for 40°C ambient environments.
 - Shunt operation eliminates annoying ballast hum.
 - Meets Federal Communications Commission requirements for electromagnetic and radio frequency compatibility for electronic devices per FCC 18.305 and FCC 18.307.
 - Operates both pulse start and conventional metal halide lamps.
 - Built-in thermal protection protects ballast against excessive temperature, automatically restores power when ballast temperatures are reduced.
 - Conformal coating provides enhanced protection of ballast components.
 - Three-year Prismastron ballast warranty is standard.

PRISMATRON™ TECHNOLOGY®



Prismastron Improves System Efficacy

Ballast Type	1	2	3	4	5
Lamp Type	400 PM	T5HO	400 PM	400 MH	400 MH
Lamp count	100	788	113	123	161
Lamp	MVR400VBLU	ES4WTEV	MVR400VBLU	MVR400VBLU	MVR400VBLU
	XHOFA	830HO	XHOFA	XHO	XHO
Initial Lumens	44,000	5,000	44,000	41,000	41,000
Mean Lumens	37,400	4700	33,000	30,475	26,500
Total mean lumens	3,740,000	3,703,600	3,729,000	3,748,425	3,736,500
System watt/lamp	476	59	460	426	460
Total watts	47,600	46,492	51,980	52,388	64,860
System mean lumens/watt	86	80	72	72	58
Improvement	52%	38%	24%	24%	

Compared to alternative metal halide systems Prismastron can provide the same light levels while improve the efficacy of a lighting system by up to 55%. The information in the example given above compares a lighting system of 100 400W pulse start lamps operated on the Prismastron ballast to other metal halide, lampmagnetic ballast systems. A Prismastron ballast operating a pulse start lamp can reduce total fixture cost by 20% and reduce the lighting system wattage consumed by over 50% while maintaining equivalent light levels.

Increased System Efficacy

PRISMATRON™ TECHNOLOGY®

Performance Specification

General

Complete luminaire shall be Holophane catalog number _____

The standard single luminaire shall consist of two assemblies: one optical and one ballast assembly.

The standard tandem luminaire shall consist of four assemblies: two optical assemblies, a main electrical assembly and a satellite electrical assembly connected by means of an MC type cable whip. Total assembly shall include electrical components, optical components, mounting hardware, and reflector support brackets.

The complete luminaire shall be listed by Underwriter's Laboratories, Inc. as suitable for damp locations in ambients up to 40°C. Luminaires shall be so rated in any combination of hook, cord and plug, hard-wired pendant mount, or Holoflex® modular wiring system.

The extruded aluminum ballast housing shall be protected by a seven stage phosphate pretreatment followed by a sprayed on polyester powder paint, cured and baked on at 218°C. This finish shall exceed ASTM standard practice for hardness, humidity, impact and salt spray resistance. All other hardware shall be either pre-galvanized or zinc plated steel for corrosion protection.

The prewired porcelain-enclosed lamp holder with corrosion resistant nickel-plated lamp grip screw shell shall be factory set. When applicable the zinc-plated steel reflector support brackets shall provide for full ventilation. The optical reflector may be field attached to

the electrical assembly to allow installation of the complete luminaire at one time.

Ballast Components

The PrismaTron electronic ballast shall be provided with integral color coded leads. This electronic ballast shall be multi-voltage capable and shall operate from a nominal voltage range of 208-277 volts AC. The electronic ballast shall have a system efficiency of greater than 93% under full lamp operation. It shall be FCC compliant for EMI/RFI as per parts 18.305 and 18.307. Total harmonic current distortion shall be less than 5%. Starting input current shall be less than stabilized lamp operating current. The ballast system shall be capable of maintaining stabilized lamp operation through two full cycles of power interruption. Electrical system shall withstand transient peaks of 2kv in line to common mode, and 4kv in common mode per IEEE C62.41.

The ballast shall be capable of powering one or two 400, 350 or 320 watt metal halide or pulse start metal halide lamps. Lamp wattage shall not vary more than +0.5% for a 10% change in input line voltage. A crest factor of 1.5 shall not be exceeded. Lamps operating on the ballast shall be warranted by the lamp manufacturer to deliver improved mean lumens as compared to same lamp operation on an electromagnetic ballast. Where applicable, a means of continuous dimming shall be a part of the ballast system. Dimming control is to be of the

common 0-10 volt DC, two wire IEC protocol. Dimming shall range from 100% down to no less than 50% of input power. Automatic over temperature protection shall be provided. The ballast shall carry a warranty of three years when installed in applications meeting the manufacturer's conditions and the requirements of the applicable UL safety listings. 0-10VDC dimming control voltage shall be derived from the ballast, not an externally imposed source.

Dimming option shall include a "Hold High" feature that maintains full power to lamps when starting up after loss of power. After a 20 minute delay, the lamp will be restored to its previous dimmed setting. This is to comply with lamp manufacturer recommendations regarding starting lamps while dimmed and the effect on lamp life.

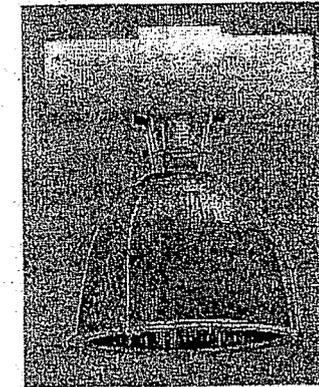
Optical Assembly

Glass optical assemblies for the PrismaTron electronic ballast shall consist primarily of Endural prismatic borosilicate glass. Glass reflectors may, where applicable, be covered on their outer surface by anodized aluminum covers. Where reflectors are of aluminum construction, rather than the borosilicate glass, reflectors shall be of 90% reflectance, with white baked-on polyester powder paint finish combined with a spun on dropped prismatic borosilicate glass refractor or high temperature acrylic lens. (See specific optical selection for more information).

PRISMATRON™ TECHNOLOGY

The Holophane PrismaTron Electronic Luminaire is the answer for those applications where high energy cost and the need for excellent lumen maintenance are the driving concerns. Electronic ballasts, commonly used in fluorescent lighting systems, will now gain acceptance in medium wattage Metal Halide packages. Available for 320 watt, 350 watt and 400 watt installations, these luminaires are ideal for light industrial, commercial, retail and educational applications.

All of the optical families shown on pages 9-16 are available with the single or tandem PrismaTron ballast.



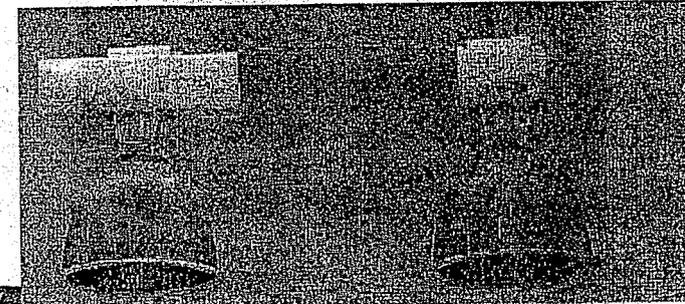
Single Luminaire

Holophane's newest offering of the PrismaTron electronic ballast technology is available in a single configuration. It utilizes the same proven ballast technology that has been in place in the tandem.

Single ballast assembly

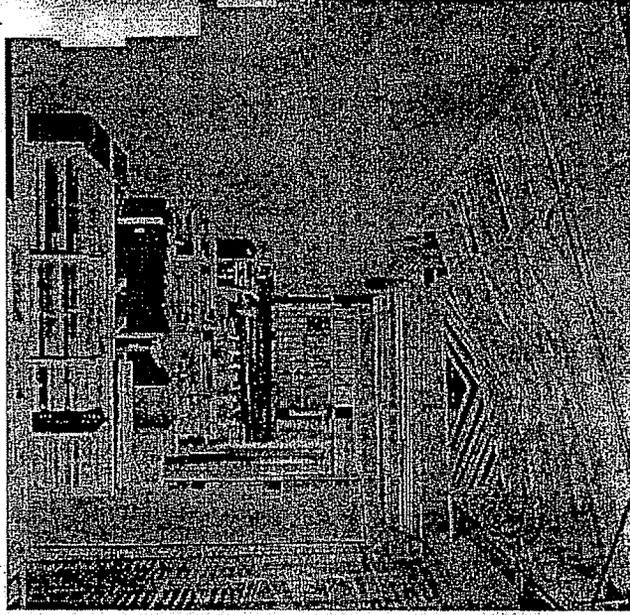
Tandem Luminaire

Holophane's offering of the PrismaTron electronic ballast technology is available in either a single or tandem configuration. In tandem assemblies "the Main and Satellite" construction reduces pipe and wire requirements by half for reduced installation costs. Modular connectors are used to quickly link the two components. These plug in connectors simplify installation and reduce labor costs. MC type cable is pre-wired to the satellite unit and simply plugs into the main unit. Standard 15, 20, 25 and 30 ft. cable lengths are available.

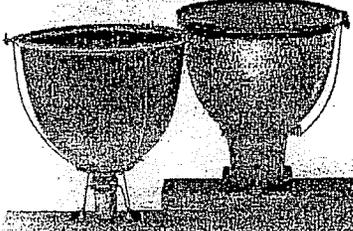


Tandem ballast assembly

PRISMATRON™ TECHNOLOGY



- Choice of factory set distributions
- Thermal shock resistant prismatic glass reflectors
- Thermoset white polyester powder paint
- Choice of tempered bottom enclosures for enclosed fixtures



Prismalume™ and Enclosed Prismalume™ Optics

Industrial

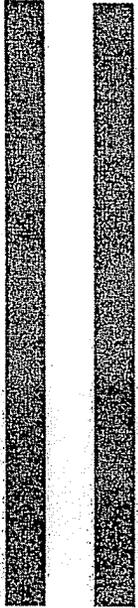
factories and other manufacturing equipment along with the surrounding area all interact with the workers' ability to see and produce products efficiently, safely and to exacting standards. The value provided by Prismalume reflectors is the result of a precise combination of horizontal and vertical footcandles.

Two critical criteria when designing lighting for an industrial area are safety and performance. The Prismalume Enclosed fixture comes standard with safety features such as toolless entry into the optics and it also meets the safety requirements for containing non-passive lamp failures. Our standard prismatic glass reflectors provide superior vertical and horizontal illumination on the work plane. This results in a uniformity of area utilizing a small quantity of lumens.

Gymnasiums, swimming pools, field houses and multi-purpose rooms demand a multi-angle lighting system. Basketball, volleyball and tennis require a totally illuminated environment. Retail



PRISMATRON™ POWERED

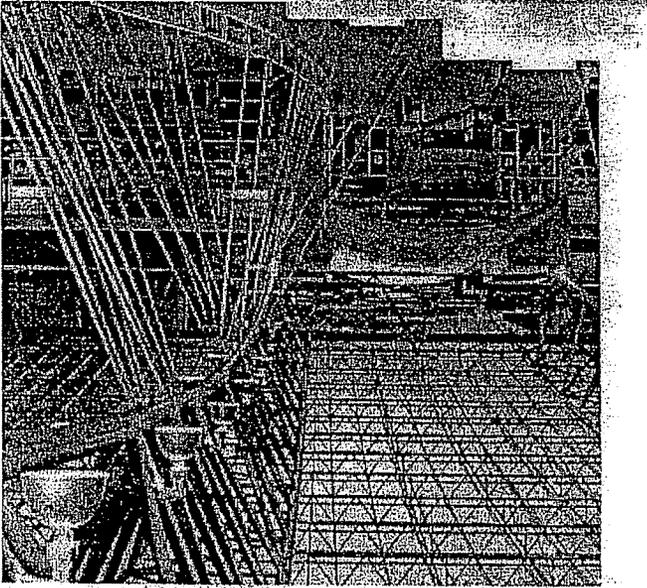


Prismapack V and Enclosed Prismapack V Optics

The industrial environment is full of airborne particles which can cause luminaires to lose their effectiveness. However, the self-cleaning action of a Prismapack V reflector creates a steady stream of air through the reflector, carrying dirt particles out the top. The prismatic borosilicate glass reflector has a smooth inner surface which has lower dirt deposition, requires fewer luminaire cleanings, and delivers more maintained light thus lower operating costs.

The enclosed Prismapack luminaire is also a feature that is easily maintained. A simple wiping with a cloth of the smooth inner surface of the reflector and top and bottom surface of the tempered glass enclosure will restore virtually 100% of the initial efficiency. Prismapack V luminaires provide both the long life and low maintenance required by industrial plants, schools, arenas and retail outlets. Efficient lighting of the visual environment both Prismapack V luminaires provide maximum efficiency for flexibility of design. The unique prismatic glass reflector system coupled with a wide selection of HID lamps and wattages means an extensive choice of distributions are available to tailor your lighting design to the application.

PRISMATRON™ POWERED



- Non-deteriorating borosilicate glass reflector
- Sealed aluminum reflector cover
- Various light distributions
- Corrosion resistant paint

Prismatron Powered Luminaires



- Prismatic glass performance
- Low maintenance design for store environments
- Resistant paint blends into painted ceilings
- UL listed 40°C damp

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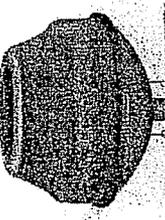
Centaglio® Optics

When designing lighting for an industrial facility, there are many considerations to contend with. The amount of light needed, the location of the fixture, uniformity ratios, uplight, brightness, horizontal and vertical illumination levels, and glare are some of the considerations that insure quality lighting.

Centaglio luminaires address and successfully control all of the issues mentioned above. For starters, the Centaglio optic is a combination reflector top with a reflector bottom. This combination allows the light to leave the fixture at a high angle providing great vertical footcandles and uniform ratios. The upward lighting component brightens the ceiling and reduces shadowing. The reflector walls evenly distribute light in a downward direction that minimizes brightness while the reduced opening eliminates high angle glare from direct view of the lamp.

Centaglio luminaires have distributors to suit a wide range of applications. A symmetrical distribution is used for larger open areas and an asymmetrical distribution is available for narrow aisle ways. Each are offered in wide or narrow distributions to suit the mounting height and desired light levels. This allows Centaglio luminaires to maximize the light output for the application while providing all the benefits of quality lighting.

HOLOPHANE®

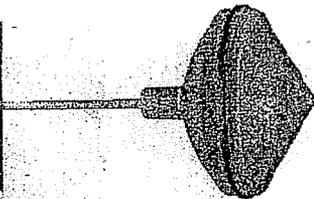


- Engineered up/down light
- Exceptional vertical and horizontal illumination
- Minimal direct and reflected glare
- Improved visual acuity

Prismatron Powered Luminaires



- Decorative shapes complement interior design
- Balanced horizontal and vertical illumination
- High efficiency with reduced glare



PRISMATRON™ POWERED



PrismGlo® Optics

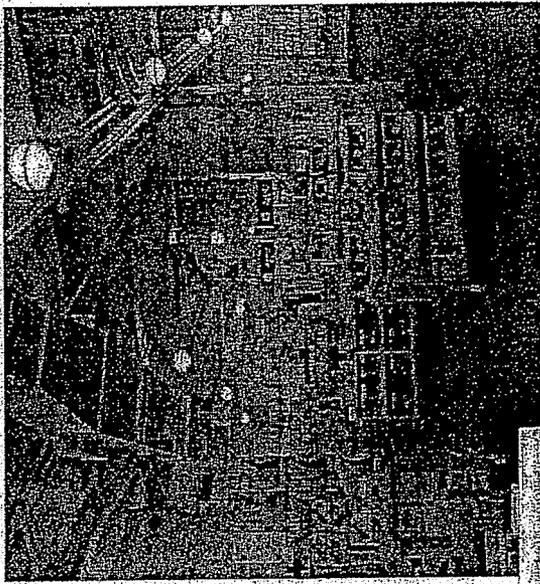
Commercial, retail and educational spaces share many of the same lighting requirements. A wide variety of visual tasks take place within the same environment. Variable ceiling types and heights are used to define form and function. Both horizontal and vertical tasks require perfectly balanced illumination.

Retail lighting presents a complex challenge. A stylish and inviting setting is needed, while maintaining effective visibility of merchandise. Color, texture, form and quality must be effectively illuminated to increase sales. Information such as prices, instructions, contents and sizes must be easily seen on signs, labels, tags, shelves and walls. PrismGlo luminaires' unique lighting has been proven in many successful installations to improve sales.

Interior design of commercial space continues to evolve. Open space and open ceiling offices require illumination of horizontal writing surfaces, catalogs, CRT terminals and charts. The upright component from PrismGlo reflects off ceilings into offices without being cut-off by partitions while the horizontal component provides the illumination needed for exacting visual tasks.

Classrooms and libraries need illumination on desks, book racks, paintings, chalkboards, bulletin boards, work benches, cafeteria tables and auditorium seats.

PRISMATRON™ POWERED



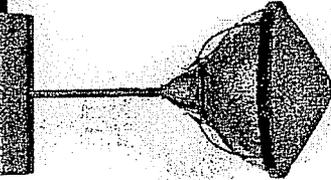
02454 Optics
The 02454 luminaire from Holophane provides the ideal lighting design element for applications requiring an industrial, retro warehouse, or open loft look. This product has been used in residential applications for more than half of our 100 year history.

The unpainted cast aluminum husk and latches portray the rugged look desired for an industrial image. Custom colors and optional reflector covers are also available to match your specific design theme. The traditional steel wire latch bases help capture a time period from the past and the borosilicate glass optical assembly provides timeless beauty and glitters when illuminated.

Since 1917, the 02454 has been the ultimate in low brightness energy efficient lighting. A combination of stainless steel rods, a cast aluminum husk and ageless borosilicate glass create a luminaire that transcends the years. When a realistic industrial/retro look is desired, the 02454 from Holophane is the original.

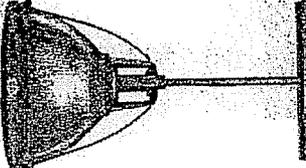
The 02454 product line offers 2 covers and 3 color options to contribute to the style and function of any lighting environment. The optional copper cover brings out the classic metal's beauty to add elegance to the retro-industrial design.

- Conical or round glass bottom refractor provides sparkle and glitter to entice customers.
- Glass reflector top allows an uplight for softly filling the ceiling cavity.





- Slotted socket huck with steel rods that holds the glass reflector to create an authentic image from yesterday
- Three sizes, many shapes and various options allow for tailoring the ideal image to the design theme



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PGRL Optics

The PGRL series is the original Prismatic Glass Reflector Luminaire. The products heritage can be traced to the beginning of innovative lighting solutions. The glazing glass reflector is supported by steel rods attached to a slotted socket huck. This design creates a timeless image. All units can be ordered with a wire guard on the bottom of the glass reflector. The large unit is available with two glass reflector choices depending upon desired dimensions and light distributions. The fixture can also be ordered with an aluminum or copper cover over the prismatic glass reflector. The larger versions have a socket huck and bottom ring made of cast aluminum. Each is available painted black, white, copper or unfinished.

Either the aluminum or copper covers accentuate the modern industrial look with the metal's timeless appeal. The rib copper cover emphasizes brass or copper detail elements in any decor.

Enduramine V Optics

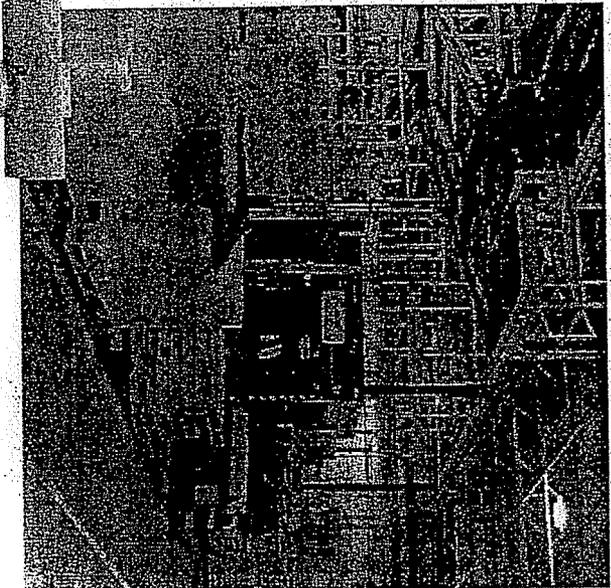
There are applications where the conditions require an enclosed fixture producing efficient, wide spread lighting distributions. The Enduramine V fixture combines a white painted highly reflective reflector with a spun on borofloat glass or acrylic refractor. The reflector/refractor combination results in a low brightness appearance providing an efficient blend of horizontal and vertical illumination.

The luminaire may be installed in a wide variety of environments. Its appearance and ruggedness permit it to be equally at home in commercial as well as industrial applications.

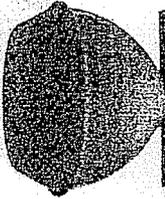
The Enduramine V luminaire with its enclosed optics, is suited for moderately dry environments as well as clean areas. The luminaire will provide long life and easy maintenance as required by these applications.

The Enduramine fixture's unique design of combining a solid reflector with a prismatic refractor results in high vertical footcandles.

The Enduramine V luminaire provides maximum efficiency for almost all design requirements. A selection of wattages allows the most efficient system to be chosen for a specific application.



- Thermal shock resistant prismatic glass or 100% clear acrylic refractor
- Thermally set white polyester powder paint
- Choice of factory set lighting distributions

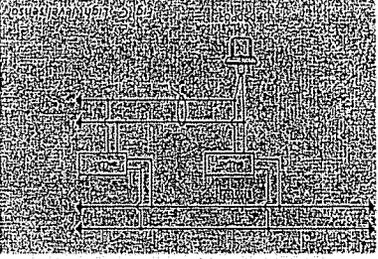
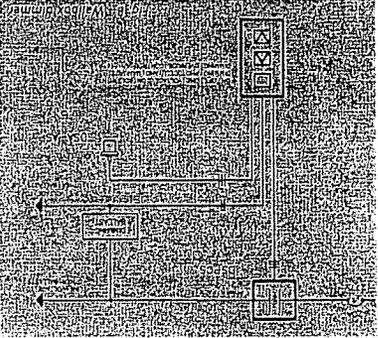
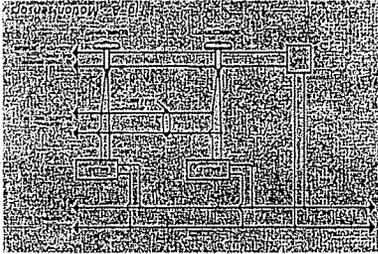


Prismatron Powered Luminaires

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HOLOPHANE®

Typical Prismatron Control Configurations



New to the Holophane family of products is the Director Series of lighting control products. These will allow users to discretely control their lighting system via the Prismatron ballast and to maximize their energy efficiency while laboring the system to best suit their individual needs. Utilizing standard 0-10V DC controls (wedge source is internally derived from the ballast reduce energy consumption in a number of different ways. extended periods of time, motion sensors can be incorporated so that when individuals enter the area, lights that were dimmed can be automatically restored to full output (see Fig. A). This could also be accomplished manually through the use of a standard wall box dimmer, cat #DSQ-8C (see Fig. B).

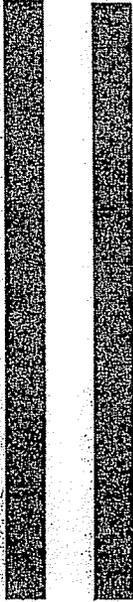
PRISMATRON™ POWERED



HOLOPHANE®

Daylight Harvesting™

In order to take advantage of ambient light, light level sensors (cat #DS5PC) can be utilized to automatically dim the luminaires when the ambient light is high and then raise the output level when the ambient light becomes lower (see Fig. C). In all cases, PrismaTron dims in a profile-no step dimming or time constant immediate response delay at various levels-of-the-way to 25% output at 50% power consumption. Clearly, to take advantage of energy savings through dimming capability and full use of Daylight Harvesting™, the PrismaTron electronic ballast in conjunction with Director Series of controls from Holophane is the right choice for all your applications. Contact Holophane for more information on the Director Series control capabilities.



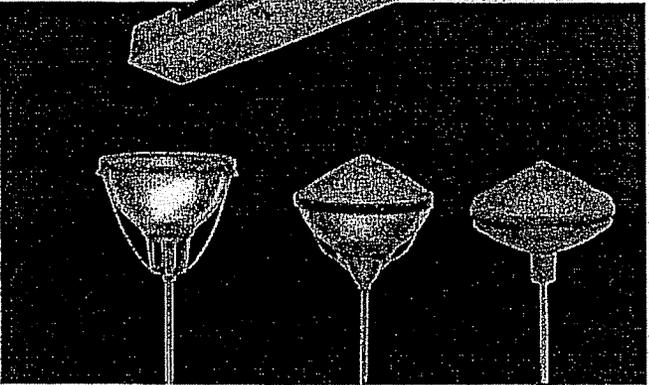
HOLOPHANE®

Available with Illuminaire™



The surface ballast configuration will also be available with the Illuminaire™. This allows for the aesthetically pleasing optical assembly of this exciting new product to be powered by the most efficient electronic ballast. The PrismaTron has dimming capabilities that add an excellent ambience to retail and commercial applications, as well as in religious and institutional areas.

Surface Mounted PrismaTron Ballasts



- Large 02A54
 - PrismaTronPrismaLume
 - Enclosed
 - PrismaPackPrismaPack
 - PrismaClio
- RGRIL

following existing fixture families; used in conjunction with the ceiling. This surface ballast can be being pendant hung from the open area away from the luminaire itself can easily be mounted in a configuration for both single and tandem units. The ballast capsule configuration for both single and available in a surface mounted PrismaTron ballasts are and not vertically mounted to the luminaire, PrismaTron ballasts are removed from the fixture itself in cases where the ballast needs to

PRISMATRON™ POWERED



Typical Layout

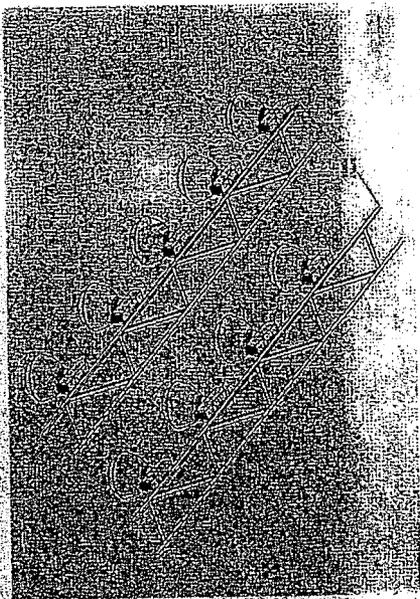


Figure 1 - Typical Single Configuration

- Supply cord and connector cable parallel to truss
- Easiest layout, most flexibility

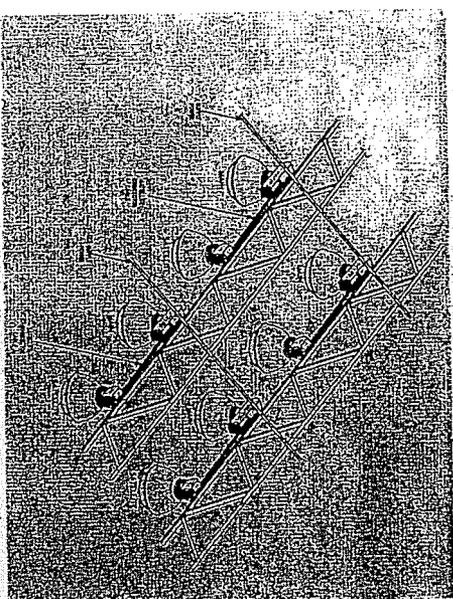
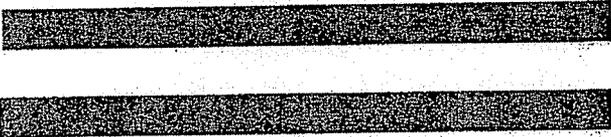


Figure 2 - Typical Tandem Configuration

- Supply cord is perpendicular to truss
- Connector cable parallel to truss
- Pipe and wire savings versus previous layout (fewer supply power runs)



PRISMATRON™ POWERED

19

HOLOPHANE®



HOLOPHANE®
11100 401 0200 Acuity Lighting Group, Inc.

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS
An Acuity Brands Company

Acuity Lighting Group, Inc.
1114 Oldwood Ave., Newark, NJ 07102 /
Holographix Canada, Inc. 8000 14th Street, Suite
208 Montreal, PQ H3T 1A4 / Holographix
Australia, Pty. Ltd. 100/100-1000
100, Springwood / Holographix, S.A. de C.V.
Avenida Piedad No. 918, Neopolis de Juarez,
53000 Edo. de Mexico
Contact your local Holographix Factory sales
representative for application assistance, and
information on other lighting products and
systems, call the toll-free customer department
at 740-345-9311. In Canada call 905-970-
5839 or fax 905-970-5835.
Limited Warranty and Limitation of Liability
refer to the Holographix Factory literature.
The Holographix logo, name, and other
product, which are published in the "Term and
Condition" section of the current product
spec, and is available from our local Holographix
sales representative.
Visit our web site at www.holographix.com

Printed in USA

"R" Series 2' x 2' Recessed Louver

Dimensions	Fixture Height	Fixture Width	Approx. Ship Wt.
RTV Series	10.75"	23.75" Sq.	35 lbs.
RMV Series	10.75"	23.75" Sq.	40 lbs.

10.75"

23.75"

The HD Recessed 2' x 2' is typically used in low height areas that require high brightness and high quality illumination. Ideal for office, commercial or retail areas.

Housing

One-piece, step housing with high reflective white powder coating.

Ballasts

A Potted magnetic CWA Quadrate Electronic dimmable 350-400W Pulse Start Ballast can be used.

Electronic Ballast

Fixture can be offered with fully dimmable electronic ballast which can be attached to various controls to operate 350W or 400W Pulse Start Metal Halide Lamp.

Lamps

175W 250W & 400W MH and 250W 400W Pulse Start MH and 50W 400W TPS mogul based vertical born coated lamps are standard.

Optics

Diffused clear parabolic 16-cell or 9-cell 4" deep aluminum louvers sit in the middle of a black reveal.

Thermal Protector

This fixture is fitted with a cutout to protect against overheating.

Mounting Options

Designed to fit a standard 2' x 2' grid using T type ceiling support bracket.

Warranty

The 2' x 2' Series R Series Square Recessed Fixture sold by C E W Lighting, Inc., unless otherwise specified, will be warranted to be free of defects in materials and workmanship under normal use and service for a period of five (5) years from date of shipment, 175W 400W and (3) years for the electronic ballast. If found to be defective by us, we will replace the non-performing components.

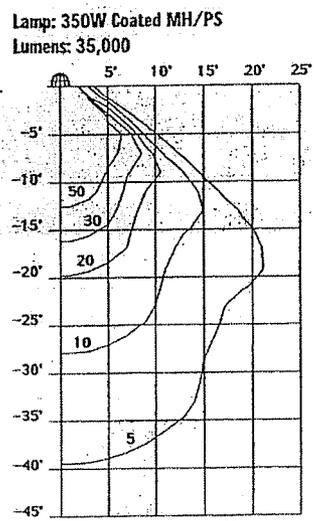


40°C Ambient Rated

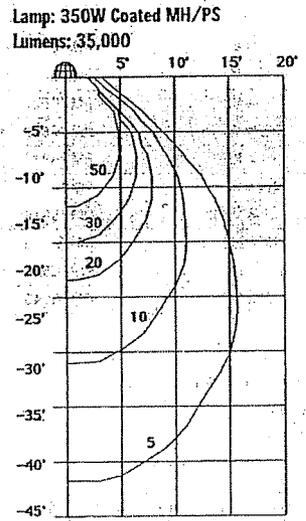


LISTED FOR RECESSED/DAMP LOCATIONS
CONSULT FACTORY FOR CUL AVAILABILITY

I.E.S. photometrics available by e-mail or on disk



9 Cell Louver



16 Cell Louver



To build catalog numbers refer to inside front cover

Recessed Fixture Order Information

Catalog Numbers

Housing Size	Wattage Lamp	Magnetic Ballast Open Rated	Electronic Ballast Open Rated
24" Square			
Grid Mount			
	175W MH	RMVG217-(a) (b)	
	250W MH	RMVG225-(a) (b)	
	250W MH	RMVG925-(a) (b)	
	300W MH	RMVG935-(a) (b)	RMVG935-(a) (b)
	400W MH	RMVG440-(a) (b)	
	400W MH	RMVG940-(a) (b)	RMVG940-(a) (b)
	150W HPS	RMVG515-(a) (b)	
	250W HPS	RMVG525-(a) (b)	
	400W HPS	RMVG540-(a) (b)	

(a) Voltage Suffix Key: Indicate voltage in space (a)

Description				
Magnetic Only				Magnetic Only
1	2	3	4	M
120V	277V	208V	240V	Multi-tap

(b) Options: Indicate options in space (b) (Factory Installed)

Description	SUFFIX (b)
High-2-Low™ (CWA Magnetic Only)	H
Quartz Option (Electronic ETL Listed)	Q
9 Cell Louver	L9
16 Cell Louver	L16

*Consult Customer Service or Your Local Sales Rep for control options for Electronic Ballast/See Pgs. 90-93

"R" Series 2 X 2 Recessed Louver Lens

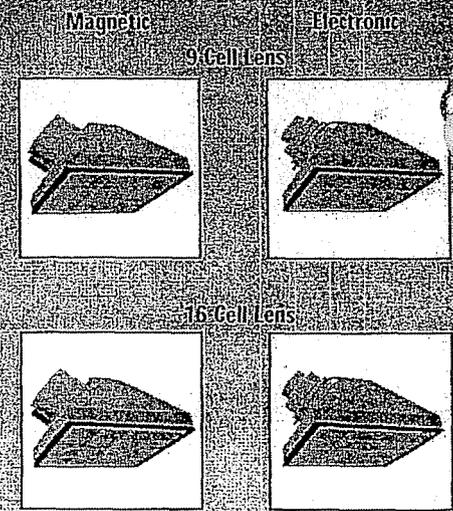
Wattage Range
175-400W (Magnetic)
350-400W (Electronic)



Lamp Holder

Electronic Housing with 9 Cell Louver shown

LOUVER OPTIONS



PHILIPS

SEARCH

PHILIPS LIGHTING | North America | Product Information | Lighting App Center | Featured Events | Pressroom | Where To Buy

The Light Site North America

MARATHON HOME
 ABOUT MARATHON

PRODUCTS

- Outdoor
- Household
- Specialty
- Table Lamp
- Universal
- Dimmable

OUR GUARANTEE

SAVE MONEY

WHERE TO BUY

FACTS OF LIGHT

Contact Philips Lighting
1.800.555.0050

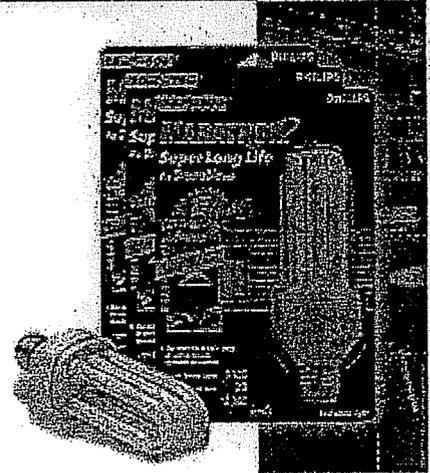


Dimmable

Super Long Life

Ideal for...

- Sockets controlled by standard incandescent dimmers, photosensors, electronic timers, motion detectors, or occupancy sensors
- Downlights



- **Dimmable**
Allows user control of light levels down to 10%
- **Super Long Life**
Reduces maintenance costs with average rated life of 10,000 hours (longer than incandescent lamps)
- **No additional control wiring is required**
Can be used with standard wall dimmers, photosensors, electronic timers, or occupancy sensors
- **Amalgam Technology**
Provides stable light output over broad range of temperatures and of positions for indoor and outdoor applications—ideal for use in recessed applications
- **Energy Savings**
Saves up to 70% in electricity costs compared to incandescent lamps
- **Soft, White Light**
Tri-chromatic phosphors provide light similar to soft white incandescent lamps
- **Medium Screw Base**
Direct retrofit into existing incandescent applications

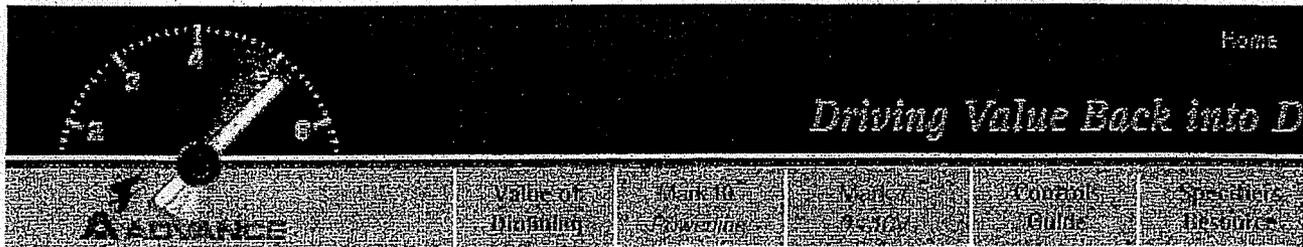
| ©2003 Koninklijke Philips Electronics N.V. All rights reserved. | [Privacy policy](#) |
| [Philips](#) | Access to and use of this Web Site is subject to these [Terms of Use.](#)|

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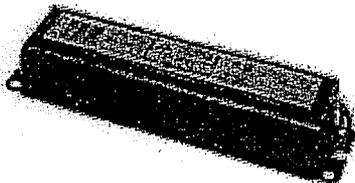
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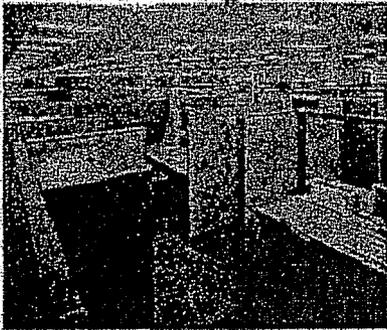
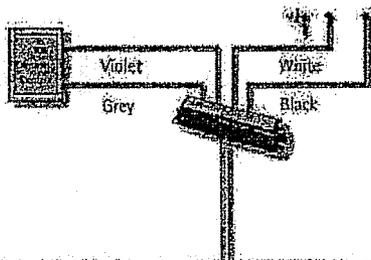
- FEATURES AND BENEFITS
- CONTROLLABILITY
- COMPATIBILITY
- LINKS TO ON-LINE ATLAS

Mark 7

The Mark 7™ 0-10V Solutions...



Mark 7 0-10V
Dimming Ballast —
4-Wire Installation



About the Mark 7™ 0-10V Dimmable Electronic Ballast

Designed to operate both linear fluorescent and 4-pin compact fluorescent lamps, family of controllable electronic ballasts satisfies the need for an affordable, flexible dimming solution. Newer models provide operation for up to six lamp types from . This flexibility is achieved through design breakthroughs, such as IntelliVolt™, Ad full range operation, 120 through 277 volts at 50 or 60 Hz.

Features and benefits include:

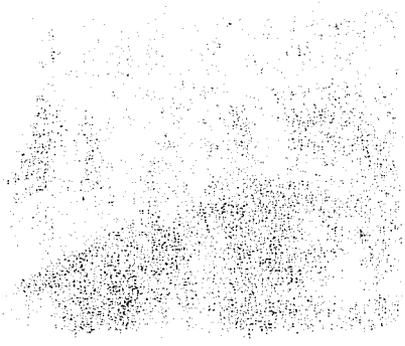
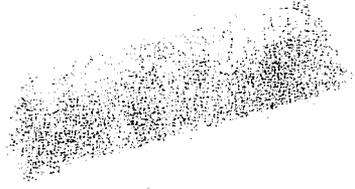
- 100%-5% Full range continuous dimming for flexibility and energy efficiency
- IntelliVolt™ operation (CFL only) from 120 through 277 volts @ 50 or 60 Hz for management and flexibility
- The most simplified connection system available
- Programmed-start operation providing continuous flicker-free dimming
- Lamp end-of-life circuitry provides additional protection
- Advance reliability, backed by a full 5-year warranty

Use Mark 7 0-10V when you're looking for...

- Total lighting control
- Unlimited flexibility in lighting controls
- Building management systems compatibility
 - Emergency lighting systems
 - Cleaning schedules
- Energy management applications
 - Daylight harvesting
 - High/low occupancy and safety applications
 - Places control in energy manager's hands, not individuals
- Retail applications where skylights are utilized
- Remote controllability
 - Internet-based control schemes



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Advance Dimming Ballasts Control Compatibility Guide

Occupancy Sensor - Mark X® Powerline

Control Manufacturer	Product Model	Occupancy System	Power Ballast Availability
Lutron Lighting Controls Div.	800-824-3095 www.lutron.com	Multi-Tap Wall Occupancy Sensor: DMW-2, Wide View Occupancy Sensor: DMWV, High Bay Occupancy Sensor: DMWB, Multi-Tap Ceiling Occupancy Sensor: DMCC, DMCC10 and DMCC20, Ultra-wide Ceiling Occupancy Sensor: DMCS, DMCS10 and DMCS20, PIR Ceiling Occupancy Sensor: DMCC4	00P S418 00P S419 00P S419 00P S419
Marlin Controls, Inc.	214-553-5700 www.marlincontrols.com	Starlight Dimming System	HP-200 HP-200 HP-200
Mytek Corp.	812-451-1100 www.mytek.com	QMR, Light Day, Light Night, L-2	WN3071
Herlight	214-423-3100 www.herlight.com	U-2R	WN3045
Trank, Inc.	770-242-1822 www.trank.com	U-2R	L-1HP-PWRBCK

Photocell Sensor - Mark X® Powerline

Control Manufacturer	Product Model	Photocell System	Power Ballast Availability
Trank, Inc.	770-242-1822 www.trank.com	U-2R and PHOTO	

Building Management System - Mark X® Powerline

Control Manufacturer	Product Model	Building Management System Interface	Power Ballast Availability
Advanced Logic Corp.	714-221-8000 www.advancedlogic.com	N Series S Series	24 VAC 24 VAC
AAK Corp.	800-222-8183 www.aak.com	RDD-DIM and RDD-DIM-E, RDR-HIC, RDR-ZINC and RDR-HIC50	
AVA America, Inc.	877-737-7374 www.ava.com	PMR Series - Model DD, DM, & DM1	
Orton Electronics, Inc.	888-ORSTRON www.orton.com	CELEST™ Lighting System	
Herlight	214-423-3100 www.herlight.com	Direct WR 338-E-214, Gateway SIV-HIC-14	24VAC 24VAC



Total Building Lighting Control System - Mark X® Powerline

Control Manufacturer	Product Model	Total Building Lighting Control System	Power Ballast Availability
AAK Corp.	800-222-8183 www.aak.com	RDD-DIM and RDD-DIM-E, RDR-HIC, RDR-ZINC and RDR-HIC50	
AVA America, Inc.	877-737-7374 www.ava.com	PMR Series - Model DD, DM, & DM1	
Bladder	812-944-0739 www.bladder.com	BBMO-MX-4-1H	
Orton Electronics, Inc.	888-ORSTRON www.orton.com	CELEST™ Lighting System	
Electronica Diversified, Inc.	502-845-5533 www.electra.com	Mark X System Rack Profile Dimming System and Verza-PK System	
Unihic Electric Products Co.	610-385-3366 www.unihic.com	APCL Inverters	PKX
Lutron Lighting Controls Div.	800-404-3500 www.lutron.com	Lutron e-2000 Dimmer System, Lutron H405 Dimmer System, Lutron i-series Dimmer System	
Lighting Control & Design	323-221-0000 www.lightingcontrol.com	GR 4000	
Unihic Controls	770-987-4300 www.unihic.com	Synergy System	
Marlin Controls, Inc.	214-553-5700 www.marlincontrols.com	Starlight Dimming System	
Trank, Inc.	770-242-1822 www.trank.com	APCL Inverters	

System Control Module Interface - Mark X® Powerline

Control Manufacturer	Product Model	System Control Module Interface	Power Ballast Availability
AVA America, Inc.	877-737-7374 www.ava.com	PMR Series - DMX	
Bladder	812-944-0739 www.bladder.com	BBMO-JK-4-1R	
Electronica Diversified, Inc.	502-845-5533 www.electra.com	Mark X System Rack Profile Dimming System and Verza-PK System	
Unihic Electric Products Co.	610-385-3366 www.unihic.com	Solstice	PKX
Lutron Lighting Controls Div.	800-404-3500 www.lutron.com	Lutron e-2000 Dimmer System, Lutron H405 Dimmer System	
Lighting Control & Design	323-221-0000 www.lightingcontrol.com	GR 4000	
Marlin Controls, Inc.	214-553-5700 www.marlincontrols.com	Starlight Dimming System	
Herlight	214-423-3100 www.herlight.com	WRB with WRT 5731-4W or WRB with WRT 5771-44	
Tech-Plan	219-461-4332 www.techplan.com	MCD-4000	
Verza-Lighting	615-455-4400	DCM with E-90 (optional) or M31 (standard)	

Advance Dimming Ballasts Control Compatibility Guide

Architectural Control - Mark X® Powerline

Control Manufacturer	Product/Model	Architectural Control	Power Ballast Available
ALM Systems, Inc.	847-800-1490 www.alm.com	AJUI	
AMX Corp.	800-222-0193 www.amx.com	RDD-DIM and RDD-DIM6 RDM-IRC, RDM-2INC and RDM-HC50	
AVAB America, Inc.	877-897-2374 www.zenith.com	PWR Series - Models DD, DIM, & UNI	
Blackbird	812-844-0739	BEACON-UB-IR	
Crestron	888-673-7878 www.crestron.com	Crestron™ Lighting System	
Electronics, Inc.	503-646-5533 www.electronics.com	Profile Dimming System and Vira-Pak System	
Diversified, Inc.	608-831-4116 www.diversified.com	UNISON	
Electronic Theatre Products, Inc.	503-404-5500 www.etp.com	EVR and I Series EVR and I Series Quad	
Coorona, A Leviton Co.	970-684-9048 www.leviton.com	Pre-set slide: PS-600-IV Mark X and PS-600-VH Mark X (120V) Pre-set slide: PS-600-3W-IV Mark X and PS-600-3W-VH Mark X (120V) Pre-set slide: PS-600-IV Mark X and PS-600-VH Mark X (277V) Pre-set slide: PS-600-3W-IV Mark X and PS-600-3W-VH Mark X (277V) Slide: SC-15-IV Mark X and SC-15-VH Mark X (120V) Slide: SC-15-IV Mark X and SC-15-VH Mark X (277V) Slide: SC-15-W Mark X and SC-15-WH Mark X (277V) Slide: SC-15-W Mark X and SC-15-WH Mark X (120V) Pre-set slide for Modular Mark X systems: PS-FC3W-IV Mark X and PS-FC3W-VH Mark X FD-30 Mark X and FD-20 Mark X 120V MASTER FD-30-S Mark X and FD-20-S Mark X 120V SLAVE FD-21 Mark X 277V MASTER and FD-21-S Mark X 277V SLAVE	
Lehigh Electric Products Co.	610-395-3388 www.lehigh.com	Solista® AGL Interface	PBK
Levicon Lighting Controls Div.	503-404-5500 www.levicon.com	Levicon e-2000 Dimmer System Levicon MDS Dimmer System Levicon 1 Series e-Dimmer System	
Lighthouse	600-824-5065 www.lighthouse.com	Power Master Station 120V, DPSE-142, DPSE-152, and DPSE-152 Master 120V: MDX10-1L and 277V: MDX20-7 Master 120V: MDX10-1L and 277V: MDX20-7 Relay 120V: E808-51 and 277V: E888-57	DPSE-112 (for 120V versions) DPSE-112 (for 277V versions) DPSE-112 (for 120V versions)
Lighthouse	800-525-2731 www.lighthouse.com	Lyramode module LMC-2000EB (120V) and LMC-2000EB-32 (180V) and LM-2000EB (277V)	Dimming cabinet
Lighting Control & Design	323-226-0000 www.lightingcontrol.com	GR-4000	
Libra Controls	770-917-4300 www.libra.com	Stargate System Synergy System	
Marlin Controls, Inc.	214-553-5700 www.marlincontrols.com	Starlight Dimming System	
Nextlight	216-828-3700 www.nextlight.com	WBH with WTV 500K Series	
Stamer Controls	920-543-3585	BPM-BNVL-2W or ABA Series	
Strand Lighting	310-637-7600 www.strandlighting.com	DE90 Dimming System (120/277V)	
Touch-Pak	214-424-4223 www.touchpak.com	CPD-000	
Vintage	801-292-2800 www.vintage.com	SP-008-100	
Vira-Light/HUB	815-455-4400	DCH with FL-60 (digital) or M35 (analog)	

ADVANCE Where great lighting starts.

Remote Control Via Computer - Mark X® Powerline

Control Manufacturer	Product/Model	Remote Control Via Computer	Power Ballast Available
AMX Corp.	800-222-0193 www.amx.com	RDD-DIM and RDD-DIM6 RDM-IRC, RDM-2INC and RDM-HC50	
AVAB America, Inc.	877-897-2374 www.zenith.com	PWR Series - Models DD, DIM, & UNI	
Coorona, A Leviton Co.	503-404-5500 www.leviton.com	EVR and I Series I Series E and I Series Quad	
Crestron Electronics, Inc.	888-673-7878 www.crestron.com	Crestron™ Lighting System	
Electronics, Inc.	503-646-5533 www.electronics.com	Profile Dimming System and Vira-Pak System	
Lehigh Electric Products Co.	610-395-3388 www.lehigh.com	Solista® AGL Interface	PBK
Levicon Lighting Controls Div.	503-404-5500 www.levicon.com	Levicon e-2000 Dimmer System Levicon MDS Dimmer System Levicon 1 Series e-Dimmer System	
Lighting Control & Design	323-226-0000 www.lightingcontrol.com	GR-4000	
Marlin Controls, Inc.	214-553-5700 www.marlincontrols.com	Starlight Dimming System	
TRAC, Inc.	770-242-1822 www.trac.com	LP-2500, LP-2500, LP-2500 and RCS-1000	
Nextlight	216-828-3700 www.nextlight.com	LS III and WR3365-64AK	WR3365-64
Vira-Light/HUB	815-455-4400	DCH with FL-60 (digital) or M35 (analog)	

Theatrical Control - Mark X® Powerline

Control Manufacturer	Product/Model	Theatrical Control	Power Ballast Available
AMX Corp.	800-222-0193 www.amx.com	RDD-DIM and RDD-DIM6 RDM-IRC, RDM-2INC and RDM-HC50	
Coorona, A Leviton Co.	503-404-5500 www.leviton.com	EVR and I Series I Series E and I Series Quad	
Crestron Electronics, Inc.	888-673-7878 www.crestron.com	Crestron™ Lighting System	
Electronics, Inc.	503-646-5533 www.electronics.com	Profile Dimming System and Vira-Pak System	
Electronic Theatre Controls, Inc.	608-831-4116 www.etp.com	SENSOR	
Lehigh Electric Products Co.	610-395-3388 www.lehigh.com	AGL Interface	
Levicon Lighting Controls Div.	503-404-5500 www.levicon.com	Levicon 1 Series e-Dimmer System	
Libra Controls	770-917-4300 www.libra.com	Synergy System	
Strand Lighting	310-637-7600 www.strandlighting.com	CE90 Dimming System (120V)	
Vira-Light/HUB	815-455-4400	DCH with FL-60 (digital) or M35 (analog)	

Advance Dimming Ballasts Control Compatibility Guide

Wallbox Dimmer - Mark VII* 0-10V

Control Manufacturer	Phone/ Website	Wallbox Dimmer	Power and Slave Packs Required
Douglas Lighting Controls	404.873.2797 www.douglaslightingcontrols.com	WPC-6721	
Honeywell, Inc.	800.345.6770 www.honeywell.com	EL7315A1019 and EL7315A1009	EL7305A1010 (optional)
HUNT Dimming	970.484.9048 www.huntlighting.com	Preset slider: PS-010-IV-120V and PS-010-WH-120V Preset slider: PS-010-3W-IV-120V and PS-010-3W-WH-120V Preset slider: PS-010-IV-277V and PS-010-WH-277V Preset slider: PS-010-3W-IV-277V and PS-010-3W-WH-277V Preset slider, controls FD-010: PS-IFC-010-IV- and PS-IFC-010-WH-120/277V Preset slider, controls FD-010: PS-IFC-010-3W-IV- and PS-IFC-010-3W-WH-120/277V Remote mounted unit: FD-010-120V and FD-010-277V	
Lehigh Electric Products Co.	610.395.3386 www.lehigh.com	Solitair	PEX
Leviton Lighting Controls Div.	800.824.3005 www.leviton.com	Leviton Centura Fluorescent Control System NumaTech™ IP7 Series DPSPE-212 (Slave Pack converts any Leviton dimmer to Mark VII)	CH100
Lightolier	800.528.2731 www.lightolier.com	ZP600FAM120 Sunrise Preset slider (120V) MP1500FAM120 Momentum Preset slider (120V) V2000FAMU Vega Slider (120/277)	
Lithonia Controls	770.987.4400 www.lithonia.com	LEQ BC LEQ LVBC and SLD LVBC SQ10C	LPCS power control station ROM FC
PDM Electrical Products*	514.342.0581	WPC-6721	
The Watt Stopper, Inc.	800.879.8585 www.wattstopper.com	LS-A used with LCD-10T and LCD-10S	

*Note: PDM Electrical products is a subsidiary of Douglas Lighting Controls.



Occupancy Sensor - Mark VII* 0-10V

Control Manufacturer	Phone/ Website	Occupancy Sensor	Power and Slave Packs Required
Cutler-Hammer	800.481.6870 www.cutlerhammer.com	PRC1000C PRC100LSI PRL100LSO PRC100LSA PRC100LES	
Leviton Lighting Controls Div.	800.824.3005 www.leviton.com	Multi-Tech Wall Occupancy Sensor: ODW 12 Wide View Occupancy Sensor: ODWV High Bay Occupancy Sensor: ODWHB Multi-Tech Ceiling Occupancy Sensor: ODC05, ODC10 and ODC20 Ultrasonic Ceiling Occupancy Sensor: ODC05, ODC10 and ODC20 Ceiling Occupancy Sensor: ODC04 PIR	CH100 CH100 CH100 CH100 CH100 CH100
Lithonia Controls	770.987.4200 www.lithonia.com	LIRW wall box sensor LMT0-H multi-technology Omni directional sensor with LPCS LMT-H multi-technology directional with LPCS LUSD-H ultrasonic ceiling mount with LPCS LIR0-H infrared ceiling mount with LPCS LIR-H infrared directional with LPCS	
Marlin Controls, Inc.	214.553.5700 www.marlincontrols.com	EFD	
Mytech Corp.	512.450.1100 www.mytech.com	OMNI Light Owl Light Hawk LP-2	MP-xxxx MP-xxxx
Novitas	310.598.9600 www.novitas.com	Ceiling Sensors: 01-080, 01-072, 01-083 and 01-092 BAS Ceiling Sensors: 01-074, 01-084 and 01-094 Ceiling Sensors: 01-076, 01-082 and 01-091 Designer Ceiling Sensors: 01-100, 01-160, 01-180, 01-110 and 01-180 Super Dual Technology Sensor: D1-300 High Bay Sensor: 01-320 SuperSwitch Mini-Wall Sensor: 01-220 SuperSwitch Mini-Wall Sensor: 01-230 SuperSwitch Mini-Wall Sensor: 01-280 Airflow Tolerant Sensors: 01-077 and 01-087 Extreme Temperature Sensor: 01-340	13-031, 13-041, 13-051, 13-061 or 13-071 24VAC Transformer GERR7 24VAC Transformer 13-031, 13-041, 13-051, 13-061 or 13-071 13-031, 13-041, 13-051, 13-061 or 13-071 13-031, 13-041, 13-051, 13-061 or 13-071 13-031, 13-041, 13-051, 13-061 or 13-071 GERR7 24VAC Transformer 24VAC Transformer 13-031, 13-041, 13-051, 13-061 or 13-071 13-031, 13-041, 13-051, 13-061 or 13-071
The Watt Stopper, Inc.	800.879.8585 www.wattstopper.com	IRT-1000, Desktop Remote Control Dimmer IRT-1000 w/Power Strip Desktop Remote Control Dimmer W Series, Ultrasonic Occupancy Sensor WT Series, Ultrasonic Occupancy Sensor CI Series, PIR Occupancy Sensor CX Series, PIR Occupancy Sensor DI Series, Dual Technology Occupancy Sensor	B120E-P or B277E-P or Isolo Power Strip B120E-P or B277E-P B120E-P or B277E-P B120E-P or B277E-P B120E-P or B277E-P
Triatek, Inc.	770.242.1922 www.triatek.com	LP-IR	LP-IR-PWRPACK

Advance Dimming Ballasts Control Compatibility Guide

Photocell - Mark VII® 0-10V

Control Manufacturer	Dimmer/Variable	Photocell	Power and Shape Factor Required
Douglas Lighting Controls	604.873.2797 www.douglaslightingcontrols.com	WFC-5700	
Leviton Lighting Control Div.	800.874.3005 www.leviton.com	Levtron Century Fluorescent Control System Photocell: 00DOP	CH100 CH100
Lithonia Controls	770.947.4200 www.lithonia.com	LEO OPC	
Alvach Corp.	512.460.1100 www.alvach.com	DLG7	
Novitas	310.568.9800 www.novitas.com	Indoor Photocell: 01-PCI Outdoor Photocell: 01-PCO Autium Photocell: 01-PCA Sylight Photocell: 01-PCS Indoor Photocell: 01-PDI	13-03113-04113-05113-06113-071 or 01-PCC 13-03115-04113-05113-06113-071 or 01-PCC 13-03115-04113-05113-06113-071 or 01-PCC 13-03113-04113-05113-06113-071 or 01-PCC
P.L.C. Multipoint	425.933.7852 www.plcmultipoint.com	EDSAB and RCD	
PDM Electrical Products	514.342.5551	WFC-5700	
Stator Switch, Inc.	203.265.2842 www.statorswitch.com	GM-ALC	
Thruak, Inc.	770.242.1922 www.thruak.com	LP-PC	
The Watt Stopper, Inc.	800.878.8585 www.wattstopper.com	LIGHTSAVER LED - 101 LIGHTSAVER LED - 103 LS-200 Light Level Sensor LS-100 Light Level Controller	81205-P or 8271E-P

*Note: PDM Electrical Products is a subsidiary of Douglas Lighting Control.

Building Management System - Mark VII® 0-10V

Control Manufacturer	Dimmer/Variable	Building Management System	Power and Shape Factor Required
AMX Corp.	800.222.0718 www.amx.com	Radix (RDM-100) RDM-DC Series Dimmers	
AMX America, Inc.	877.787.7374 www.amx.com	PVE Series - FV	24 VAC 24 VAC
Autombed Logic Corp.	770.420.3000 www.autombed.com	M Series S Series	
Creston Electronics, Inc.	848.028.0200 www.creston.com	Creston™ Lighting System	
Johnson Controls	414.274.4000 www.johnsoncontrols.com	Application Specific	
Lithonia Controls	770.947.4200 www.lithonia.com	Synergy lighting control system	
Naught	216.828.3700 www.naught.com	Direct WR 388-384K Gateway SIU Interface	



Total Building Lighting Control - Mark VII® 0-10V

Control Manufacturer	Dimmer/Variable	Total Building Lighting Control System	Power and Shape Factor Required
AMX Corp.	800.222.0718 www.amx.com	Radix (RDM-100) RDM-DC Series Dimmers	
AMX America, Inc.	877.787.7374 www.amx.com	PVE Series - Modifi FV	
Blackbird	812.824.0799	ZBMC-FL574B-IR	
Credion	848.028.0200	Creston™ Lighting System	
Electronics Direct, Inc.	503.845.5533 www.electronicsdirect.com	Mark VII System Rack Proba Dimming System and Vira-Pak System Electronic Ballast Controller	PBX
Licht Electric Products Co.	610.395.3368 www.lights.com	Synergy Social™ DCL Interface	
Levtron Lighting Control Div.	800.874.3005 www.levtron.com	Levtron 2-2000 Dimmer System Levtron MDS Dimmer System Levtron Century Fluorescent Control System	CH100
Lighting Control & Design	323.228.0000 www.lightingcontrol.com	QR 4000 EFD	
Matlin Controls, Inc.	214.553.5703 www.matlincontrols.com	Direct WR 3286-384K Gateway SIU Interface	
Naught	216.828.3700 www.naught.com	LP-LINK and LP-20V6	
Thruak, Inc.	770.242.1922 www.thruak.com		

System Control Module Interface - Mark VII® 0-10V

Control Manufacturer	Dimmer/Variable	System Control Module Interface	Power and Shape Factor Required
AMX America, Inc.	877.787.7374 www.amx.com	PVR Series - Modifi DMKE	
Blackbird	812.824.0799	ZBMC-FL574B-IR	
Crest-Hammer	803.481.8870 www.crest-hammer.com	POWER-Command System PROCD Panel Board with GIBBS Circuit Breakers	PBX
Electronics Direct, Inc.	503.845.5533 www.electronicsdirect.com	Mark VII System Rack Proba Dimming System and Vira-Pak System Electronic Ballast Controller	CH100
Johnson Controls	414.274.4000 www.johnsoncontrols.com	Application Specific	
Lithonia Controls	610.395.3368 www.lithonia.com	Synergy DCL Interface	
Lithonia Lighting Controls Div.	503.845.5533 www.lithonia.com	Levtron 2-2000 Dimmer System Levtron MDS Dimmer System Levtron Century Fluorescent Control System	
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Matlin Controls, Inc.	214.553.5700 www.matlincontrols.com	EFD	
Naught	216.828.3700 www.naught.com	WRT 424-84	
Horst Controls	330.076.1010 www.horstcontrols.com	FU (Fluorescent Dimming Interface)	
Touch-Pak	218.424.4323 www.touchpak.com	CPD-3000 D MCP-2000	
Virt-Lighting	815.455.4400	FF-Analog and FF-SH-Digital	EBIC



Guidelines on the Application of Dimming to High Intensity Discharge Lamps

A NEMA Lighting Systems Division Document

Prepared by

Lamp Section
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, Virginia 22209
Approved May 13, 2002

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Guidelines on the Application of Dimming to High Intensity Discharge Lamps

Preface

The exact performance of any high intensity discharge (HID) dimming system or of the lamp on that system is dependent upon the specific dimming circuitry employed with specific ballasts and lamps. These guidelines are meant to impart general information and considerations in the design and application of such systems. Contact the manufacturers of the lamps and dimming systems for specific recommendations. As there are few existing standards for the dimming of HID lighting systems, it is recommended that the user, lighting designer or specifier evaluate any new proposed combination of components as a system in a field test to ensure that the combined performance of the system is acceptable.

Common Types of Lamp Dimming Systems

Recently, there has been increased interest in HID dimming circuits for energy conservation applications. There are presently two types of lamp dimming systems in common use: (1) step-level or bi-level and (2) line voltage.

The step-level system generally operates by switching capacitive or inductive impedance into the ballast output to reduce the lamp current and therefore the lamp wattage. These systems are often used in conjunction with occupancy detection systems, although many types of switching controls are available. In a typical application, infrared or ultrasonic occupancy sensors are utilized to detect motion in the controlled area. During the period in which motion is detected by the sensors, the lamps operate at rated wattage. With the absence of local activity over a certain period of time, a switching mechanism in the system reduces the lamp power to a predetermined wattage, generally not lower than 50 percent of rated lamp wattage.

Line voltage dimming circuits work by changing the primary voltage to the whole system with a variable voltage transformer, by electronically modifying input voltage and current waveforms (so-called "phase control"), by employing electronic low or high frequency switching circuits, or by combinations of electronic and mechanical devices (so-called "hybrid systems") to modify the lamp power. All of these systems can reduce lamp wattage continuously. These

systems, however, have not been fully explored; and lamp power reduction due to line voltage control should generally be less than 50 percent of rated lamp wattage. Questions on line voltage lamp dimming should be directed to individual lamp or controller manufacturers.

Ideal applications of these energy saving systems include parking garages, warehouses, shipping docks, street lights, supermarkets, ball fields, factories, and security lighting. They are also used in conjunction with daylight lighting systems to conserve energy.

Issues, such as color shift and lamp performance, continually arise regarding the use of HID lamps on dimming systems. NEMA Lamp Section members make these recommendations addressing dimming issues.

A General Statement

HID lamps are designed to keep the lamp electrodes and discharge tube wall operating within a specific temperature range in order to maintain the proper vapor phase concentrations of discharge tube additives. Thus, when dimming lamps, users will experience degradation of efficacy, color, and life if the starting and operating recommendations below are not followed.

Since the exact situation is dependent on how long the lamps are operated in the dimmed mode, the type of dimming system, and how deeply the lamps are dimmed, it is difficult to quantify the effect on life when dimming an HID source. Lamp and ballast systems should meet the requirements of the appropriate American National Standards Institute (ANSI) specifications for both starting and operating lamps at full power. The information below represents some practical guidelines when considering an energy saving HID dimming system.

High Pressure Sodium

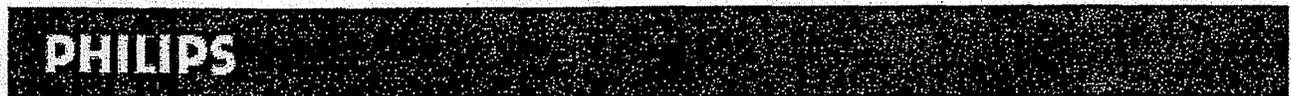
It is recommended that high pressure sodium (HPS) lamps be started and operated in the full power mode, i.e. at rated wattage, for a minimum of 15 minutes before dimming. This is necessary to clean the arc tube of deposits from starting that would artificially raise the arc voltage and promote reaction with the alumina tube. If an interruption to the ballast input voltage should occur, the lamp may extinguish and require several minutes to re-ignite. The timing circuit should be reset for 15 minutes only after the lamp has restarted. If the input voltage activates the timer, then 30 minutes is recommended before dimming is resumed.

Users need to be aware that there may be decreases in lamp color temperature and color rendering with dimming; and, depending on the depth of the reduction, there can be a loss of luminous efficacy. As a general guideline, when dimmed below 50 percent wattage for sustained periods, there is an increased likelihood of poor lumen maintenance and shorter lamp life.

LSD 14-2002

References

- "Dimming of Philips Metal Halide Lamps," *Philips Lighting Technical Bulletin*, June 1992.
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- *IESNA Handbook*, 9th Edition, pp. 6-34 and 6-55, 2000.
- R. G. Gibson, "Dimming of Metal Halide Lamps," *Journal of the IES*, No. 23, No. 2, pp. 19-23, 1993.



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New Philips electronic ballasts offer a cost-effective control solution for outdoor lighting



Compact, one-piece HID-DynaVision ballasts combine energy savings, high flexibility and system connectivity

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A new range of compact electronic ballasts from Philips Lighting meet the need to save energy, reduce cost of ownership and improve the quality of outdoor lighting. The HID-DynaVision ballasts offer a fully electronic solution for the lamps which are widely used for lighting of roads and many other outdoor locations. These ballasts are compatible with all main SON lamp brands and are compatible with all future (mercury-free) SON lamps. They can also be used with CDM lamps from 35 to 150 W.

Controlled, dimmable outdoor lighting

These new ballasts satisfy the increasing need of local authorities for light management concepts that enable a high degree of flexibility in control and dimming of outdoor lighting. This means that lighting can be optimally managed according to the prevailing conditions, for example different visibility levels, changing traffic volumes on roads or abnormal conditions such as accidents. Not only is energy saved by providing only the amount of light that is required, but at the same time excessive artificial lighting - frequently referred to as light pollution - can be avoided.

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HID-DynaVision ballasts enable optimum energy-efficiency to be achieved through their electronic operation, with significant energy savings at all dimming levels. Lamp operation is stable and flicker-free with all types of SON lamps over the full range of dimming levels from 100% down to 20%. The lamp output is held constant across a wide range of mains voltage fluctuations from 205 to 254 V, which ensures optimum lamp lifetime. But the greatest benefit arising from electronic operation is the feedback of data from the system, which minimises the need for constant spotting and costly unscheduled relamping interventions, as well as maximising road safety and helping to avoid liability claims. Further to energy economy, HID-DynaVision has a power factor of 0.98 at 100% operation, and a high power factor is maintained during dimming.

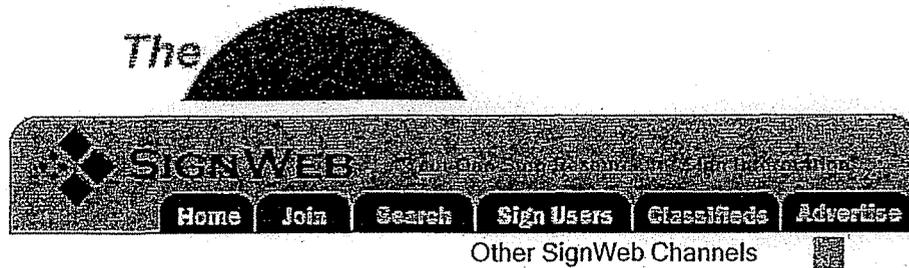
Group lighting schemes

The HID-DynaVision ballasts are designed to be incorporated in group lighting schemes, for example in telemanagement systems in which blocks of lamps are switched and controlled dynamically in response to varying needs and conditions. For this purpose HID-DynaVision offers connectivity with different control systems, including the standard 1-10 V controllers or the industry-standard DALI digital system which enables integrated switching and dimming functions with a high degree of programmability at individual lamp level. Use of the DALI system allows not only highly flexible lamp control, it also provides constant feedback of lamp status and possible malfunctions.

When used in group lighting schemes HID-DynaVision offers high flexibility in defining switching and dimming schemes, for example by time, date, address

zone, as well as easy integration with different telemanagement system architectures. The HID-DynaVision ballasts can be used in combination with main control system architectures and protocols, using appropriate interface gateways, etc. The communication medium can be an extra wire, a fibre optic cable, the mains lines, or GSM and RF wireless systems, as well as supported protocols such as LONworks, TCP/IP (Internet) and DMX512.

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LEDs for Channel Letters and Beyond

As LEDs advance in quality, brightness, color and energy efficiency, new markets open.

By James F. George

Efficiency attracts new markets

The success of LEDs in exit signs and traffic lights results directly from the color-efficiency issue. Back when LED efficacies (lumens per watt) were worse than those in incandescent lamps, red traffic signals and exit signs were still retrofitted with LEDs. They perform that particular job more efficiently because you only need red light.

According to Lighting Research Center data, typical wattage for a red, 12-in. incandescent signal is 135W, compared to 10W for today's LED model -- that's 97% savings with equal brightness. Green LED technology (using InGaN [indium gallium nitride] chips) now offers nearly as much savings. When one incandescent lamp fails, that signal fails completely; but if one LED fails, it's barely noticeable.

Conventional signal lamps, which are built for durability, should be replaced annually; most LED signals are guaranteed for five years. Longevity alone saves municipalities hundreds of maintenance dollars a year per intersection.

LED traffic signals have been tested in field conditions for the past 20 years, while the most recent generation of technology has been tested perhaps only 10 years. Failures are rare and typically caused by manufacturer defect. In the interests of energy conservation, utilities and governments are providing "carrots," such as rebates and tax credits, to speed market penetration. I'll bet the streets in your town have LED traffic signals -- or soon will.

The second tried-and-true LED application, exit signs, are universally replacing incandescent and compact fluorescent models. The Environmental Protection Agency's Energy Star program estimates that each LED exit sign saves its owner \$15-\$20 a year in energy costs, compared to older incandescent lighting, with less maintenance and better reliability.

Today's exit signs are guaranteed for five or 10 years, but LED retrofit kits carry 25-year, and even lifetime, guarantees. Some LED exit signs will outlast their buildings, while burning 24 hours.

Neon channel letters and building accent strips are the next major markets targeted for LEDs. Despite LEDs' higher initial cost (which will decrease over time), owners can save on energy costs, as well as maintenance. Existing applications have been in place for only the past few years. Where quality products were installed properly, failures are minimal. We expect 10 years' average life on these products.

These systems' energy efficiency depends on the transformers and number of

resistors used in the LED circuit. Comparing equally luminous letter faces, depending on the color, savings estimates range from 75%-90%.

Independent testing is forthcoming. At presstime, public utilities in California are developing and instituting component rebates for LED retrofits: \$2-\$6 per foot of neon replaced, based on letter height and a standardized estimate of the length of neon contained therein. LED systems must demonstrate energy savings of 80% or better.

Since 1987, when President Reagan signed the National Appliance Energy Conservation Act, federal, energy-efficiency standards mandate that such products as refrigerators, electric motors and air conditioners meet minimum efficiency standards. Certain types of incandescent lamps and fluorescent ballasts are effectively "outlawed" for sale in the United States.

Efforts are underway to target exit signs and traffic signals, with environmental groups demanding maximum wattage standards. Could the U.S. government's "stick" be used to convert certain signage markets to LED?

But how long will they last?

There's no solid answer to that question. With no moving parts, glass or filaments to break, LEDs are extremely rugged -- tough enough for traffic-signal and automotive applications. They won't last forever, but an LED product won't fail with a pop and a flash like an incandescent lamp.

Most LEDs don't fail, they just fade away. Light loss over the years necessitates replacing LED products. The brightness of exit signs and traffic signals is strictly regulated by life-safety building codes. Signage has much looser brightness requirements, and, in some cases, LEDs may be replaced even though they're still operating.

Life ratings, as stated by manufacturers, approach 100,000 hours for red, with less than 20% light loss. New technologies claim those same numbers for all colors -- for white, 50,000 hours with less than 30% light loss. That relates to 10 years at 12 burning hours per day.

But these numbers may be conservative! OSRAM Sylvania advertises life "up to 100,000 hours." Its current models weren't tested over five years, but via manufacturer-laboratory "accelerated life testing," which forces these products to fail more quickly than they would under normal use. On the other hand, a laboratory, with its pristine environment and perfect power quality, is much more forgiving than the real world.

There's no hard proof that today's generation of top-quality, brilliant, energy-efficient LEDs will last 100,000 hours. Come back in five years, and we'll see. Will internal illumination systems for channel letters from Permlight or OSRAM, installed carefully, last 10 years? "Wait and see" is the only answer.

Sign companies have that option. You can wait until the new technology is proven in situ. But frankly, in five years, the competition may have eaten your lunch, or the government may have forced your customers to go elsewhere. The safest bet is to buy top-quality LED lighting systems, and train and supervise installers carefully.

So dive in, and see what your customers think. As sign fabricators prove how profitable the LED channel-letter market can be, the products will become more versatile, with more colors and applications. The industry is in motion, and, like the Jumbotron, new products and markets will arise. Combinations of red, green and blue LEDs mix to create millions of colors, including white light. A standard RGB module might be used to "dial-up" any color a sign fabricator could need. Or, changing color sequences might be programmed, dialed up by the owner at a whim, or even controlled by the retailer's customer.

Quality, white LEDs with good efficiency and life will probably replace many fluorescents and even enable new sign configurations. A channel letter doesn't have to be 6 in. deep any more. By thinking outside the box, new sign construction methods will be based around the new technology. I can't wait to see what you come up with.

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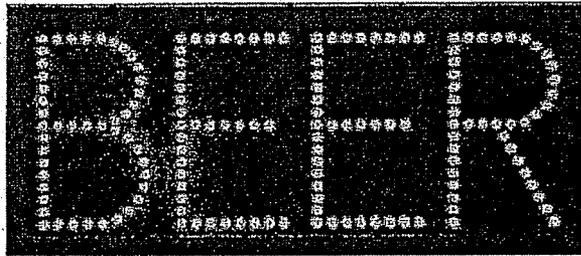


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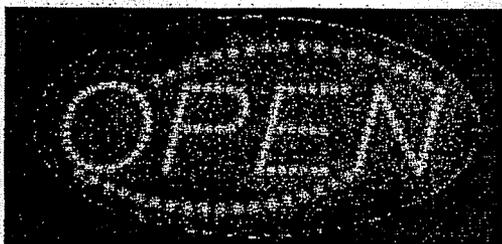
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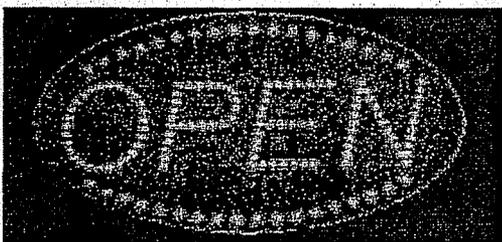
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LED OPEN Sign

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LED OPEN Sign

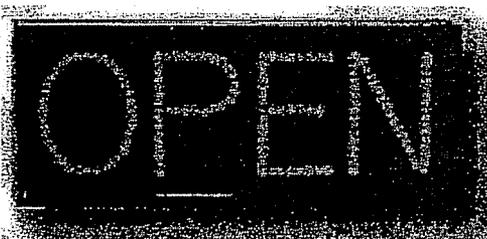
LED-OP300

21" W x 13" H x 2" D

Red letters, Blue Border can be set Chasing or Continuous on 115AC, 10W

Retail **Discount Price**
\$349.95 **\$266.50**

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LED OPEN Sign

LED-OP001

15" W x 6 3/4" H x 1 5/8" D

Red letters, Flashing or Continuous-on, 110VAC, 7W

Retail **Discount Price**
\$179.95 **\$126.50**

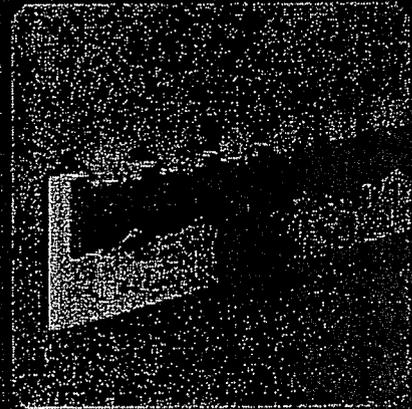
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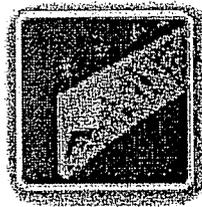


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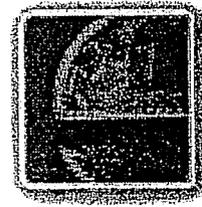
Applications ThinLED is a flexible LED product designed to provide consistent, even illumination for reverse channel letters or other narrow stroke applications. ThinLED can bend to a radius as small as 1.0 inch and fits into stroke widths as narrow as 0.5 inch.

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Superior Design Using a proprietary LED, ThinLED provides bright, even illumination in Red, Amber, Yellow, Green, Blue or White. This rugged weather resistant package is designed for signs mounted indoor or outdoor (with acrylic back).



Peel-N-Stick or
Mechanical Fastening



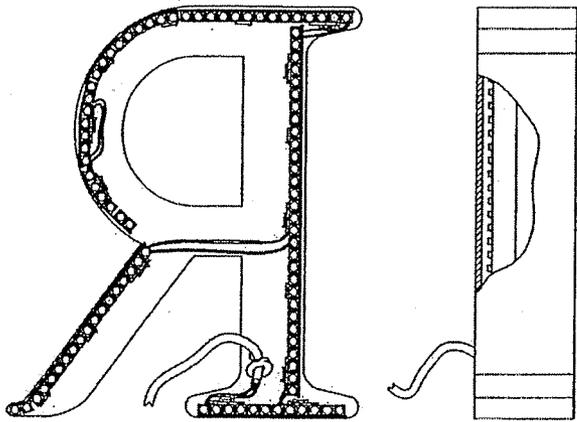
Cut-To-Fit
Easy Connections

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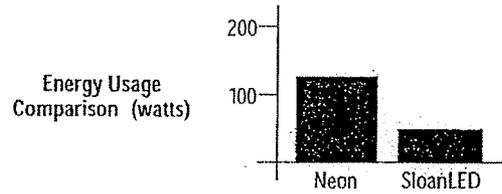


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Sample Layout of ThinLED



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Power Comparison

	Neon 15mm Red, 12kV 30mA Transformer	SloanLED Red ThinLED
Power usage per foot	4.2 watts	2.1 watts
Nominal installation (feet)	29	26
X Power consumption (watts/ft)	4.2	2.1
Total Power consumption (watts)	122	55

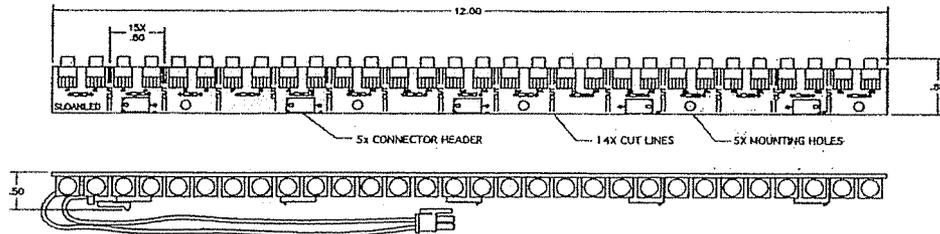
Power savings

55%

Easily Cut to Size

Easy Connections

Compact Design Thin Stroke



Technical Specifications - Warm Colors

Colors:	Red, Amber and Yellow
LED Type:	Ultra Bright, AllInGap
LEDs Per Foot:	30
Power Usage:	2.1 watts per foot
Power Supply:	SloanLED UL Class 2
System Voltage:	7.5 V DC
Limited Warranty:	Up to 5 years

Technical Specifications - Cool Colors

Colors:	Green, Blue & White
LED Type:	Ultra Bright, GaN/SiC
LEDs Per Foot:	30
Power Usage:	3.0 watts per foot
Power Supply:	SloanLED UL Class 2
System Voltage:	12.0 V DC
Limited Warranty:	Up to 3 years

UL ThinLED is UL Recognized

Item	P. N.	Contents	Item	P. N.	Contents
Red	701228-R	One 12" Strip	Green	701228-G	One 12" Strip
Amber	701228-A	One 12" Strip	Blue	701228-B	One 12" Strip
Yellow	701228-Y	One 12" Strip	White	701228-W	One 12" Strip

6" Jumper 701312-6

"Y" Connector 410102-B

Technical and Installation Support

- Online product, technical and installation information at www.SloanLED.com
- Installation training and assistance
- Thorough installation manual
- Toll free technical help desk 888.747.4LED
- Sign layout service



888.747.4LED
 Phone: 805.676.3200
 Fax: 805.676.3206
 Email: info@SloanLED.com
www.SloanLED.com

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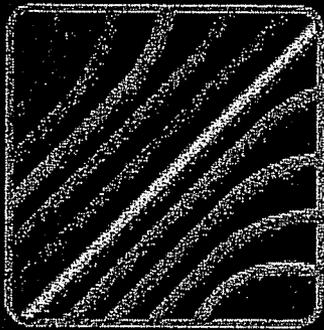
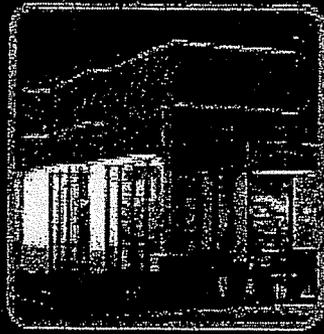
Patent Pending

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#TL-0303

LEDStripe

The LED Alternative
To Neon Perimeter Lighting



NEW
CUSTOM BENDS, CURVES
& MORE COLORS!



SloanLED Brings the LED Advantage to Perimeter Architectural Lighting

Applications

LEDStripe provides perimeter or accent lighting for all types of buildings, from fast food restaurants to retail chains. LEDStripe, utilizing the brightest light emitting diodes (LED) available, is low energy, low voltage and long lasting.

Bright, Vivid Colors

LEDStripe is manufactured with a proprietary blend of color and diffuser to produce a uniform glow in Red, Orange, Yellow, Green, Blue, White and our new pastel colors in Pink, Tangerine, Green and Blue. Actual field testing data shows that LEDStripe is as bright or brighter than neon. LEDStripe eliminates cold start problems and is built to withstand the toughest weather conditions.

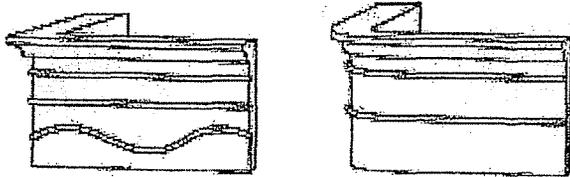
Easy To Use

LEDStripe is available in varying lengths that can be adjusted in the field to any size building. Custom bends and curves are now available. LEDStripe is easy to install, requires minimal maintenance and is designed for new installations, as well as retrofits.



SloanLED
Leaders in LED Technology

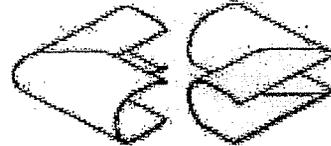
Curves & Radius Corners



8" Minimum Radius

Corner and Cover Configurations

Outside Corner



Inside Corner

Step Corner

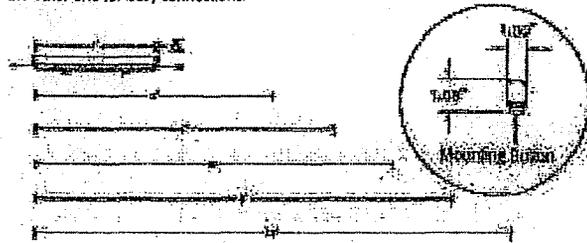


Adjoining Segment Cover

Other corner configurations available

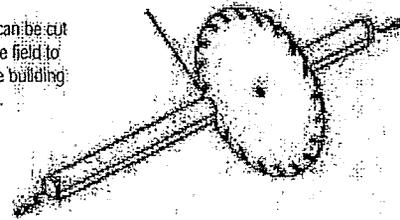
LEDStripe is Available in Various Lengths

Each length has a waterproof male connector at one end and a female connector at the other end for easy connections.



LEDStripe is easy to cut and Field Adjustable

All lengths can be cut to size in the field to accommodate building dimensions.



LEDStripe Technical Specifications

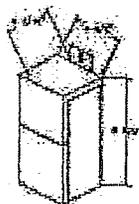
LED Type:	Ultra Bright, AlInGaP or InGaN
Primary Colors:	Red, Orange, Yellow, Green, Blue, White
Pastel Colors:	Pink, Tangerine, Green, Blue
Lens Material:	High Impact, UV Stable, Hydrocarbon Insensitive, Non-Fading Polymer
Input Voltage:	110 VAC - 270 VAC
LEDStripe Voltage:	24 VAC
Safety Recognition:	UL 48
Environment:	-20 Degrees F to +160 Degrees F
LED Life:	Up to 100,000 hours
Limited Warranty:	Up to Five Years
Maximum Power Supply Output:	90 Feet (3x30 Feet)

The LED Advantage: Low Energy, Low Voltage, Long Life and No Breakage.

Power Comparison

	Neon 12kV 60mA, 15mm	LEDStripe Red
Power per foot	8.3 watts	2.8 watts
Typical installation	300'	300'
Total power	2.49 kw	84 kw
12 hrs/day x 365 days	10,906 kw	3,679 kw
Power savings		66%

UL Listed
Transformer



Technical and Installation Support

- Online product, technical and installation information at www.SloanLED.com
- Installation training and assistance
- Thorough installation manual
- Toll free technical help desk
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Patent Pending

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#LS-0403

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Lighting Technology

Electroluminescent Lighting for Compact and Portable Medical Applications

New polymer chemistries have revived an old lighting technology, making it a viable option for the stringent requirements of medical electronics.

D. G. Sime

Thick-film electroluminescent lighting (EL) displays have become a mature technology providing cost-effective solutions to backlighting, display, and other human-interface challenges. Essentially an old technology, EL has been revived over the past decade with the introduction of efficient and economical polymer chemistries. These new chemistries have allowed the maturity of the EL phenomenon itself to be combined with modern means of manufacture to provide a practical, lightweight, thin, cool, and versatile means of illuminating controls and displays.

The all-polymer constructions now available provide high-reliability, low-noise displays in a wide variety of styles. Displays are now available in multicolor designs and in a variety of thicknesses, including very thin constructions. Together with simple uses in display backlighting applications, it is now also possible to integrate membrane (and other) switch technology with EL. Integrating these technologies avoids the difficulties, inefficiencies, and mechanical disadvantages associated with the use of light-emitting diodes (LEDs) or other illumination schemes for control systems. In addition, EL components are made with very-high-speed, large-volume, highly automated production facilities.

This article looks at the properties of EL technology and discusses its viability for medical electronics applications. New chemistries and construction techniques have made it a more attractive option. The properties of EL match the requirements for illumination of a variety of medical devices. EL provides an efficient, uniform light source that is effective at modest brightness levels.

History and Background

Although the basic phenomenon of thick-film EL has been known for some time, the materials and requirements for a practical lamp have until recently remained expensive, difficult to work with, and challenging to package into a useful and practical format.

A primary advantage of EL is that light can be generated over a wide area rather than at a point source or along a line source, as in other forms of illumination. Because it can be generated over a wide area, a mechanical (and thermal) structure to house and otherwise accommodate the light source is no longer necessary. The applications for such an extended source of light were immediate, and EL technology has proven to be the best option for many of today's compact portable devices.

Benefits. The fundamental advantages of EL remain those demonstrated in the earliest applications. It provides a uniform illumination over an extended field, and a cool light with no heat to dissipate. EL can be manufactured in a thin structure, and it offers a highly efficient use of power. Each property is unique to EL, and each has driven the development of low-cost, practical ways to realize the benefits.

Challenges. There are challenges, however, to achieve each benefit. Early on, such challenges were difficult to meet, leading to a reticence in many industries to use EL. A problem that plagued early use of EL was its poor structural integrity. The thin structure was achieved by roll- or blade-coating a slurry onto the substrate; the available chemistries were principally cellulose-based gel systems that kept the phosphor particle in suspension. The result was a soft lamp that could not be worked into practically useful shapes.

Another major challenge has been addressing the vulnerability of EL phosphors to moisture damage. At one time, their low resistance to environmental stress limited their useful service life to a few tens of hours. The chemistries used in early lamp development provided little protection against penetration by moisture. As a result, long-lasting lamps had to be made either on solid, impermeable substrates or, eventually, made by using hard-to-handle fluoropolymer packaging materials such as Aclar. Both approaches complicated the manufacturing and handling of EL and added significantly to its expense.

The development of the modern EL display has been the story of the response to the challenges to produce a compact, lightweight, thin, reliable, and inexpensive lamp that displayed EL's advantages, but in a reliable, affordable, and versatile form. Although there have been many attempts to express the various benefits, the best and most lasting results have come from material and technique advances that have addressed several key concerns. As a result, the current EL lamp industry is based on several new approaches.

Polymer Chemistry

The introduction of practical polymer chemistry approaches to the structure of the chemical matrix that holds the phosphor has revolutionized the building of EL lamps. With the use of this chemistry, EL achieved a major improvement by providing a much higher level of structural integrity. This higher level of structural integrity is achieved in several ways. The chemical binders dry completely and polymerize, forming a solid structural element. The lamp no longer exists only as a series of soft layers stacked between two sheets. The resulting lamp structure is of a solid polymer nature in which separately formed layers are cross-linked to provide an effectively monolithic structure. With the

The obvious, although not easy, answer to protecting phosphor particles from moisture is to cover the particles themselves with an impermeable material. This approach was taken initially by Sylvania Corp. and led to the early availability of so-called treated phosphor, which essentially has a glass encapsulant entirely covering each crystal. The intrusion of coating, of course, brings a (brightness) penalty in the optical and electrical properties of the phosphor and an increase in cost, but it greatly extends the life of the products. Essentially, for all but the most rigorous environments, the need for Aclar and similar products has been removed.

Substrates. The widespread availability of substrates on which transparent conductive materials can be deposited is a parallel development of significance to the production of EL displays with high structural integrity. ITO can now be routinely sputtered in thin films onto a variety of substrates, including optically clear substrates.

Although sputter-coated glass has been available for a long time, it is possible now to generate mass-production quantities of ITO on flexible substrates sputter-coated onto flexible films. Although there are few restrictions intrinsic on the film, it is generally polyethylene terephthalate (PET) film that is coated because it can be provided with the precision, clarity, stability, and low cost necessary for the EL market. Sputter-coated polyester is therefore the most widespread substrate used for printed EL lamps. Of significant interest is its growing availability in varying thicknesses. Most lamps to date have been made on 7 mil (0.19 mm) thick PET, but the trend is toward thinner lamps in response to the growing demand for compactness in the displays for consumer devices.

Results

The outcome of the past several years of development has been an EL product that maintains and improves on the basic properties of EL and improves the practical manifestations in which it can be produced in the mass quantities needed for the consumer market. Table I shows a summary of typical modern EL display specifications. A modern lamp should feature the following:

- A rugged, mechanically flexible, and reliable structure that does not delaminate.
- Long service life (to be measured in thousands of hours at 110 V ac, at 400 Hz).
- High brightness.
- No thermal dissipation.
- Absence of mechanical noise.
- High resistance to the effects of adverse environments (high temperature, high humidity).
- Stable electrical properties.
- Multiple colors.
- Arbitrary shapes.
- Thin construction.

Brightness (aviation green)	
-----------------------------	--

	>15 fL (58 cd/m ²)
Dynamic capacitance	0.003 μF/sq in. (0.00046 μF/cm ²)
Power consumption	18 mW(max)/sq in. (2.79 mW/cm ²)
Typical physical thickness	0.008–0.010 in. (0.2 mm)
Typical unlit edge	0.025 in. (0.635 mm)
Peripheral bus bar	Usually not necessary

Table I. Summary of typical modern electroluminescent display specifications.

Electrical Characteristics. Much of the discussion in this article addresses the mechanical and optical properties of modern EL lamps and their suitability for use in handheld devices. The electrical properties are also important to consider. Although they have not perhaps been a driving force in the development of a modern lamp, they have in fact benefited from the development of the new materials.

The electrical characteristics of an EL lamp are those of a lossy capacitor. The effect of modern polymer chemistries has been to increase the effective dielectric strength and dielectric constant in the lamp. The result shows both in the resistance to shorts as well as in the generally higher efficiency of the lamp. With the resulting higher impedance, smaller currents are needed, and as a result, smaller driving circuits are required. This tendency toward better efficiency (at least in terms of light output per unit power) is enhanced by the use of better and more optically clear substrates.

A basic property of thick-film EL is the need to supply ac power. This, in turn, leads to the need, in most handheld or portable devices, for an inverter circuit to change the dc power supplied from the battery pack to the ac required by the lamp. Historically, these circuits were bulky, heavy, and electrically noisy. Indeed, their use often defeated the advantages of the light, compact, and efficient light source. However, the ability to print (and thus the ability to make the lamps as small as possible), the use of polymer chemistry, and the availability of high-voltage silicon switches in integrated circuit (IC) form have all led to improved efficiencies. In addition, the improved intrinsic efficiency of lamps and phosphors has allowed a new generation of inexpensive and compact IC-based, relatively noise-free EL lamp drivers to be developed.

A modern lamp typically shows resistance to breakdown at up to 1200 V and a stable and high dc effective resistance. The load is well modeled with a capacitance of 2.5–3.0 nF/sq in. (0.39–0.46 nF/cm²), with a resulting power dissipation of around 15 mW/sq in. at 110 V ac, 400 Hz. This represents a remarkable efficiency for the range of 15–20 fL brightness (luminance) and indicates that typical lamps themselves require only a few hundreds of microamps in operation.

The result of this efficiency is that the power budget for the application (an important aspect of the design) is likely to be dominated not by the current draw of the lamp, but by the efficiency of the inverter. With typical modern IC-based circuits, this is likely to be better than 50%, so a

required to be mounted on printed circuit boards. Together with the economies offered by the use of EL and membrane switch techniques, the availability of packages integrating these other functions offers tremendous potential. In addition, use of the low-cost processes of printing also extends the potential for effective and user-friendly interface and display components in the next generation of handheld or vehicle-mounted devices (see Figure 2).

Medical Device Applications

The properties of EL are well suited to the illumination requirements for medical devices over a broad range of functions. Whether on a hospital ward, in transit, or in the home sickroom, an efficient, uniform light source that is effective at modest brightness levels has many advantages. The absence of hot spots in the illuminated field of an EL display means that less ophthalmic accommodation is needed and information is more readily viewed. The efficiency means that displays can remain lit for longer periods with less power drain. The design versatility provides a host of uses including illuminated control knobs, backlit graduated scales, and backlit sample holders.

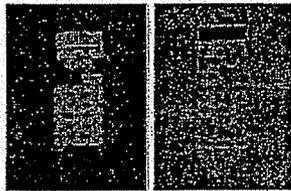


Figure 2. A stand-alone package with a completely self-contained membrane switch and electroluminescent lamp for display and keypad, shown from both sides (DEC phone application).

With the modern thin, flexible EL, the same properties are now available to switch and control panels, which means that uniform illumination is possible for interface panels without affecting the flatness or compactness of the design. Indeed, designing with membrane switches that include the integration of illuminated elements, whether areas of EL material or surface-mounted LEDs, allows an inexpensive fabrication approach to be used in the development of cost-effective, user-friendly control panels.

Uniform, efficient illumination can be patterned and applied without the use of bulky, heavy, and expensive reflectors, diffusers, or light pipes. EL adds functionality to many displays and controls without the penalties that stem from conventional approaches. With selective deposition, lighting goes only to the required areas, such as the indicia on a dial, the set point on a scale, or the user instruction to be followed at any given time.

The efficiency of EL as a light source, together with the freedom from special mechanical requirements, means that the integration of EL has little impact on the packaging or weight of the final assembly. The intrinsic low mass of the illuminating elements and the low power requirements allow a designer to include the full functionality of an illuminated, user-friendly device, while maintaining compactness and lightweight designs required for handheld or portable use.

Finally, a point that must not be neglected in these applications is that modern all-polymer EL is an environmentally friendly material. Designers can avoid the use of hazardous materials typically found in conventional display lighting systems.

Conclusion

Thick-film EL lighting technology has greatly improved in the past decade, so that it is now available as a low-cost, highly reliable, and efficient source of illumination for portable and handheld control and monitoring devices. The use of polymer chemistry with printing techniques for manufacture also means that the technology provides a low-cost, high-reliability manufacturing process and expands the innovation that can be applied to both the graphic and visual versatility of the displays. This versatility enables the use of multisegmented and multicolor displays, variable sizes and shapes, and the integration of flexible lamp technology with switch packages that include membrane switch systems.

Such properties have made EL highly appealing for premium and mass-produced personal communications systems, especially because manufacturers are also no longer constrained by conventional approaches to the construction of EL lamps. The properties and manufacturing techniques are well-suited to the requirements of medical electronics.

D. G. Sime, PhD, is vice president of research and development for MetroMark Inc. (Minnetonka, MN). He can be reached at d.sime@metromark.com.

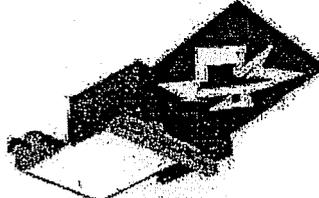
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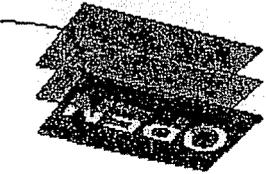
15.0", 18.0" & 24.0"

** Cut pieces must be re-sealed with sealing tape or re-laminated.

Can be cut into custom strips, panels or shapes using tools, dies or pattern cutting machines.



Apply vinyl graphics, transparencies, colors, masks or any other overlays



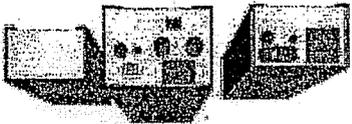
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12V
24V

From 100 sq-in to 10,000 sq-in.
110 or 220 VAC



Potential Applications:

A truly novel opportunity to integrate light on nearly any surface, contour or object.

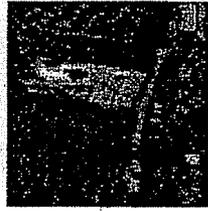
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- Arcades
- Restaurants
- Boats
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Architectural



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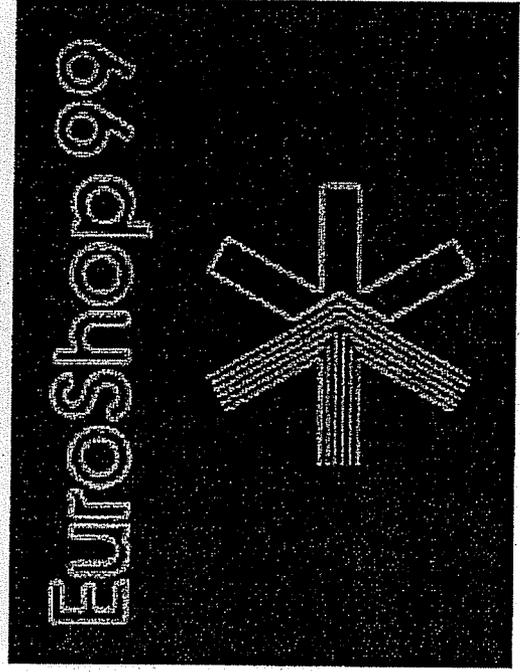
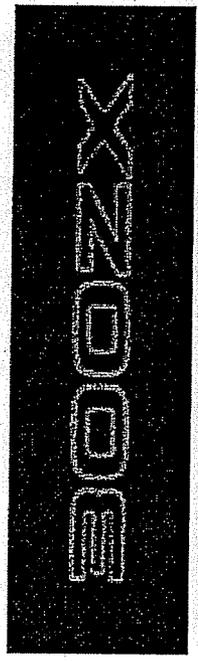
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Flexible Electroluminescent Lighting

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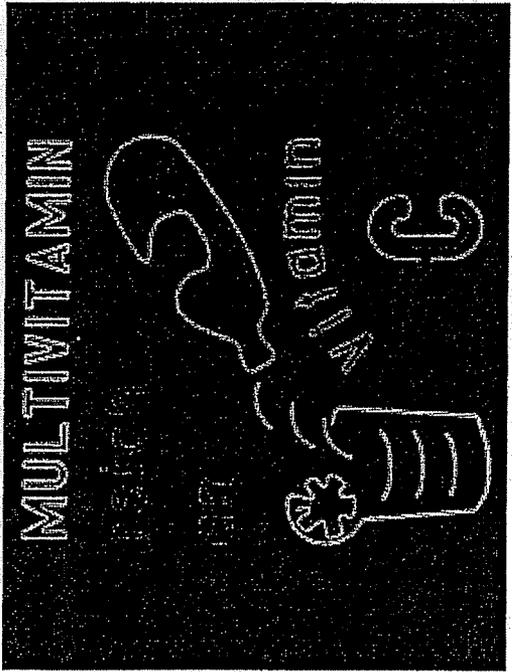
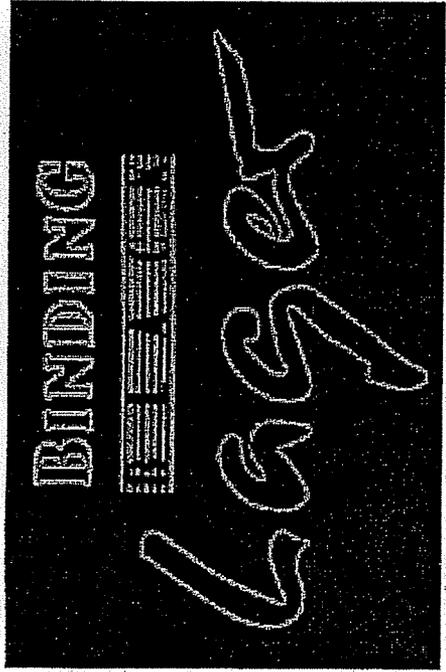
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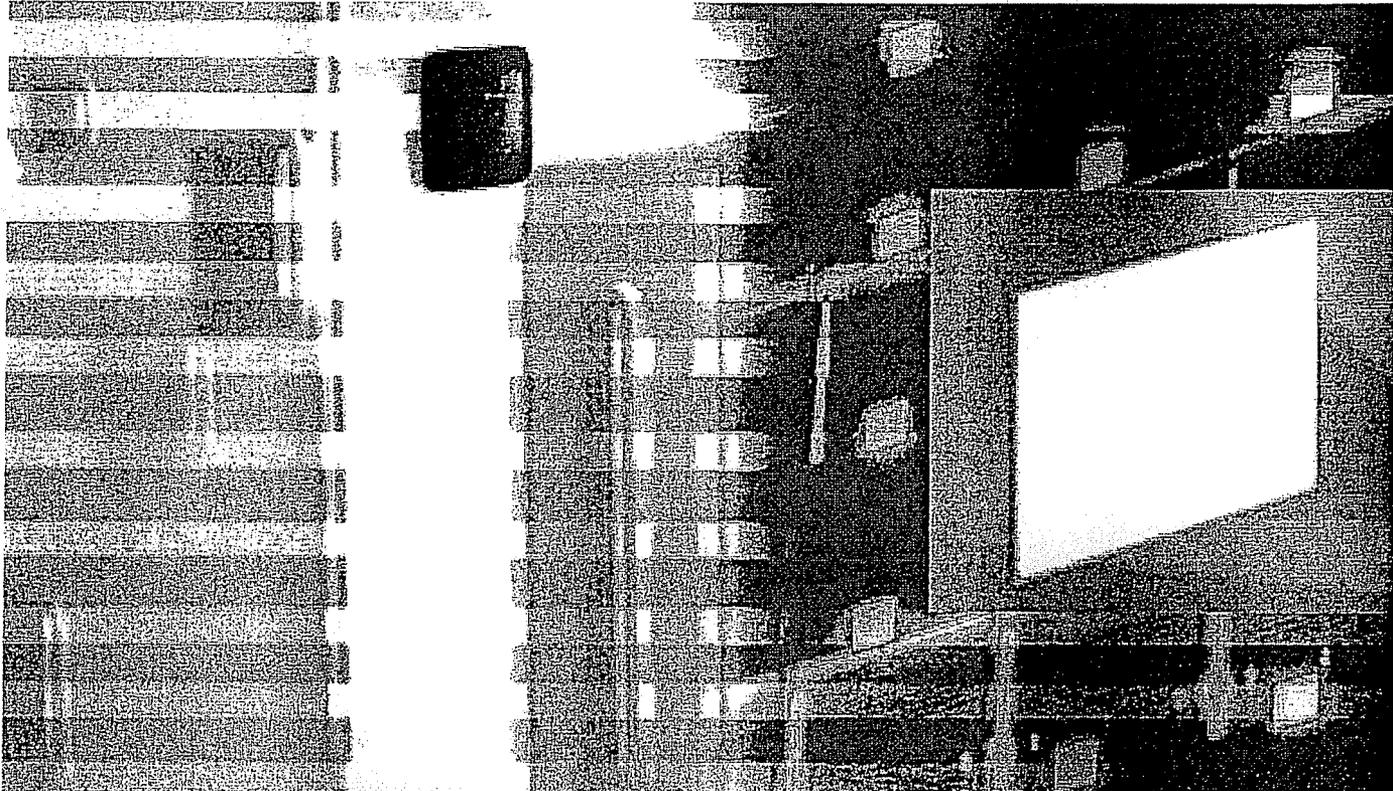
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General Information

OSRAM PLANON®

The OSRAM PLANON® is a two-dimensional, mercury-free light source based on the operating principle of excimer discharge.

Der Flächenstrahler OSRAM PLANON® ist eine zweidimensionale, quecksilberfreie Entladungslampe basierend auf dem Prinzip der Excimerentladung.

SEE THE WORLD IN A NEW LIGHT

OSRAM



OSRAM technology sets standards

Mercury-free light tile

The luminous body of OSRAM PLANON® can be compared with a tile. Thanks to its specific shape and unique constant high illuminating performance, PLANON® opens new construction and application possibilities for the light industry.

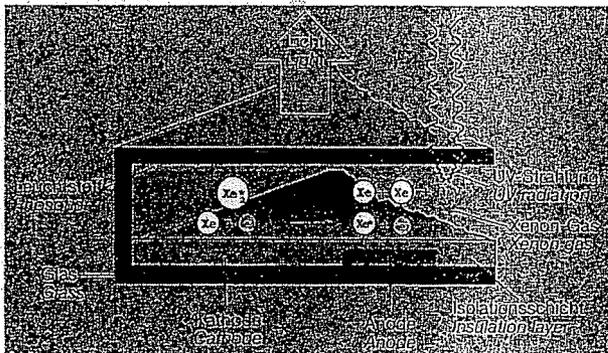
Unique advantages

The new mercury-free discharge light source OSRAM PLANON® has a number of unique product characteristics:

- **Unique lighting power**
 - wide viewing and illumination angle
 - constant high luminance from centre to edge
- **Extreme long lamp life up to 100,000 h**
 - absence of damage susceptible electrodes
 - no severe darkening
- **Extremely flat - 10mm**
- **Mercury-free**
 - luminous flux not related to temperature -30°C to +85°C
 - instant light with high luminance
 - true power-save mode
 - no ramp-on/ramp-off effects
 - no hazardous waste
- **Lamp and ballast available as system**

Two-dimensional mercury-free discharge light - OSRAM PLANON® with QT-PLANON®

Zweidimensionale quecksilberfreie Entladungslampe OSRAM PLANON® mit QT-PLANON®



OSRAM-Technologie setzt Maßstäbe

Quecksilberfreie Lichtkachel

Der Leuchtkörper der OSRAM PLANON® ist mit einer Kachel vergleichbar. Durch die besondere Geometrie und die einmalige gleich hohe und konstante Lichtleistung eröffnet die PLANON® neue Konstruktions- und Anwendungsmöglichkeiten in der Lichtindustrie.

Einzigartige Vorteile

Die neue quecksilberfreie Entladungslampe OSRAM PLANON® hat eine Reihe von einzigartigen Produktmerkmalen:

- **Einzigartige Leuchtkraft**
 - Großer Sicht- und Beleuchtungs-Bereich
 - Hohe Leuchtdichte
 - konstante hohe Gesamtleuchte
- **Extrem hohe Lampenlebensdauer von bis zu 100.000 h**
 - keine empfindlichen Elektroden
 - kein Verschleiß der Leuchtflächen
- **Ultradünne - 10mm**
- **Quecksilberfrei**
 - Temperaturunabhängigkeit
 - Lichtstrom von -30°C bis +85°C
 - Sofortlich-berworfener Leuchtdichte
 - Energiesparmodus
 - Kurzzeitig-anschaltbar
 - Kein Entsorgungsproblem
- **Lampe und EVG als System verfügbar**

Constantly tested for best quality.

ständig auf den Prüfstand für beste Qualität

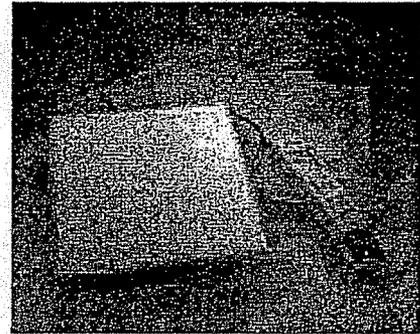
The operating principle of PLANON®: generating light using pulsed dielectric impeded discharge.

Das Funktionsprinzip der PLANON®: Lichterzeugung durch gepulste dielektrisch behinderte Entladung in Xenon

SEE THE WORLD IN A NEW LIGHT



PLANON® Flat Panel Light Source Technology



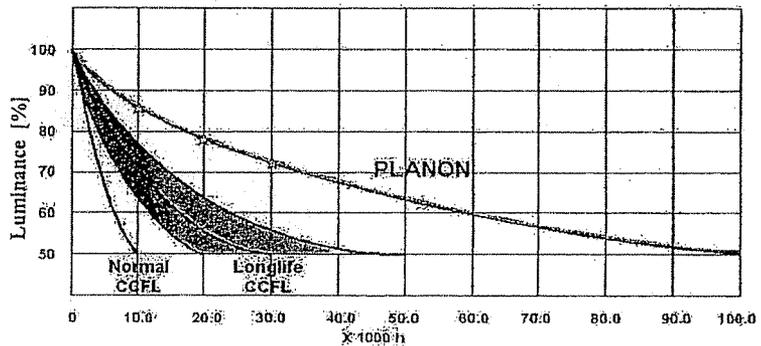
May 2003

Special Edition SID '03

OSRAM PLANON® Flat Panel Light Source for Industrial Display Applications

At under 10 mm thin with extremely uniform and high luminance up to 10,000 cd/m², the OSRAM PLANON® lamp integrates easily into advanced LCD applications in sizes from 10.4" to 21.3" to fit most standard displays. With lamps available in a number of color temperatures and with inverters of different types, the OSRAM PLANON systems offer display integrators design flexibility.

Its long lifetime of up to 100,000 hours (MTTH) and excellent maintenance characteristics, coupled with its great stability under the harshest thermal and mechanical stresses, enable a new generation of displays with



PLANON Maintenance Curve

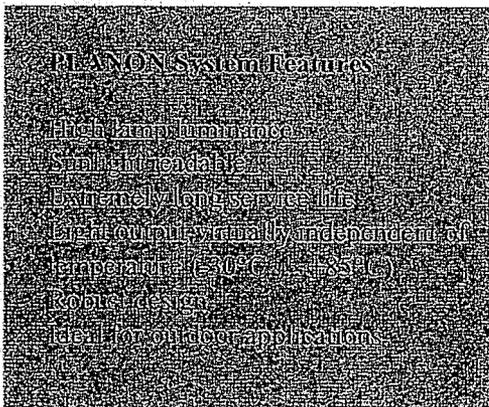
unprecedented reliability in the most demanding of applications.

Instant-On Capability

Since the dielectric barrier discharge is based on xenon, the light generation process needs no warm-up or starting time. As xenon is normally in a gaseous state, it is available for direct ignition of the discharge. In contrast, the mercury in standard fluorescent lamps must be heated from a liquid to a gaseous state to create the discharge for the generation of light.

The starting time of the PLANON lamp is on the order of only a few milliseconds. This instant-on feature allows a true power-save mode to be incorporated into industrial displays for the first time.

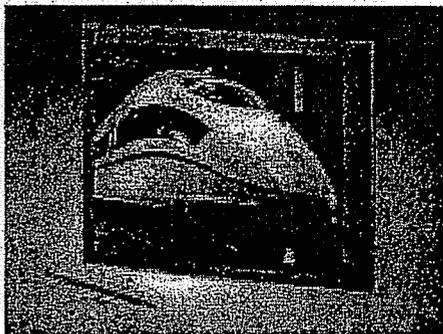
During idle times, the backlight may even be switched completely off. The restart is achieved within the time necessary to restart the LCD.



OSRAM PLANON® Flat Panel Light Source for Industrial Display Applications - continued

For industrial displays used in applications such as factory automation and transportation information systems, durable and robust solutions are critical. The unique electrode design and the mercury-free xenon excimer discharge of the OSRAM PLANON lamp result in a backlight that is resistant to vibration and gives instant, full output when switched on.

In industrial environments where ambient temperatures are high, OSRAM PLANON offer extremely reliable solutions even under continuous operation, reducing maintenance and service to nearly zero.



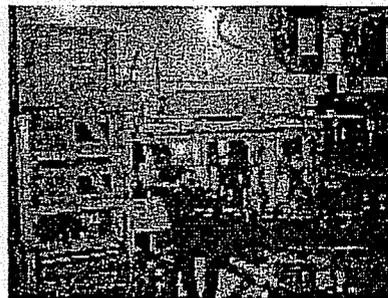
Industrial Display Unit
© SIEMENS i-SFT



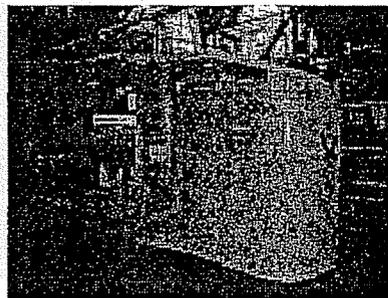
City-Train Passenger Information System
Berlin, Germany

PLANON Industrial Display Applications

- Game and Entertainment Kiosks
- ATM Consoles
- Industrial Display Units
- Air-Traffic Control Monitors
- Outdoor Advertisement Panels



Industrial Display Unit



15.0" PLANON-lit Display of a Pack Station
Parcel Retrieval Kiosk

For point-of-sales and point-of-information displays, the stable, high output of the OSRAM PLANON technology makes sunlight readable displays possible even outdoors in temperature ranges from -30°C to +85°C. The low temperature starting capabilities render the need for preheat circuitry unnecessary.

The excellent maintenance characteristics of PLANON systems have yielded displays at greater than 70 percent of initial luminance even after five years of continuous operation.

For air traffic control (ATC) applications, displays require excellent image quality with very high resolution and brightness. Reliability in these critical safety operations cannot be compromised.



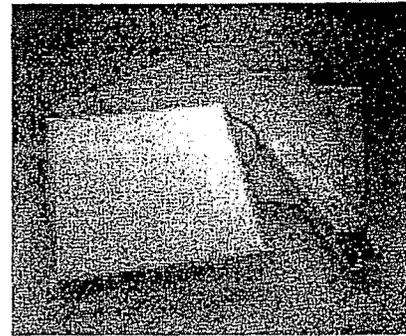
Air Traffic Control Monitors
Airport Tower Frankfurt

The OSRAM PLANON system addresses all of these needs and has been installed in ATC applications in sizes up to 21.3" with up to 600 cd/m² at SXGA resolutions.

For more information, please check out our web-page at www.planon.de or contact either Ms. Karen Lee (karen.lee@sylvania.com) for the NAFTA-region or Dr. Norbert Haas (n.haas@osram.de) for all other countries



PLANON® Flat Panel Light Source Technology



May 2003

Special Edition SID '03

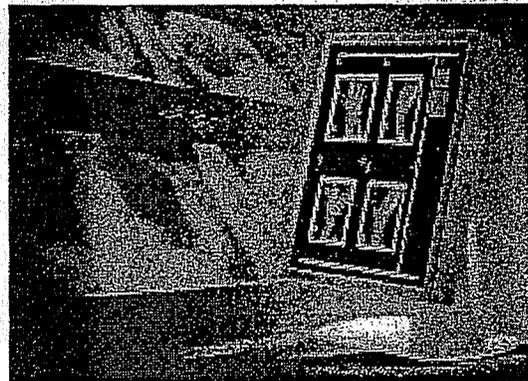
OSRAM PLANON® as Backlight for Hi-Resolution LCD Displays for Medical Applications

The OSRAM PLANON® Flat Light Source shows a brilliant performance in hi-resolution medical LCD monitors

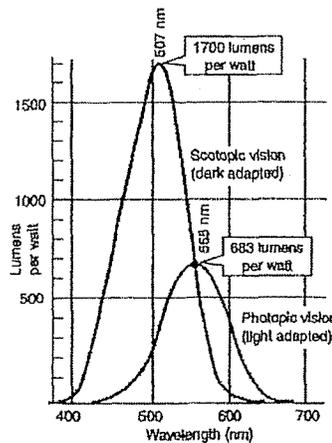
The use of hi-resolution LCD displays for medical applications has become increasingly important. This is especially true for diagnostic medical monitors that need to have high contrast and excellent resolution even at reduced ambient light levels, where the visual perception and sensitivity of the human eye is different from normal lighting conditions.

Under normal lighting conditions, the $V(\lambda)$ -curve of the eye shows maximum sensitivity at 555 nm. This is called "photopic vision". At somewhat reduced light levels (mesopic vision) or at further reduced light levels (scotopic vision), the sensitivity curve of the human eye shifts to lower wavelength values. Medical analysis of X-ray films or digitized X-ray pictures is usually performed at reduced illumination levels.

OSRAM and the Display Technologies division of SIEMENS Automation and Drives (A&D) have partnered to develop a series of improved high-resolution digital gray-scale flat panel displays that meet the requirements for best picture resolution. The LCD-monitors feature excellent picture quality, even illumination, and consistent luminance over the entire service life.



SIEMENS AG, A&D SE DT / 5 Mega-Pixel Digital Gray-Scale Flat-Panel Display SDM 21500D with PLANON Backlight 21.3" (© Siemens A&D)



Sensitivity curves of the human eye.

From: Berman, S.M., Energy Efficiency Consequences of scotopic sensitivity. J.IES Vol. 21, No. 1, Winter 1992

Optimized Phosphor Coating

The main contributor to the excellent performance of the PLANON system is the special phosphor coating of the lamp. It was optimized in order to match the sensitivity curve of the human eye at reduced light levels.

OSRAM PLANON® as Backlight for Hi-Resolution LCD Displays for Medical Applications - continued

True Energy-Saving Mode

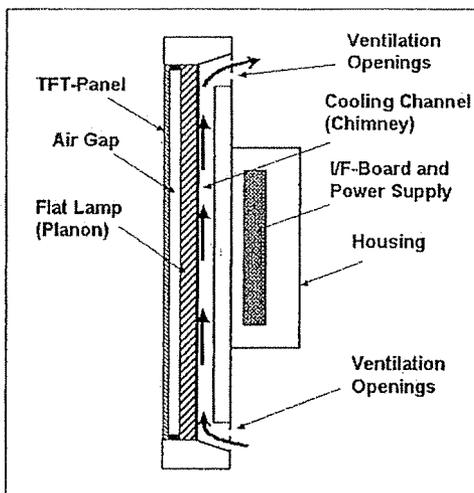
Since the dielectric discharge of the PLANON lamp uses only xenon gas and no mercury, there is no warm-up time when a lamp is switched on for the first time or resumed from energy-saving mode.

Independent of Ambient Temperature

The light output of the mercury-free PLANON lamp is virtually independent from ambient temperatures in the range -30°C to +85°C.

Fan-Free Design

The PLANON lamp was integrated into the backlight unit such that a chimney effect was generated between lamp and back-plate. Here, the PLANON lamp acts as a dividing element between airflow and optical components, thus allowing for a very efficient heat management that renders noisy and failure-susceptible fans unnecessary.

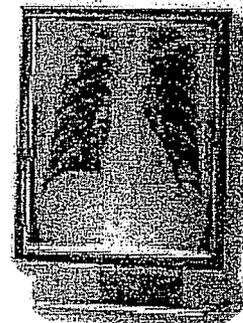


Advantages of PLANON Backlight

- Extremely long service life
- Improved thermal management
- True power-save mode
- Instant on
- Uniform illumination
- Mercury-free lamp system
- Temperature-independent light output

With the unique features of the OSRAM PLANON technology, for the first time, a mercury-free flat lamp has been integrated into a high resolution diagnostic LCD monitor

This combination yields many improvements over conventional approaches and therefore represents a tremendous advancement in the technology of medical LCDs displays.



Gray-Scale Flat Panel Display
(©SIEMENS A&D)

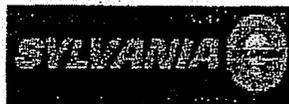
For more information about the SIEMENS digital gray-scale flat-panel display: www.siemens.com/displays

Or contact: SIEMENS Automation and Drives, Infoservice, P.O. Box 23-48, 90713 Erlangen, Germany, Fax: +49-9151-978-3321, e-mail: infoserv@sen.de

Improved heat management through chimney effect (fan-free design)

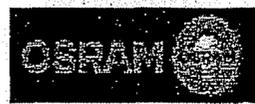
For more information, please check out our web-page at www.planon.de or contact either Ms. Karen Lee (karen.lee@svlvania.com) for the NAFTA-region or Dr. Norbert Haas (n.haas@osram.de) for all other countries





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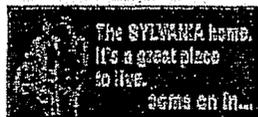
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PLANON® flat panel lighting - Frequently Asked Questions

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1. **What is PLANON?** – The OSRAM PLANON is a mercury-free flat fluorescent lamp system, consisting of a lamp, an electronic control gear (ECG) unit, and an optional diffuser set.
2. **What are the unique features of PLANON?**
 - Mercury-free
 - Less than 10mm thin
 - Extremely uniform luminance
 - Long life – 100,000 hours
 - Capable of rapid switching cycles
 - Instant full light output
 - Instant restrike
 - Wide temperature range
 - Minimal color shift
3. **What are the system options?** – Lamps are currently in sizes that mirror the monitor industry, and are measured in diagonal lengths (like monitors and TVs). Standard sizes are 10.4", 15.0", 18.1", and 21.3". All systems are available with electronic control gear (ECG) which operate on a 24V DC input. The 18.1" and 21.3" systems are also available with ECG's that are universal voltages. (100-240V AC input).
4. **Is the PLANON system dimmable?** – PLANON systems are dimmable. Some ECG's are dimmable by analog dimming down to 50%; others are dimmable via pulse width modulation (PWM) down to 20%.
5. **How is the PLANON lamp different from a standard fluorescent lamp?** – Standard fluorescent lamps use a mercury discharge to produce UV energy that excites the phosphors to produce visible light. The low-pressure mercury discharge produces UV at a wavelength of 254 nm, as opposed to PLANON'S xenon excimer discharge, which produces 172 nm ultraviolet similar to standard fluorescent

energy. The shorter wavelength energy also excites the phosphor.

6. **Are PLANON systems energy efficient?** – The efficacy of PLANON systems is currently on the order of 24-28 lumens per watt (lpw). This is generally adequate in applications for which PLANON is designed. There are limitations when attempting to produce visible light using radiation as low as 172 nm – it's physics!
7. **What are the possible applications?**
 - Sign backlighting
 - Decorative fixtures
 - Challenging environments
 - Backlighting for LCD display
 - Backlighting for x-ray imaging
 - Industrial displays
8. **Where is PLANON currently being used?**
 - Building façade - KPN Telecommunications HQ
 - Photographic lighting - ARRI – <http://www.arri.com/news/cinec/2002/skypanel.htm>
 - Lighting fixtures - LichtTechnik – <http://www.licht-technik.com/e/plan-o-light.html>
 - Imaging equipment - SIEMENS I-SFT – http://www.i-sft.com/e/prod/prod_con006.html
 - Industrial displays - Frankfurt Air Traffic Control Tower
9. **Who can I call if I have any questions regarding this product?** – Please contact Susan Reminger by phone at 978-750-2895 or via email at Susan.Reminger@sylvania.com.