The National Lighting Bureau Guide to Retail Lighting Management

THIRD EDITION

A Guide to Cost-Effective Lighting for Stores, Shopping Centers and Malls
Just Desserts For The Lighting Inefficient.

92% Electricity
Your power bill makes up 92% of the total cost of lighting your business. And that's a lot to eat.

5% Product
Lighting products like lamps and ballasts comprise 5% of costs, and the price of this piece of pie stays about the same, no matter when you order it.

3% Labor
Labor is only 3% of all lighting costs, yet this part has the most potential for satisfaction. Work with IllumElex, and we can slice that 92% of energy costs into much more appetizing proportions.

Maybe you should cut back a little. But how? In the last 15 years energy costs rose more than 500%, and those rapidly escalating costs make up 92% of what you spend! That's a very rich dessert.

But IllumElex can help. We can reduce your consumption and take a big bite out of costs with lighting management programs that make economic and environmental sense. So call us. We make saving money on your lighting systems as easy as pie.
Introduction

Lights. Action.

A movie set? Hardly. Rather, it's just about any shopping center or retail store in the United States where electric illumination is properly applied. Because properly applied retail lighting means enhanced retail sales. Proper application of electric illumination does not necessarily mean that the lighting is proper for the times, however. Where there is electric lighting there also is energy consumption. When a retail lighting system consumes more energy than needed to get its job done, it is not proper for today's conditions.

In fact, much of today's retail lighting is not proper because it wastes energy. Even systems that are just seven or eight years old can fall into this category due to the tremendous technological advances achieved by manufacturers of modern lighting systems and components.

While it is important to eliminate lighting energy waste, it is equally if not even more important to retain the benefits of proper application. To create visual appeal. To set off different spaces and displays. To support consumer discretion. Or to handle any one of the numerous other "jobs" that electric illumination performs in today's complex retail world and the even more complex society of which "retail" is such an important part.

The purpose of this guide is to relate some of the basic information associated with upgrading existing retail illumination systems in an intelligent, cost effective manner. To assist in that endeavor, the guide provides information about a number of actual cases where lighting has been used to positive effect, and also presents the results of important studies. In addition, we provide a series of "calculation examples" that illustrate how certain basic modifications can be made, and the techniques used to evaluate these procedures from a financial point of view.

It is not the National Lighting Bureau's intent to provide specific how-to "nuts and bolts." Other guides and manuals are available for that purpose, prepared for use by those whose advanced, specialized knowledge can help a retail operation reduce its lighting expenditures while deriving more of the benefits that lighting was installed to obtain in the first place.
Retail stores rely extensively on indoor and outdoor lighting to achieve their sales objectives and support performance of various employee tasks.

As a consequence, data indicate, lighting accounts for 60% of an average store's energy consumption (Figure 1).

The resultant expense has prompted retailers to institute energy-saving measures.

Success or failure is not determined in terms of energy savings, however. Rather, it is evaluated by considering how well a lighting system performs its retail functions.

CONSERVATION VS. MANAGEMENT

Either of two distinct approaches can be used to modify a lighting system: lighting energy conservation or lighting management.

Lighting energy conservation focuses attention on reducing energy consumption and numerous options can be applied for that purpose. For many people, the best modification is that which attains the fastest payback.

Lighting energy conservation is fine as far as it goes. The problem is, in retail settings, it does not go far enough. It fails to address the fundamental question, "Why do we have lighting?"

To answer that question, imagine what would happen if a store could no longer have electric illumination. Sales would plummet; the time required to perform functions such as restocking and inventorying would skyrocket; and the amount of errors made would be intolerable.

Of course, no retail manager is about to forgo lighting. It's too important. Nonetheless, this importance can go overlooked when lighting energy conservation is applied, because it does not provide a framework for evaluating what the illumination system originally was installed to do.

Lighting management is a much more effective approach to retail lighting, because it goes beyond energy conservation alone to provide valuable benefits that might otherwise not be available.

Simply using less of a resource does not necessarily mean that the resource has been used more wisely, as when using less does not get the job done.

As such, lighting management presupposes that those responsible for lighting know exactly what the "lighting job" is, or, perhaps more accurately, know what the job could be.

![Figure 1: Average energy use in a retail store](Image)

In other words, if the existing lighting system is not doing all it could, if it is not providing all the benefits it could, investing in conservation could result in a system that consumes less energy, but whose capabilities still are far more limited than they have to be.

By applying lighting management, you come to learn more about the benefits that effective electric illumination can provide. You can develop a lighting system that is more valuable, one that provides more benefits while minimizing waste.

In short, lighting management helps you maximize the benefits derived from our energy resources. Is your lighting system doing all it can right now to make your retail operations more profitable? Consider the following questions. Can you answer each one with a Yes?

- Does your lighting help achieve the overall image that your store is trying to project?
- Do you use electric illumination to create environments that enhance displays?
- Can your lighting highlight racks of impulse-purchase goods no matter where they are located?
- Does your lighting help speed retrieval from storage and minimize the mistakes caused (and time wasted) due to misreading a label?
- Does your outdoor system identify your store at night to passers-by?
- Does your outdoor illumination reduce shoppers' apprehensions about parking lot crime?

The lighting management concept was developed to help retailers and others manage their stores' lighting to maximize the return on each dollar invested. To facilitate this process, all lighting impacts and potential impacts should be considered.

Payback analysis still can be applied to identify the best modifications, but such analysis—to be effective—must consider all bottom-line implications. In essence, a change that will reduce lighting costs by $5,000 per year is not nearly as desirable as one that could reduce costs by $2,500 while generating $100,000 more in sales.

Make no mistake: Lighting management does not at all disregard the value of saving energy. In fact, reliance on energy-efficient equipment and design techniques is fundamental to the concept.

In all cases, however, lighting equipment and design techniques should be applied principally to support optimal performance of visual tasks essential to retail success.
The Benefits of Effective Retail Lighting

The principal difference between a high-quality electric illumination system and one of lesser value is more a matter of design ingenuity than initial cost or ongoing operation and maintenance expense. In other words, the system that performs each task appropriate to your facility, and performs it as well as possible, would not cost that much more than a system that does not function as well.

In fact, the monthly cost of your existing system might be far in excess of a new system, given the energy to be saved and the additional sales that could be made.

That is why an understanding of the benefits and their value is so important. With that understanding, it is far easier to recognize why you cannot afford to pass up an investment in better electric illumination.

MORE SALES, EXPENSES, INCREASED PROFITS

Retail’s bottom line is profit. Lighting can help improve profits by increasing sales and reducing costs. Sales can be increased by relying on some of the newer electric illumination systems to enhance the appearance of store interiors and their merchandise, be it soft goods or items such as jewelry and crystal.

Outdoors, lighting can beautify grounds at night and otherwise increase attraction.

Effective lighting can even turn the outside of a store into an advertisement for itself, creating in the minds of passers-by the desire to be there when the store is open.

Insofar as expense reduction is concerned, energy conservation presents a key opportunity for savings. But don’t stop there.

By reducing incidents of parking lot crime and vandalism, better lighting can reduce the cost of insurance, attorneys and bad publicity.

And the same lighting that does all that also can boost traffic counts, by making it clear that those who park in your lot and walk to the store have nothing to fear at night.

These and numerous other benefits of lighting are discussed more fully below.

SUPPORT OF CONSUMER DISCRETION

Consumer discretion encompasses several factors, such as the ability to read care labels on different garments and to compare the colors and textures of soft goods. Good lighting can make reading small print much easier. It also can permit a more accurate evaluation of colors and textures.

Sometimes overlooked is the relationship between the products being displayed and the lighting normally associated with their use.

For example, a paint store could have one type of lighting to simulate daylight, so consumers can evaluate exterior paints and finishes. Other
lighting could be used to help consumers evaluate indoor colors under lighting conditions similar to that in their homes.

This latter approach would be appropriate for just about any type of color-sensitive item and could go a long way toward reducing the incidence of “It just looked so different in the store” complaints.

In other words, by using lighting to enhance consumer discretion, a store can become more popular by being more “user-friendly.” It could also experience reduced costs as a consequence of fewer returns.

MORE EFFECTIVE DISPLAYS

A flexible lighting system can help assure that certain displays receive special attention, to make them more effective. As an example, a display of formal wear could be complemented by lighting that suggests a posh occasion of some type; just as other lighting could be used to suggest a ski slope or a bright summer day.

ENHANCED PRODUCT APPEARANCE

Electric illumination can have a dramatic impact on how a product appears. In fact, certain types of lighting are far more suited to certain products than others.

As an example, the light used to illuminate racks of men’s suits would differ dramatically from that suggested for jewelry and crystal. The latter benefits from lighting that brings out sparkle, while the former is most effective when it brings out the depth and richness of fabrics and colors.

Likewise, the lighting used for foods, sporting goods, and so on, all can be selected with respect to what is being illuminated. Products that make a better appearance are more appealing, leading to more sales. Positive appearance can also result in more traffic and longer stays in a store, as well as sales of “high ticket” items.

INCREASED IMPULSE PURCHASES

Lighting can be particularly effective to spur sales of impulse purchase items, as well as seasonal items. Effective lighting calls these goods to the attention of shoppers, encouraging them to buy.

Of Note

In a test conducted by the Illuminating Engineering Research Institute (IERI) to determine the impact of different lighting levels on subjects’ ability to proofread mimeographed documents, it was found that the number of errors made decreased as lighting levels were improved (Figure 3).

It was also shown that older workers made more errors than younger workers, and that improved lighting had a far more pronounced impact on error reduction for older workers than for their younger counterparts.

This study, as do many others, points out that older workers, often considered among the most reliable employees, need better quality lighting to offset physiological changes that affect their eyes due to the aging process.

While the reduced errors and improved productivity that result from better lighting can justify greater lighting expense, the gains are often realized with reduced lighting expense, through proper LMO selection.

Better lighting improves productivity, especially for older workers.

Figure 3: Results of an IERI study show that frequency of errors declines when illumination levels are increased.

ACCOMMODATION OF SPATIAL CHANGES

Many retail operations maintain a high degree of consumer interest by frequently rearranging layouts. A flexible lighting system is needed to accommodate this marketing approach.

Such a system permits easy adjustment of lighting, in terms of location, quantity and quality, so it remains continually appropriate for the spaces and displays involved.

This does far more than merely support the sales effort. It also optimizes energy use because no more energy than needed is consumed.

By contrast, a store that does not

Figure 4: Results of a warehouse lighting test show that productivity increased 11% to 13% when lighting levels were increased from 5fc to 50fc.
employ a flexible system must rely on the same lighting all the time, irrespective of space or display layout changes. Opportunities for visual excitement, space differentiation and mood establishment are lost and, in many cases, the amount of energy consumed is more than what otherwise would be needed.

SPACE DIFFERENTIATION

In most larger stores, and even in some smaller ones, electric illumination can be used to set off one area from another through use of different lighting levels, lighting fixtures and overall lighting techniques.

For example, the lighting used to set off an area where candy and peanuts are sold should be different from that used in a jewelry department.

SUPPORT OF STOCKING AND DISPLAY METHODS

Stocking and display methods seldom are selected on the basis of the lighting installed. In many cases, the lamp/luminaire combinations in place cannot provide maximum support to the methods used. Lamps and luminaires can be modified, however, both to support the stocking and display methods employed and to save energy.

For example, when items are stocked on shelves, an effective high-efficiency illumination system will distribute light so that items on the bottom shelves are as well-illuminated as those on top.

INCREASED PRODUCTIVITY

Productivity is particularly important in administrative and warehouse areas, and lighting is essential to productivity.

In fact, more than three decades of research and numerous case histories show that better lighting permits people to work faster and with fewer errors.

It is essential to recognize that even relatively small productivity increases can be extremely valuable.

For example, in an operation of just 10 employees, a 3% productivity improvement is likely to be worth four or more times the total amount spent each year to operate and maintain the lighting they need to get their work done, as follows:

Assume 10 employees receive $18,000 per year each, including FICA and fringe benefits. As such, a 3% productivity increase saves the company:

$18,000/prsn/yr x 10 prsns x 3% = $5,400/yr

Assuming the illumination system costs $125/person to operate and maintain each year, its overall annual cost is:

$125/prsn/yr x 10 prsns = $1,250/yr

In many administrative and warehouse areas, the amount spent on lighting is much less than $125 per person—many of whom receive much more than $18,000 per year.

BETTER STORE IDENTIFICATION

Lighting identifies a store at night. Sign lighting, facade lighting, parking lot lighting, walkway lighting—all contribute to an overall illuminated whole that makes a store stand out.

Special effects such as landscape lighting can make an additional contribution, identifying the store not only because it is well-illuminated, but, also because of the unique nature or quality of the illumination.

Especially when a store is located along a busy thoroughfare, effective lighting can turn the store into an advertisement for itself.

And note that the same lighting used for identification can also be used to provide safety, security and attraction. All these and other benefits must be taken into account whenever a change is being considered.

ATTRACTION OF CUSTOMERS

Although outdoor lighting can make the presence of a store known, it will not necessarily encourage people to enter. When the lighting provides what customers perceive as a high degree of safety and security, attraction is provided by offsetting fears.

In addition, the lighting can be designed to complement the store’s image, thereby attracting those persons who are looking for what the store has for sale.

For example, stores catering to the needs of young adults and teenagers may find it effective to install “light show” type displays in storefront windows.

By contrast, a freestanding boutique that carries high ticket items could be better served by an outdoor lighting system that uses landscape lighting and other effects to convey an aura of sophistication.

Interior lighting also has an important role in attraction, in part by fashioning a visual environment that meets a consumer’s expectations.

In many furniture stores a relatively low level of area lighting may be appropriate. In the case of a hardware store, however, low lighting levels would not be consistent with consumer expectations, and so might give the store a “dingy” appearance.

Of Note

In a study of productivity in warehouses, workers were required to search among 30 bin locations for labels with 15 different designations as listed on a requisition sheet.

The labels on the bins contained necessary pricing information for entry on the requisition sheet. Careful instructions were given on how best to visually search the bin locations for the correct labels.

Results of the study (Figure 4) showed conclusively that unit production went up from 11% to 13% when the lighting level was increased from 5fc (typical in many warehouses) to 50fc.

The value of improved productivity can be especially significant, depending on the number of persons employed and how much they are paid, among other variables.

For example, in offices, the cost of office labor (employee wages, salaries and fringe benefits) relates to the cost of lighting system operation as a ratio of 250:1 on a per-square-foot-per-year basis. As such, a 100% increase in lighting system operating cost generally can be justified by less than a 0.5% increase in productivity.

Most case histories reveal that lighting-induced productivity gains and reduced lighting expenses are completely compatible.
Case In Point

Safeway’s controls produce fast payback

Safeway gained significant benefits when it began to rely on line-carrier control systems.

These systems turn off rows of fluorescent fixtures in a uniform manner during periods when less light output is sufficient, typically during stocking periods or when they can take advantage of daylight during particularly clear days.

Each system consisted of a transmitter mounted on the lighting panelboard and receivers connected to luminaire ballasts. The transmitter could be controlled manually, by a time clock or by a computer.

When less light was acceptable, the transmitter’s signals were sent to receivers over existing lighting circuits. No rewiring was needed.

According to the chain’s energy management director, the first installation—in a 20,000-square-foot Stockton, Calif. store—paid for itself within a year.

“Recognizing the likelihood of future cost increases, we opted for 175W mercury vapor lamps. They were more efficient and longer-lived than incandescent lamps. Although fluorescent lamps provided even better efficiency and life expectancy, none then available was able to provide the color rendering properties we needed.

“Then, just a few years later, improved-color fluorescent lamps were introduced and those are the ones we installed to attain substantial savings.”

“The new fluorescents we used produce a color that we think is even superior to daylight. The efficiency results in large part because the lamps’ color-rendering properties permit us to provide better seeing conditions for the merchandise even though there is less light. By measurement, we now have about 35fc on the display racks compared to the 50fc we had previously,” Dr. Young said.

The luminaires used also played an important role in the quality and efficiency of the lighting. They distribute light well and control glare effectively and efficiently. The previous fixtures trapped light, thus wasting energy and in some cases causing glare that eroded the appearance of the store.

The store’s new lighting saved $20,500 per year in energy and other operating and maintenance costs. The simple payback on that basis alone would have been 2.3 years, given a total installation cost of $48,000 for equipment, labor and materials.

“Everyone was pleased with the new lighting. Management, of course, was doubly pleased because the improved quality cost so much less. You can imagine the delight, then, when we started to take a look at sales figures. Virtually overnight, sales shot up by about 8%. And it was sustained. The one and only explanation seemed to be the new lighting,” Dr. Young commented.

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Case In Point

Better lighting spurs sales for Target stores

A lighting system change made to save energy and improve aesthetics at the Thalhimer Brothers Cloverleaf Mall branch store in Richmond, Va., contributed to an annual sales increase of $1 million.

When the profit portion of the sales increase is considered along with the energy savings of some $20,000 per year, the payback period for replacing a six-year-old system and installing 800 new luminaires and lamps was less than 12 months.

According to Dr. Robert Young, Thalhimer’s vice president of properties at the time, “What we did demonstrates the rapid progress that has been made by the lighting industry. The Richmond store was completed in 1975, almost two years after the OPEC oil embargo that marks the dawn of today’s era of energy awareness.

In response to rising energy costs, Target Stores reduced floor lighting by 20% through lamp removal. According to one Target executive, the change “made top management wince at the darkened appearance of the store.”

But that wasn’t the only unfortunate outcome. Reducing the light by 20% also reduced lighting system heat gains by 20%, forcing the store’s central heating system to make up the difference during the heating season.

The result: The cost of the additional natural gas consumed exceeded the value of the electricity saved by removing lamps.

Target Stores thereupon restored the former illumination levels, this time using high-efficiency reduced-wattage lamps. Electrical load was reduced by 12%, and Target recovered much of the lighting system heat lost when the original lamps were removed.

Improper lighting system modifications can also lead to reduced sales, because they detract from what otherwise would be a stimulating, inviting retail environment.
FEWER SECURITY-RELATED PROBLEMS

Effective lighting can help prevent a number of security-related problems by displacing the activity that gives rise to these problems.

After all, why should those who want to perform an idle act of vandalism do so in a well-illuminated area—where they may be detected and identified—as opposed to an area hidden in darkness?

Vandalism is one of the most common problems that can be avoided: spray-painted walls, broken windows, ruined shrubs, upended litter containers and other destruction creates an embarrassing image.

Effective repairs can be aggravating, time-consuming and costly. Many owners would rather not report the minor damage to an insurer for fear of higher premiums or policy cancellation. The ugliness must be cleaned quickly in those circumstances where it could otherwise affect business or create a long-term negative image, possibly one that says, “This area is dangerous.”

As those with experience will relate, vandalism may be the least serious crime problem. Others include break-ins and assaults. Assaults may lead to legal action. Break-ins can lead to significant losses when the material stolen is irreparable or uninsured, or when it consists of data stored in a computer.

A number of security procedures and services can be used to prevent them. These include security patrols, sensors of all types, and closed circuit TV (CCTV), among others.

Of them all, however, only lighting can be seen from a distance, creating a significant deterrent effect. That does not mean that you should rely on lighting alone, but it does point out the danger of not relying on sufficient lighting. Electric illumination is among the least costly of all security measures and often is the most effective.

REDUCED SECURITY COSTS

Many stores and centers employ a variety of security measures, including lighting, CCTV and security patrols. By increasing reliance on any one of these, it often is possible to reduce reliance on others.

Effective measures that are comparatively low in cost are those that merit emphasis. In security, the most expensive tool usually is personnel and the least expensive usually is electric illumination.

Documented cases show how more and better lighting can permit less reliance on security forces to create significant savings. Lighting can do this without compromising safety because of its deterrent aspects and because it permits security personnel to see faster and more accurately.

In many cases, lighting also can attract more people to illuminated areas, something else that, in and of itself, can enhance security.

AVOIDANCE OF LEGAL PROBLEMS

Sometimes an unfortunate event goes virtually unnoticed by the news media until an injured party institutes a lawsuit. The real legal problems are not those associated with the negative publicity, however. Those are image problems.

The legal problems are those associated with cost, much of which insurance does not cover. A deductible usually must be satisfied and, until it is, one has to pay attorneys, expert witnesses and private investigators.

Time also is needed to review files, answer interrogatories, participate in depositions and confer with attorneys.

In fact, having to deal with a claim resulting from an assault or accident can easily create an unrebimbursable cost of $25,000 or more, not including the financial impact of the negative publicity that might result.

To the extent that effective security lighting can make such claims unlikely, it can save tremendous amounts of money.

INSURANCE ADVANTAGES

Many store owners and managers are familiar with the myriad problems that have gripped the insurance industry in recent years. Insurance has been difficult to obtain at times, very costly, and—more often than not—less comprehensive in coverage.

Effective security lighting helps minimize risks associated with accidents and assaults, reducing the likelihood that insurance will have to be called upon to satisfy a claim.

Furthermore, by pointing out to an agent or underwriter the effectiveness of lighting, it may be possible to obtain coverage when some others cannot, and/or to obtain coverage at more favorable rates.
Conducting a Lighting Management Audit

To evaluate proposed changes to a lighting system it is essential to first analyze the existing system. The form shown in Figure 5 (pgs. 14 and 15) is provided for that purpose. One form should be used for each identifiable space or area, including those comprising the sales floor, administrative areas, stockrooms, and so on, as well as outdoor spaces.

Here are instructions on how to complete the form:

**Unit or Space Served:** Indicate the location involved. Be specific. You may wish to coordinate the form with a layout of the building or floor area, so that “Sales Area #3” or “Children’s Apparel” can be found by quick reference.

**Square Footage:** Indicate the square footage of the space involved, obtained by wall-to-wall measurement or reference to plans. Do not include large non-illuminated areas.

**Types of Luminaires (Column 1):** Luminaires are designed to operate particular types of lamps. Incandescent lamps are used with incandescent fixtures, fluorescent lamps with fluorescent fixtures, and so on.

There are some exceptions, however, since certain types of self-ballasted fluorescent or mercury vapor lamps can be used on incandescent sockets.

In addition, certain models of metal halide and high-pressure sodium lamps have been developed for use in specific types of mercury vapor luminaires.

**Input Watts per Luminaire Type (Column 2):** Calculate input watts per luminaire based on the specific types of luminaires installed. In other words, if there are five different types of luminaires in a space—say, three different types of fluorescent and two different types of incandescent—watts per luminaire must be computed for each of the five different types.

Watts per luminaire is determined principally by the wattage of the lamps installed. For example, if a luminaire contains six 25-watt (25W) incandescent lamps, luminaire wattage would be (25W/lamp x 6 lamps = ) 150W.

Except for incandescent lighting, a factor must be added to account for the power drawn by the ballast. A factor of 1.1 is generally applied as a “rule of thumb” for fluorescent luminaires equipped with standard magnetic ballasts.

Accordingly, if a fluorescent luminaire has four, 40W lamps installed, watts per luminaire would be (4 lamps x 40W/lamp x 1.1 = ) 176W.

A factor of 1.2 usually is applied to high-pressure sodium lamps that are less than 1,000W. Exact ballast power requirements can be obtained by consulting the ballast or luminaire manufacturer.

**Number of Luminaires by Type (Column 3):** Indicate the number of identical luminaires in a space. For example, if there are five different types of luminaires, indicate how many of each type are installed.

**Total Watts (Column 4):** This refers to the total power requirements for each type of luminaire and for the space itself. If there are 10 fluorescent luminaires each having a 176W power requirement, total watts would be (176W/luminaire x 10 luminaires = ) 1,760W.

If the space also has 10 incandescent fixtures each requiring 180W to operate, total watts for the space would be (1,760W + 1,800W = ) 3,560W or 3.56kW.

**Watts/Ft² (Column 5):** Watts per square foot (watts/ft² or W/ft²) for a space is determined by dividing total lighting watts by total square footage.

**Annual Hours of Use (Column 6):** Annual hours of use are determined by identifying when lights are turned on and off Monday through Friday, Saturday, Sunday and holidays.

Do not assume lighting is used 12 hours per day just because the store or shopping center is open 10 am to 10 pm. Lighting often will be activated in the morning at the convenience of operating personnel and left on late at night for cleaning crews. Inspect the spaces involved during other-than-normally occupied periods.

**Energy Consumption (kWh) (Column 7):** Determine energy consumption by multiplying total watts (Column 4) by annual hours of use (Column 6).

Thus, if a space has a connected lighting load of 3,560W (3.56 kW) and the lighting system is on for 2,800 hours per year, total energy consumption would be (3.56 kW x 2,800 hrs/yr =) 9,968 kWh/yr.
Lighting Energy Cost (Column 8): Determine annual lighting energy cost by multiplying annual kWh (energy consumption) by the cost per kWh.

You may need some assistance to develop accurate figures. Many electrical utility rate structures are incremental in nature. For example, $0.05/kWh for 1-500 kWh, $0.085/kWh for 501-1500 kWh and so on.

In addition, lighting use affects electrical demand charges and/or low power factor penalty charges that a utility may impose.

When smaller buildings are involved, it probably will not be worth while to expend the time required to make calculations "to the penny" precise. Instead, an average price per-kWh can be used to account for all utility lighting charges.

In larger buildings, however, it probably will be beneficial to calculate demand and/or low power factor penalty charges separately. Speak with a utility representative or some other reliable source to obtain more guidance in this regard.

Replacement Lamp Cost (Column 9): To determine the annual average cost of replacement lamps, first determine the average number of lamps replaced each year.

If lamps are left in place until they burn out, divide annual hours of use by the rated life of the lamp in question. (Lamp manufacturers list lamps' rated lives in their catalogs.)

Thus, if a lamp is used 4,000 hours per year and its rated life is 20,000 hours, (4,000 hrs/lamp divided by 20,000 hrs/lamp) = 0.2 lamp/yr would be used.

If a system uses 400 identical lamps, it would require, on average, about (0.2 lamp/yr x 400 lamps =) 80 new lamps/yr. If each lamp costs $2, the annual average cost would be (80 lamps/yr x $2/lamp =) $160/yr.

Life ratings of most lamps vary according to how many hours they customarily are kept on after each start (fewer starts mean longer life).

Note: If all lamps in a system are replaced at the same time at a predetermined interval (group relamping), determine replacement lamp requirements based on the interval, not rated life.

Lamp Replacement Labor Cost (Column 10): Determine this cost by multiplying the average number of new lamps installed each year by the time (in hours) required to install each. Then multiply the product by the hourly rate of the persons who customarily install replacement lamps.

If lamps are replaced one at a time, as they burn out (spot relamping), it may take a half-hour (0.5 hr) or more to replace each.

Obtain an accurate estimate by walking through the process with a person who customarily performs it.

To estimate hourly labor cost, consider not only a person's hourly wage or salary, but also the value of taxes and fringe benefits. Typically, the overall amount paid is from 1.3 to 1.4 times the hourly salary or wage.

Ballast Replacement Costs (Column 11): Most conventional indoor and outdoor ballasts last from 12 to 15 years. (Hot operation can reduce this life expectancy significantly.)

Energy-saving and some electronic fluorescent ballasts may last two to three times longer than their conventional counterparts, due to their cooler operation.

Determine the anticipated life of the types of ballasts now installed and divide it into the cost to effect a replacement (labor and materials included). Multiply the result by the number of ballasts (of each type of luminaire) installed.

For example, if you will have to pay an electrical contractor $50 to replace a ballast that will last 15 years, annualized cost is ($50/ballast divided by 15 yrs/ballast =) $3.33/yr. If the system comprises 100 four-lamp fluorescent luminaires, with each luminaire housing two ballasts, the total cost would be (100 luminaires x 2 ballasts/luminaire x $3.33/yr =) $666/yr.

If a company is considering relocating in the near term, or if the anticipated life of a ballast will exceed the anticipated life of the system, then calculating the annualized cost of ballast replacement may be unnecessary.

Note: Only a qualified electrician should attempt ballast replacement. Faulty replacement can create safety hazards and other problems.

Case In Point

Sloan's relamps and sales climb

In an effort to reduce energy consumption, Sloan's Supermarket chain in New York removed two lamps from most of its stores' four-lamp fluorescent fixtures.

According to the executive vice president of the chain, "Energy conservation is important to us, especially when you consider that we pay about 10.3 cents per kilowatt-hour for electricity. We attempted to cut back by removing two of the 75-watt fluorescent lamps from most of our eight-foot fixtures. [Each Sloan's Supermarket used 75 to 150 F96 fluorescent luminaires.] We kept them that way for a while, but I wasn't satisfied with the results.

"While energy conservation is important, marketing is important too, and we believe that using energy to support our marketing efforts represents a wise, cost-effective use of energy. Accordingly, we returned to four lamps in each fixture, but we didn't use the same 75-watt lamps as before. Instead, we installed high-efficiency 60-watt fluorescent lamps.

These cut energy consumption and costs by about 20% yet reduced light output by an amount so small the difference is virtually imperceptible.

"Immediately after we returned to four lamps in each fixture, store sales took off, providing us with a gross sales increase of from 10% to 15%. We did nothing else in the stores during this period, so I can attribute virtually all the increase in sales to the new lighting."

Other Maintenance Costs (Column 12): Other annual maintenance costs typically include the
Case In Point

New lighting creates multimillion dollar benefit at Colonial Park Plaza

Prior to initiating a lighting management program, owners of the 500,000-square-foot, 72-store Colonial Park Plaza in Harrisburg, Pa., were spending $12,745 annually to operate and maintain the mall’s common area incandescent lighting.

They scrapped the existing system and replaced it with a high-efficiency fluorescent system that cut common area lighting operating and maintenance (O&M) costs by 66% percent to $4,348 per year.

As substantial as the $8,397 annual savings were, they were almost insignificant compared to the other benefits created by the new system (Figure 6).

Because it provided far more light, it gave what some patrons called “new sparkle” to the promenade area, lending more depth and brilliance to surface colors, and generally making the mall a much more pleasant place for shopping.

Word spread, and within two years the average traffic count moved from 60,000 persons per week to 80,000. Store owners who were surveyed indicated their sales rose by 36%, worth $10 million per year.

Because sales increased, more retailers became interested in locating in the mall and the vacancy rate fell from almost 19% to just 8%, increasing the owners’ rental income by $1.75 million annually.

In addition, the number of slipping/tripping accidents—something that had affected older shoppers in particular—was significantly reduced, saving the general public what an independent underwriter estimated to be $10,000 per year.

Altogether, these benefits created yet another—increased resale value of the mall—worth an estimated $12.5 million.

Annual O&M Costs (Column 13): Annual operating and maintenance (O&M) costs comprise the sum of energy cost (Column 8), replacement lamp cost (Column 9), lamp replacement labor cost (Column 10), ballast replacement cost (Column 11) and other maintenance costs (Column 12).

Method of Control (Column 14): Indicate how lighting in each space is controlled; for example, by one or more local switches, a master (circuit breaker) at the central panelboard, time clocks, or dimmers. Indicate where controls are located on a diagram.

Visual Tasks Performed (Column 15): Visual tasks are all tasks performed in a space except those that can be done—literally—with eyes closed: How quickly and accurately visual tasks are performed depends substantially on visibility, a factor dependent on the amount and quality of lighting provided.

Identify the principal tasks for each worker or each group of workers, as well as customers. (Familiarity with the requirements associated with completing the next column will help facilitate this process.)

IES/NA Illuminance Recommendations (Column 16): The IES Lighting Handbook identifies hundreds of different visual tasks, and provides a method for establishing how much light (illuminance) should be provided for each. This method may be too complex for some non-technical personnel to apply and, if so, a source of assistance should be relied upon.

Do not bypass this step. Comparing results of data inserted in this column with that inserted in Column 17 is an absolutely crucial step for effec-
tive lighting system evaluation. It helps identify how well your lighting system is doing what it's supposed to be doing. If it is not doing it well, you or your company could be wasting thousands of dollars each year.

You may be able to borrow an IES Lighting Handbook from a local source. Otherwise, contact the Illuminating Engineering Society of North America (IES/NA, 345 East 47th Street, New York, N.Y. 10017) for details.

**Illuminance on Tasks (Column 17):** A light meter is required to measure the amount of light that falls on a task. You may be able to borrow or rent one from a local source.

Follow the instructions that should accompany the light meter and be certain to take measurements where the visual tasks are actually performed.

It may be best to rely on an outside source for assistance, to help assure accuracy of measurements. (Wearing light-colored clothing while taking measurements, or casting even slight shadows can significantly affect the accuracy of data.)

An experienced individual can take other meaningful measurements too, relative to brightness ratios and similar factors that are useful in evaluating a lighting system. The complexity of these measurements goes beyond the scope of this publication.

If the amount of light provided for a task exceeds the amount recommended, the lighting system may be wasting energy. However, if less light than recommended is being provided, far more costly outcomes may be involved, such as lost sales, low worker productivity, or compromised safety or security. How many dollars are being lost? This requires an expert's opinion.

**User Comments (Column 18):** User comments can be particularly important because they represent the reactions of those who actually use the lighting system.

Ask both workers and shoppers for opinions. Is the lighting “easy on their eyes” or do they sometimes feel symptoms of eyestrain, such as headaches or fatigue?

Do they believe “there's too much light in here?” Such a comment almost always means they are bothered by glare, a quality issue that seldom has much to do with lighting quantity.

Do they believe that better lighting is needed? How do they feel about walking to and from the parking lot at night?

If comments are negative, and if a comparison of Columns 16 and 17 indicates that insufficient lighting quantities are being provided, chances are new lighting will have a dramatic impact on performance. Some consideration should be given to this improved performance when evaluating how much benefit will be derived from applying lighting management options.

**Overall Appearance (Column 19):** A lighting professional can use several different techniques to quantify the appearance of lighting. However, if professional assistance is not obtained, at least subjective judgments will do.

In fact, how does the lighted environment appear? Is it visually comfortable while being somewhat stimulating, or is it dull, flat and visually boring? Is it doing all it can to enhance the aesthetics of a space or could more be done? Could it be rated excellent? Good? Fair? Poor?

What about outdoor lighting? Does it create a feeling of safety, or do dark spots and shadows create areas where people could easily hide or trip?

Does the lighting trespass onto neighboring property or into other areas where it is not wanted? Does it enhance the appearance of a facility and its surroundings at night? Does it draw attention to a facility and identify it to passersby?

Remember, lighting can be used to create a predetermined nighttime environment. Assuming that would be beneficial, does your present lighting do it?

**OTHER INFORMATION**

Additional information should be recorded and referred to, to help assure all important factors are considered. For example, notes should be made about the condition of lighting equipment. Are lamps and fixture surfaces being cleaned often enough? If not, the dust and dirt that build up absorb light. Have luminaires lenses yellowed due to age? If so, they are robbing you of light and should be replaced.

Examine maintenance records or speak with maintenance personnel to determine when lamps were last changed. Also, determine how old fixtures are and whether or not they have ever been re-ballasted.

Examine the ceiling. If fluorescent lamps are used, do they have different colors? If so, inadequate maintenance or purchasing controls may be the cause. Higher-efficiency, better-color lamps would help improve the appearance of the space as well as whatever merchandise is on display.

Examine the windows that admit daylight. Are they kept clean? If not, dust and smudges can cause glare. Inspect the cleanliness of walls and ceilings as well. Dirt on those surfaces absorbs light and the money paid for it. If it is time for repainting, consider use of lighter colors that are better reflectors.

**DO YOU NEED HELP?**

Can you perform a lighting system analysis on your own or do you need assistance? Can you select lighting management options on your own or do you need assistance?

If one assumes it will be necessary to pay for assistance, a decision about obtaining help usually will be based on how much additional value will be derived from that assistance in comparison to its cost.

To evaluate this potential value in terms of potential lighting energy or lighting O&M cost savings alone would be an error. The real value of better lighting is its ability to provide important benefits, such as increased retail sales, improved productivity, reduced errors, decreased accident rates, and so on.

It almost always requires an experienced professional to design the type of lighting necessary to realize these benefits. The value of these benefits is such that it usually justifies the fee or fee premium required to obtain expert guidance. But effective guidance is available from many sources for a very modest fee or none at all.
Figure 5: LIGHTING MANAGEMENT AUDIT FORM (See Instructions)

UNIT OR SPACED SERVED

<table>
<thead>
<tr>
<th>(1) Types of Luminaires per Luminaire Type</th>
<th>(2) Input Watts by Type</th>
<th>(3) Number of Luminaires by Type</th>
<th>(4) Total Watts</th>
<th>(5) Watts per Square Foot</th>
<th>(6) Annual Hours of Use</th>
</tr>
</thead>
<tbody>
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TOTAL

<table>
<thead>
<tr>
<th>(14) Method of Control</th>
<th>(15) Visual Tasks Performed</th>
<th>(16) IES/NA Illuminance Recommendations</th>
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<tr>
<td>(7) Energy Consump. (kWh)</td>
<td>(8) Lighting Energy Cost</td>
<td>(9) Replacement Lamp Cost</td>
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<tr>
<th>(17) Illuminance on Tasks</th>
<th>(18) User Comments</th>
<th>(19) Overall Appearance</th>
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CHAIN STORE AGE EXECUTIVE, DECEMBER 1991
Identifying Lighting Management Options (LMOs)

Information gathered through the lighting system audit should indicate whether or not changes will be beneficial. If so, many alternatives are available, both to attain desired lighting and to minimize energy and related system operating and maintenance (O&M) costs. These alternatives are spoken of as lighting management options or LMOs.

For purposes of discussion, the following LMO information is segregated by components, e.g., lamp LMOs and luminaire LMOs.

In almost all cases a variety of LMOs will be applicable to any given store or to different spaces inside or outside a store or shopping center. With few exceptions, no LMO should be considered an entity unto itself.

For LMO selection to be effective, each should be evaluated in terms of its impacts on interrelated system components. In other words, do not think in terms of lamps alone, or luminaires alone or controls alone.

Rather, think of an integrated system and how any change will affect or be affected by another system component or a change to that component.

Similarly, consider how a lighting system modification will affect or be affected by other changes that are planned, be it other energy-oriented modifications, new store hours, additions or modernizations.

LAMP LMOs

Lamps are evaluated in terms of several factors. Insofar as energy is concerned, however, one of the most important factors is efficiency (known technically as efficacy), rated in terms of lumens (of light output) per watt (power required to operate the lamp).

Table A indicates lumens per watt ratings (including ballast losses) of the six lamp types in common use: incandescent, fluorescent, mercury vapor (MV), metal halide (MH), high-pressure sodium (HPS), and low-pressure sodium (LPS). Efficiency varies considerably within any given lamp category, e.g., some fluorescent lamps are more efficient than others.

As a general rule, the most efficient lamp suited for the purpose is the one that should be specified. Determining suitability requires consideration of many additional factors. One of these is a lamp's light distribution characteristics.

The light from tubular (or linear) sources—fluorescent and low-pressure sodium—is more difficult to control than that of other types, commonly known as "point sources."

The impact of a lamp's inherent light distribution characteristics cannot be fully assessed until one considers the type of luminaire that will be used. The true efficiency of a lamp, therefore, depends not so much on how much light it provides without a fixture (raw lumens), but rather how much light it delivers to the work plane when it is in a luminaire in the space involved.

A lamp's color-rendering properties are particularly important in stores. They influence the colors actually seen by a person with normal vision. Although many lamps produce what is called "white light," there can be significant differences.

Table A: Lamp/Ballast Characteristics

<table>
<thead>
<tr>
<th>Type of Lamp</th>
<th>Wattage Range</th>
<th>Initial Lumens per Watt</th>
<th>Average Rated Life (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Pressure Sodium</td>
<td>18-180</td>
<td>62-150</td>
<td>12,000-18,000</td>
</tr>
<tr>
<td>High-Pressure Sodium</td>
<td>35-1,000</td>
<td>51-130</td>
<td>7,500-24,000+</td>
</tr>
<tr>
<td>Metal Halide</td>
<td>70-2,000</td>
<td>69-115</td>
<td>5,000-20,000</td>
</tr>
<tr>
<td>Mercury Vapor</td>
<td>40-1,250</td>
<td>14-60</td>
<td>12,000-24,000+</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>4-215</td>
<td>14-95</td>
<td>6,000-20,000+</td>
</tr>
<tr>
<td>Incandescent</td>
<td>15-1,500</td>
<td>8-24</td>
<td>750-3,500</td>
</tr>
</tbody>
</table>

NOTES

1. Data are based on the more commonly used lamps and are provided for comparison purposes only. Actual results to be derived depend on factors unique to the specific products and installation involved. Consult manufacturers for guidance.

2. Lumens (of light output) per watt (of power input) is a common measure of lamp efficiency (efficacy). Initial lumens-per-watt data are based upon the light output of lamps when new. The light output of most lamps declines with use. The actual efficiency to be derived from a lamp depends on factors unique to an installation. The actual efficiency of a lighting system depends on far more than the efficiency of lamps/ballasts alone. More than efficiency should be considered when evaluating a lighting system.
More than 11,000 retail locations now rely on IllumElex technicians to perform their lighting services. And the number is rapidly growing.


Working closely with BI-LO personnel, IllumElex provides monthly lighting maintenance in every BI-LO store, has engineered and performed an energy-efficient meat case retrofit, manages a group relamping program, and has been involved with construction, renovation and point-of-sale advertising programs.

Together, IllumElex and BI-LO have been able to reduce energy costs, reduce in-house maintenance demands and improve store appearance.

In addition to BI-LO, the list of smart retailers now enjoying IllumElex services includes Circuit City, Food Lion, Harris Teeter, Home Depot, Kroger, Revco, Rite Aid, Variety Wholesalers, Walgreens, Winn Dixie, Woolworth and more.

Call today for information about how IllumElex can help you save money on your lighting systems. We can change how you see the future.

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within any given lamp type, such as fluorescent, and even more significant variance from type to type.

Generally speaking, incandescent lighting has excellent color-rendering properties. But, incandescent lighting is the least efficient of all and it has the shortest life ratings.

The color-rendering properties of fluorescent lamps vary considerably, due to the many different phosphor coatings used in their production. Some have color-rendering properties best described as "harsh." Others produce color that some retailers consider even better than daylight.

Coated mercury vapor lamps provide relatively good color rendition. Mercury vapor lamps are rapidly becoming "a thing of the past," however, due to their low efficiency. Indoors, they are being replaced by compact metal halide lamps, when color rendition is important, and—outdoors—high-pressure sodium lamps when color is not as important.

The most commonly used high-pressure sodium lamps produce what is called a "golden white" color. Reds and certain other colors, although remaining recognizable in most cases, take on a different hue. This color shift can be offset when other lamps, such as metal halide, are mixed into the system.

"Color-corrected" high-pressure sodium lamps are available, but they are not as efficient nor do they last as long as standard HPS lamps.

Low-pressure sodium lamps are the most efficient of all, but they produce a monochromatic yellow light that makes all colors appear as shades of yellow or gray. Nonetheless, retail stores may find uses for LPS lighting outdoors, in some warehouses where color is not important, and mixed with other lamps in the same system.

This latter approach could be effective for security lighting, when it is sufficient to identify the presence of intruders, as opposed to identifying the color of their clothing as well.

The impact of color-rendering properties of different types of lamps is best considered with the guidance of lighting professionals.

Another factor to consider is lamp life. Rated life is the average amount of time a lamp can be expected to operate. It equates to the amount of time that passes until half the lamps in a test group fail.

Service life is determined as the amount of time that passes until half the lamps in a group actually installed at a facility fail.

Perhaps the most important life rating is useful life, meaning the amount of time that a lamp is left in place until it is removed.

Effective maintenance requires replacement of lamps that are still operating, but at their point of economic obsolescence. That point varies for different types of lamps, depending on their lamp lumen depreciation (LLD) characteristics, that is, the rate at which the amount of light produced by a lamp declines over time.

Since LLD means that the cost per lumen rises, at some point it is economically worthwhile to replace the existing lamp to reduce the cost per lumen.

Low output can also have a negative effect on the appearance of a space; color rendition can be affected as well.

Lamp cost also is important, but it must be reviewed in proper perspective. Obviously, it makes more sense to pay $25 for a lamp that will last 20,000 hours than $5 for a comparable lamp that will last 3,000 hours, unless the latter has some other attribute that makes it worthwhile. One also must recognize the labor cost associated with lamp replacement.

Another factor to consider when evaluating new lamps for an existing system is the type of luminaire now employed, as well as its age and overall condition. In some cases it may be possible to make a direct substitution, that is, removing one lamp and installing a more suitable one in its place.

Even in such cases, however, it may be more appropriate to replace the fixture, particularly when the potential benefits of a new lamp/luminaire combination are greater than those attainable through relamping alone.

A system's distribution patterns or geometry also must be a concern. Given that an existing system was designed to use a specific type of lamp, will a different lamp be suitable? In many cases it will be and significant benefits will flow.

If R40 150W reflector flood lamps
currently are installed in stack-baffled downlights, a 75W ellipsoidal reflector flood (75ER30) can be substituted. The amount of light produced beneath the fixture is the same as that provided by the R40 lamp, but only half the energy is consumed.

In the case of other incandescent sockets, consider using one of the new fluorescent substitutes that consumes 80% less energy while lasting 10 times longer. This approach is particularly applicable to displays that involve table lamps, as in furniture and department stores.

If mercury vapor (MV) lamps are installed indoors or outside, consider a metal halide or high-pressure sodium replacement, providing the MV ballast is suitable.

Table B provides information on some of the most common direct substitutions available.

**LUMINAIRE LMOs**

Luminaires, as lamps, are rated on the basis of several factors.

**Coefficient of utilization**, or CU, is the factor most commonly considered relative to a luminaire’s efficiency. The CU rating indicates how much of the light emitted by the lamps alone becomes useful illumination on the work plane.

The CU data listed by manufacturers in their catalogs are derived based on standardized tests. The CU actually experienced is likely to vary because it depends on factors unique to the installation involved, such as room size and shape, mounting height and reflectances of room surfaces.

Actual CUs can be calculated using manufacturers’ tables or, when non-uniform illumination patterns are employed, through use of computer programs. (Some manufacturers provide computer studies without charge.)

A luminaire’s impact on overall lighting system efficiency can be considerable. If a 100 lumen-per-watt lamp is installed in a luminaire with a CU of 0.70, the efficiency of the lamp/luminaire combination would be 70 lumens per watt. Place the same lamp in a fixture whose CU is 0.50 and efficiency drops to 50 lumens per watt.

The difference in CU feasibly could mean the difference between 100 luminaires and 75 (or fewer) luminaires being needed to provide the same amount of light in a given space.

While initial cost impacts would be significant, long-term effects on operation and maintenance costs would be even more substantial.

Fixtures also are rated in terms of **VCP**, or **visual comfort probability**, a measure used to indicate how many people will be visually comfortable (i.e., will not be bothered by glare) when seated in a space illuminated by the type of luminaire being evaluated. (Glare is the sensation experienced when you look into the high beams of an oncoming vehicle at night.)

Having comfortable, low-glare lighting is important. In sales areas, glare can detract from the aesthetic support and visual comfort that a lighting system should provide. In administrative, warehouse and other work areas, it can be a serious impediment to productivity.

As mentioned before, glare always is a function of lighting system design and the quality of illumination derived from that design. The lighting system used to provide 150fc in one area may produce far less glare than a system designed to provide 50fc in another area.

While glare is always a concern, it is a particularly important consideration when HID lighting is used; proper fixture selection is essential. As indicated in Figure 7, however, luminaires that provide both high efficiency and good glare control are available for HID lamps, just as they are for other types.

Another luminaire rating factor is **luminaire dirt depreciation** (LDD), meaning the rate at which dirt is likely to build up on lamp and luminaire surfaces. This can be a particular problem in dirty, dusty environ-
### Table B: Interchangeability of several selected lamps.

<table>
<thead>
<tr>
<th>STANDARD LAMP</th>
<th>REPLACEMENT LAMP</th>
<th>WATTAGE SAVINGS (^2)</th>
<th>COMPARATIVE LIGHT OUTPUT OF REPLACEMENT LAMP (^3)</th>
<th>VALUE OF ENERGY SAVINGS OVER LIFE OF REPLACEMENT LAMP AT $0.08/KWH (^4)</th>
<th>OTHER BENEFITS</th>
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<tr>
<td>60W Incandescent</td>
<td>55W Reduced-Wattage Incandescent</td>
<td>2</td>
<td>+</td>
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<tr>
<td></td>
<td>13W TT Compact Fluorescent with Ballast Adapter</td>
<td>44.5</td>
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<td>75W Incandescent</td>
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<td>22W Circle fluorescent</td>
<td>45</td>
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<td>18W Compact fluorescent</td>
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<td>100W Incandescent</td>
<td>95W Reduced-Wattage Incandescent</td>
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<td>44W Circle fluorescent</td>
<td>56</td>
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<td>30W R-20 Incandescent</td>
<td>Q20MR16 Low-Voltage Quartz Incandescent (^6)</td>
<td>8</td>
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<td>50W R-20 Incandescent</td>
<td>Q20MR16 Low-Voltage Quartz Incandescent (^6)</td>
<td>28</td>
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<td>75W R-30 Spot or Flood Incandescent</td>
<td>Q35MR16 Low-Voltage Spot or Flood Quartz Incandescent (^6)</td>
<td>36</td>
<td>+</td>
<td>$11.52</td>
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<td>50W PAR-30 Spot or Flood Incandescent (Halogen)</td>
<td>25</td>
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<td>75W PAR-38 Spot or Flood Incandescent</td>
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<td></td>
<td>45W Incandescent (Halogen)</td>
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<td></td>
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<tr>
<td></td>
<td>120W ER-40 Incandescent</td>
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<td>$4.80</td>
<td></td>
</tr>
<tr>
<td>150W PAR-38 Spot or Flood Incandescent</td>
<td>60W PAR/PHIR (Spot Halogen Infrared Incandescent)</td>
<td>90</td>
<td>+</td>
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<tr>
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<tr>
<td></td>
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<tr>
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**NOTES:**

1. This table does not indicate all possible lamp replacement options and, in some cases, replacing the ballast and lamp, or relying on a new fixture, ballast and lamp will provide better overall performance and energy management than the replacement shown. All numbers reported in the table are approximations, and in certain cases assumptions are made about the types of luminaires and other conditions involved. Consult manufacturers for accurate data relative to direct replacements possible for a given installation as well as any ballast operating temperature or other restrictions that may apply.

2. Wastage savings include ballast losses, where applicable, assuming use of a standard ballast. Actual ballast losses to be experienced depend on the specific type of ballast involved and operating conditions that affect its performance. In those cases where wastage savings exceed the difference in lamp wattage (if any), the operation of the replacement lamp also has the effect of reducing ballast losses.

3. Symbols used indicate the following: + + (substantially more) + (more) = (about the same) * (less) - (substantially less). Consult manufacturers for accurate information relative to conditions unique to the lamps and installations involved.

4. Other benefits typically provided by retrofit lamps include: lowered maintenance costs due to longer lamp life; improved productivity; safety/security; quality control, etc.; due to higher light output, ability to reduce the number of lamps installed systemwide due to higher output of retrofit lamps; and improved color rendition.

5. Retrofit with low-voltage lamps requires use of a screw-in adapter/transformer for downlighting, or a snap-in adapter/transformer for track lighting.

6. When installed in a stack-bathed downlight.

7. For high voltage only.
A number of other factors are commonly considered when specifying luminaires. One of these is aesthetics, that is, the appearance of the luminaire. Some are permanently mounted on the ceiling while others can be dropped into a suspended ceiling grid. When this latter type is employed, and when major store renovations are involved, it may be advisable to check into flexible wiring (Figure 8).

Through the use of branch wiring modules, fixtures can be relocated quickly and simply by disconnecting plugs, moving the fixtures and then reconnecting them.

Since it can be removed and reused elsewhere, the flexible wiring system and whatever is attached to it on the distribution side may be categorized, for tax purposes, as portable. As such, manufacturers claim, almost the entire lighting system is subject to more favorable tax treatment than permanent improvements to real property.

Flexibility can also be obtained through use of track lighting, long a favorite in many retail operations. It permits a luminaire to be moved anywhere on an electrified track. It is particularly effective for incandescent spotlighting which is still a staple for retail operations.

By relying on new compact low-voltage equipment, however, much better operating and maintenance performance can be obtained, in addition to more effective lighting.

Literally hundreds of luminaire types are available. Each represents a potential LMO, depending on the space being served. Expert guidance should be obtained for proper luminaire selection.

Note that changing the position of a fixture can also have a considerable impact on energy consumption in terms of general illumination, spotlighting, show window lighting and valance lighting, as follows:

**General Illumination:** In many cases, luminaires are mounted 14 to 18 feet above the floor. When aesthetic considerations permit, it is appropriate to consider lowering the luminaires. This is done easiest when the fixtures are pendant- or chain-mounted. Even when lowering is not relatively easy, however, the option should be investigated since the potential savings may approach 50% of what is being spent now.

**Spotlighting:** Two of the most common spotlighting targets are five-foot-high vertical displays, such as clothing racks, bookshelves and mannequins, and horizontal targets such as table and countertops.

Figure 9 shows how luminaire position affects the amount of light needed to spotlight a vertical target. It also identifies some of the lamps to consider, depending on fixture position and the footcandle level to be obtained on the target. Figure 10 does the same for horizontal targets.

**Show Window Lighting:** Show window lighting in many older stores is provided by general service incandescent lamps mounted in reflectorized fixtures. The fixtures are inefficient because they direct much of the light outside the show window.

The fixture can be modified simply by installing an adjustable socket extender that permits lamp aiming outside the fixture and installation of reflector lamps (R- or PAR-type).

These are far more efficient than general service incandescent lamps because the reflector is built into them; little of the light they produce is wasted. They also last longer. The savings that can be derived from this uncomplicated LMO can be substantial.

**Valance Lighting:** Fluorescent valance lighting is effective for illuminating linear displays, such as clothing racks. Nonetheless, many existing systems do not work well, often because the lamps are mounted too close to the vertical edge of the merchandise (Figure 11).

This situation can actually reduce merchandise visibility, because the eye is drawn away from the dimly lit merchandise to the extremely bright wall surface above and behind the display. As the luminaire is moved out from the display, its lighting becomes more effective.

A variety of fluorescent lamps and lamp combinations is used in valance lighting. When effectively designed and located, single-lamp luminaires can provide adequate illumination. If a higher light level is needed, a polished parabolic reflector fixture can be used (Figure 12).

**BALLAST LMOs**

Fluorescent ballasts have gone through major changes in recent years, to provide improved performance, longer life, more versatility and much lower energy consumption.

The changes were inaugurated when manufacturers developed energy-saving magnetic coil and core ballasts that were able to reduce systemwide energy consumption by as much as 9%; even more when matched with reduced wattage, high-efficiency lamps.

These energy-saving ballasts also last two to three times longer than standard magnetic ballasts.
The most recent development occurred when electronic ballasts were introduced. Many of the early "glitches" have been overcome, and these now are used extensively. They can help improve the quality of light by reducing lamp flicker, while also reducing (significantly) energy consumption.

Note that electronic ballasts do not all perform the same functions, such as dimming, so selections should be made with great care.

Electronic ballasts also are available for use with certain compact metal halide lamps, which are particularly suited to retail operations.

SHIELDING AND DIFFUSING MEDIA LMOs

Shielding and diffusing media consist of the lenses and louvers that are elements of most luminaires, except for those designed for "bare lamp" use, such as the strip lighting used in the calculation example.

The lens or louvers specified for a fixture affect CU and VCP ratings because they have such a significant effect on light distribution. Some are far more efficient than others, however, permitting certain tasks to be performed with less light—and therefore less energy—being needed from the source.

Replacement lenses should be installed when those now in place are inefficient because of their design or because they have yellowed with age.

Replacements should be selected carefully, and not just in terms of energy efficiency. Impact on visual comfort must be assessed, along with appearance, maintainability and weight.

When an existing system's condition is such that new lamps, ballasts, and lenses may be warranted, it may be most cost-effective to obtain a new installation. Most luminaire manufacturers permit specification of any type of shielding or diffusing medium.

CONTROL LMOs

For many years it was common practice to control large banks of luminaires with just a few master switches at a central panelboard. Energy was so cheap, the investment required to save it could not be cost-justified.

Today's high energy costs, emerg-
ing packages are required for dimming, except in the case of incandescent lighting.

Manual controls are effective only when the people required to operate them are reliable. Lighting use schedules, color-coding of switches, light switch stickers, posters, incentive programs and other techniques can be used to help improve reliability. These approaches take considerable effort, however, which is why automatic controls have gained so much popularity.

**Time clock controls** are among the most popular automatic controls, especially for outdoor uses. Some of these are highly sophisticated, and can be programmed a week at a time.

An astronomic feature on some automatically adjusts for changing hours of daylight and darkness during a year. Battery packs or spring-wound mechanisms eliminate the need to reset the clocks in the event of a power blackout or brownout.

Time clocks also have a place indoors, especially when specific lighting, such as that in store windows, can be fully or partially deactivated at predetermined times. In such cases, local controls often are installed to act as limited-time overrides.

**Photocell controls** also got their “start” outdoors. They activate and deactivate electric illumination based on the amount of ambient light available.

Note that two-stage photocell controls are available. These can provide one lighting level for signage and another for safety and security.

Some people prefer **photocell/time clock** controls for outdoor uses. The time clock is used to keep lights off for a given period of time, say 1 a.m. to 7 a.m. During other periods lights are controlled by the photocell.

When photocells are used indoors, they usually are applied to control fixtures near windows.

Daylighting also can have disadvantages. Careful study is needed to determine the amount of heat gained from natural lighting and the amount of cooling needed to offset it.

The quality of daylight also is an important consideration, since light coming in through windows can create glare. More frequent window washing may be needed to minimize absorption caused by dust and dirt.

Daylighting can cause fabric discoloration or fading, and can inter-

**Figure 11:** Inefficiency mounted valance fixture.

**Figure 12:** Single-lamp valance lighting with a parabolic reflector fixture.

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**CALCULATION EXAMPLE # 3**

Assume that a study of the space served by the 110-fixture installation from the prior calculations indicates that 70% of all sales are made during the hours of 11 a.m. to 1 p.m. and 5 a.m. to 8 p.m.

Management decides to reduce lighting levels by 25% during other open hours, and by 50% during the 8 a.m. to 9 a.m. and 9 p.m. to midnight periods.

To accomplish this, the existing luminaires are rewired in such a way that 20 local on/off controls are installed, two for each of the 10 rows of 11 fixtures each. One of the two controls operates the two outboard lamps of each fixture; the other operates the two inboard lamps.

In this way, all 44 lamps in each row may be on or off, or just 22 (inboard or outboard) may be kept on.

Adherence to the new schedule has the same impact as reducing full system use from 16 hours per day to 12.25 hours per day, for an annual savings of 1,369 hours. At $0.08/kWh, savings are worth $2,895/year (assuming energy-saving lamps and ballasts have been installed), bringing annual energy costs down to $9,451—$7,508/year less than the $16,959/year original cost, a savings of more than 44%.

If the control rewiring is performed when the new ballasts are installed, payback should occur well within two years.
Effective lighting maintenance is absolutely essential in order to derive cost-effectiveness from your lighting system.

Unfortunately, good maintenance practices are not as commonplace as they should be, leading to waste. This is a genuine shame, especially so because good maintenance is so easy to establish.

One of the key lighting maintenance concerns is the cleanliness of lamps and luminaires. As dirt builds up, the amount of light transmitted is reduced. Dust absorbs light and thus wastes the energy required to produce it.

The cleanliness of walls and other space surfaces also has an impact, as do the colors and textures of these surfaces. Generally speaking, light-colored surfaces reflect light, while dark-colored surfaces absorb it.

In some cases, a given lighting level can be obtained using 25% less energy simply by changing the colors and textures of space surfaces.

The frequency of lamp/luminaire maintenance best for a given installation, indoors or outside, depends upon many factors, including the amount of dirt in the air and the fixtures' ability to resist it.

Irrespective of dirt buildup, maintenance also must consider the light depreciation that accompanies the normal aging process of most lamps. Insufficient illumination due either to reduced lamp light output or dirt buildup can interfere with sales, safety, security and other performance objectives.

It is an accepted rule of thumb that fluorescent lamps should be replaced after they achieve about 60% to 80% of their rated lives. It is extremely difficult to keep track of when a lamp is installed to determine when it should be replaced, however. Partially for this reason, group relamping is usually recommended as the preferred lamp replacement strategy.

Group relamping is the practice of replacing all lamps in a system or large area at the same time. One of its two primary benefits is labor cost savings.

When lamps are replaced as they burn out (spot relamping) it takes about 30 minutes (0.5 hr) to effect a change, accounting for the time required to fetch a ladder and/or lamp changer and lamp, travel to the fixture, move displays and so on.

By contrast, when all labor, equipment, and materials are assembled for the purpose of group relamping—usually after hours to prevent disruption to the normal routine—replacement time is cut to about three minutes per lamp.

Group relamping does not eliminate occasional burnouts that require spot relamping, although it does make them somewhat rare.

The other significant attribute of group relamping is energy savings. Energy is saved because lighting system designers usually assume that less than optimal lighting maintenance will be provided.

Accordingly, they design additional lighting capacity into a system so adequate illumination is provided despite poor maintenance.

In cases where a system includes this “compensatory lighting,” re-sorting to group relamping may permit elimination of some lighting capacity, because the average amount of light provided by the system will be higher during the life of the lamps.

For example, if lamps produce 100fc after initial burn-in and 60fc just before replacement, the average light output—for purposes of this discussion—is about 80fc. If lamps are removed when their light output recedes to 80fc, average light output is about 90fc. If the 90fc is more than needed, fewer lamps and luminaires are required.
Bi-Lo has improved its lighting levels and lowered its lamp and maintenance costs in its meat department since switching from an incandescent cool beam flood system to fluorescent lights. The supermarket chain initiated the retrofit to upgrade the image of the department.

“We wanted to communicate visually to shoppers the fact that we had improved the quality and expanded the number of cuts in our meat department,” explains Paul L. Young, corporate energy analyst, Bi-Lo, which is based in Mauldin, S.C. The chain operates 178 grocery stores throughout South Carolina, North Carolina and Georgia.

Before rolling out the retrofit, the chain looked at a number of different types of lighting systems. After receiving input from various departments, Bi-Lo decided that a fluorescent system (featuring a General Electric SXL/SPX 30 fluorescent lamp with a Paracube louvre) was the one that best met its needs in terms of improved appearance and energy efficiency.

“The new system uses less wattage to provide 50% more light,” says Young. “It also requires less maintenance and less lamp changes because fluorescents burn much longer than standard incandescents.”

The first phase of the rollout was scheduled for Bi-Lo’s older stores.

“We knew that making the switch from incandescents to fluorescents in the meat cases would be a demanding job,” says Young. “We asked IllumiElex, who had worked for us previously, to do a test installation.”

The Raleigh, N.C.-based lighting management company engineered an energy-efficient system for Bi-Lo that increased light-levels some 50%. After viewing several different installations, Bi-Lo chose IllumiElex to implement the retrofit. Approximately 52 stores were converted to the new system. It was, says Young, a worry-free installation.

“As customers perceived it, one day we had one lighting system and the next day we had a different lighting system,” he explains. “IllumiElex didn’t interfere at all with normal store operations. They were efficient and thorough.”

The results of the meat-case lighting retrofit have been impressive. The IllumiElex-engineered system has saved Bi-Lo a total of $24,800 in reduced lamp costs, $9,850 per year in reduced energy costs and $1,450 a year in lower maintenance costs.

“It’s been an all-around savings,” adds Young.

In addition to its economic benefits, the new lighting has also brightened Bi-Lo’s product presentation.

“The overall appearance, including the color, of our fresh meat display has significantly improved with the lighting changes,” says Roy Williams, vice president of meat and deli operations, Bi-Lo. “The meat products look fresher which improves the customer’s perception of quality. That, in turn, should help create additional sales.”

One unexpected benefit of the lighting retrofit is prolonged product shelf life.

“The fluorescent system puts less heat on the surface of the meat which helps prolong shelf life and gives a better ‘bloom’ to the meat in the refrigeration cases,” Williams explains.

Based on the success of the first phase of the rollout, Bi-Lo will install the fluorescent system in the meat cases of all its remaining stores in 1992. Once again, the retailer will use IllumiElex to do the change-out.

“We are very satisfied with the work IllumiElex did for us,” says Bi-Lo’s Paul Young. “It was excellent.”
Williams-Sonoma Aims to Lower Energy Costs

Lighting is an important component of store design at Williams-Sonoma. The home-centered specialty retailer uses lighting to create warm and inviting interiors that enhance the merchandise on display and attract shoppers.

“We want our stores to be beacons in the crowded retail arena—lighting helps us accomplish this task,” says Bud Cope, director of construction, Williams-Sonoma, which is based in San Francisco. In addition to 93 Williams-Sonoma stores, the company operates 50 Pottery Barn outlets and 26 Hold Everything shops.

Each of Williams-Sonoma’s three retail concepts has a different lighting emphasis. Pottery Barn is marked by the generous use of point source lighting, while Hold Everything stores feature more general illumination. The more upscale Williams-Sonoma stores combine the best of both concepts.

“We conceal fixtures, but we also use them as visible parts of the design,” says Cope. “It all depends on what we are trying to accomplish.”

An environmentally-concerned retailer, Williams-Sonoma is about to roll out a new energy-efficient lighting system featuring biax lamps and solid-state electronic ballasts. The system, which will be installed in all new stores, uses 2-by-2 Metalux fixtures from Cooper Lighting. The Elk Grove Village, Ill.-based company, is one of Williams-Sonoma’s primary lighting suppliers.

“Because we feel that illumination is such a key element of design, we are very selective when it comes to choosing lighting fixtures,” says Cope. “We use Cooper because their products meet our two most important objectives: high quality and great design.”

Reduce energy costs: The electronic ballasts featured in the new system are designed to lower power requirements and cut energy costs by using electricity more efficiently.

“They produce more light but use significantly less energy than the standard ballasts,” says Cope. “They also last longer.”

While electronic ballasts are more expensive than standard ones, Williams-Sonoma is confident the payback will be relatively quick.

“The extra upfront costs will be offset by the reduction in energy costs and lamp costs,” explains Cope. “Cooper predicted a payback in four years, but we expect it will be even sooner.”

In addition to the actual reduction in energy costs, the retailer can look forward to energy rebates from select local utility companies.

“The rebates, which we didn’t take into account in the payback, will add to our savings,” Cope adds.

The new 2-by-2 system will be incorporated with the energy-efficient incandescents (quartz Halogen) that the retailer uses for accent and perimeter lighting.

“With this new program in place, Williams-Sonoma will have the most energy-efficient and environmentally-safe lighting system it can possibly have,” Cope says. “And that fact is as important as the actual cost-savings.”

Education is Cutting-Edge at the Source

Williams-Sonoma had a chance to take a peak into the future of lighting technology at the Source. Located on the grounds of Cooper Lighting’s headquarters in suburban Chicago, the new 20,000-sq.-ft. plus, dazzling high-tech facility is a living class room in retail lighting applications.

“We left the Source with what amounted to a mini-college education in lighting,” says Bud Cope, director of construction, Williams-Sonoma. “It’s a great place—we will definitely use it again.”

In addition to several on-staff engineers, Cope brought several outside architects that do work for Williams-Sonoma to the Source.

“Part of the reason for the trip was to get a better understanding of the costs and benefits of the lighting retrofit that we plan to roll out in 1992,” says Cope. “We saw firsthand how the available new technology can best be applied to Williams-Sonoma. We also learned about new technology that will be available in the future.”

The visit served as a reality check, Cope adds, on the lighting design in general and Williams-Sonoma’s own lighting systems.

“We were happy to find that, at least for 1991, our company is right where it should be in terms of its lighting applications,” he says.

Cope was most impressed by the educational bent of the facility.

“The center is set up to serve as a source for information about lighting design and technology,” he explains. “When you visit the Source, you get an education and not a sell.”

Cooper Lighting invites retailers to visit the Source. Williams-Sonoma’s Cope says the trip is well worth the effort.

“Anyone who has any interest in retail design should visit the Source,” he says. “I’ve visited similar centers over the years, but I definitely got the most out of the Source.”
Creating the Lighting Management Plan

When a lighting system is such that a great many LMOs can be employed, but the budget prevents you from implementing all LMOs at the same time, develop a lighting management plan. This can be done by developing a report that identifies applicable LMOs, the cost of each (including the value of lighting benefits) and the savings to be obtained.

LMOs considered most applicable should be identified; those that should be implemented at the same time to minimize cost can be combined into one LMO.

An example of the latter would be installing new ballasts and rewiring for new control strategies at the same time.

Next, prioritize LMOs to determine which should be implemented first, which second and so on. Changes then are made over a predetermined period, with the plan being monitored and updated at least on an annual basis.

This permits an orderly pattern for change, as well as integration of new technology, so even more energy savings are obtained, while maintaining or even improving upon the benefits that are provided by effective retail lighting.

Before proceeding with plan development, it is important to determine the various procurement options that may be available to you. For example, your local electrical utility may be offering a variety of rebates and/or low-interest loans or other incentives to encourage more efficient use of electricity.

Determine what’s available. Likewise, recognize that it may be possible for you to lease some of your lighting equipment, particularly outdoor lighting. However, do not forget that it may also be possible to lease certain indoor equipment, such as that connected via flexible branch wiring.

And be aware that some companies can offer excellent shared energy savings programs through which they install energy-saving equipment that ultimately reverts to your ownership after a period of time.

Also, even when some of these additional programs may not be available, be sure to properly evaluate lighting benefits with respect to O&M savings.

If financing a new system will cost, say, $1,000 per month for 60 months, but the combination of O&M savings and benefits should total two to three times that amount, then, clearly, the investment should be worthwhile.
The National Lighting Bureau was established in 1976 and functions as an information source to create more awareness of and appreciation for the benefits of good lighting, such as improved employee productivity and enhanced safety and security.

The quality of the lighting used to achieve these benefits determines the extent to which they are realized. The value of these benefits is usually many times greater than the cost of the electric illumination needed to attain them.

The NLB has developed a series of publications that address such questions as the types of benefits lighting can provide, the cost of lighting and how to compare lighting options.

All NLB guides have been prepared using non-technical language and extensive illustrations to help those who make decisions about lighting.


The National Lighting Bureau also sponsors the annual National Lighting Awards Program and works with a number of other organizations which are concerned with electric illumination.

The NLB derives its funding almost exclusively from its sponsors. These include a variety of non-profit organizations active in the lighting community, as well as those who manufacture, distribute, install or maintain electric illumination.

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For more information on the National Lighting Bureau, or to obtain copies of any of the publications, contact the NLB at 2101 L Street, NW, Suite 300, Washington, D.C. 20037 or call 1 (202) 457-5437.

The NLB does not promote a company’s specific products.
Glossary of Terms

**Ballast:** A device that modifies incoming voltage and controls current to provide the electrical conditions necessary to start and operate electric discharge lamps.

**Brightness:** As commonly applied, brightness is the intensity of the sensation which results from viewing a surface or space that directs light into the eyes.

**Coefficient of Utilization:** A measure commonly applied to indicate the efficiency of a luminaire. Coefficient of utilization (CU) comprises a ratio of the light delivered to the area to be illuminated compared to the total light output of the lamp(s) alone.

**Contrast:** The relationship between the brightness of an object and its immediate background. An example of this would be the relationship between the letters printed on this page and the paper itself. An example of poor contrast would be a third or fourth carbon copy of a purchase order or computer printout.

**Diffuser:** A device commonly put on the bottom or sides of a luminaire to redirect or spread the light from a source. It is used to reduce brightness from the source.

**Footcandle:** The basic measure used to indicate illuminance (level of illumination). One footcandle is equal to one unit of light flux (one lumen) distributed evenly over a 1-square-foot surface area.

**Footcandle (or Uniformity) Ratio:** The relationship between average footcandles and minimum footcandles (such as 3:1) or maximum footcandles and minimum footcandles (such as 6:1). The maximum:minimum ratio generally is preferred because average footcandles cannot be seen.

**Footcandles, Average:** The theoretical average amount of light falling on a surface, as derived by averaging the illumination falling on all points of the surface. Two systems may produce identical average footcandles while providing highly dissimilar illumination.

**Footcandles, Initial:** Footcandles (minimum, maximum or average) produced when lamps and luminaires are new.

**Footcandles, Maintained:** Footcandles (minimum, maximum or average) calculated through application of a light loss factor.

**Footcandles, Maximum:** The amount of light falling on that point of a surface with the most illumination.

**Footcandles, Minimum:** The amount of light falling on that point of a surface with the least illumination.

**Glare:** A discomfoting or disabling condition that occurs when a high-brightness source contrasts with a low-brightness background, making it difficult for eyes to adjust. High brightness alone does not cause glare.

**HID:** High-intensity discharge lighting including mercury vapor, metal halide and high-pressure sodium light sources. Although low-pressure sodium lamps are sometimes included in the HID category, they are not HID sources.

**Lamp:** A light source, commonly called a bulb or tube.

**Lens:** A glass or plastic shield that covers the bottom, and sometimes sides, of a luminaire. Lenses can also be designed to control the direction and brightness of the light as it comes out of the luminaire.

**Light Loss Factor:** A multiplier that is applied to account for conditions that reduce light output over time. These include temperature and voltage variation, lamp aging, and dirt buildup on lamp, luminaire and room surfaces. In common practice, light loss factors are applied to initial footcandles to determine the light level that will be maintained in a given area.

**Louver:** A series of baffles arranged in a geometric pattern used to shield a lamp from view at certain angles to avoid glare from the bare lamp(s).

**Luminaire:** A complete lighting fixture including one or more lamps and a means for connection to a power source. Many luminaires also include one or more ballasts and elements to position and protect lamps and distribute their light.

**Non-uniform Lighting:** A system that has lighting located with respect to the tasks, so more lighting falls on these tasks than on surrounding areas.

**Reflector:** A device used to redirect the light from a lamp or luminaire by the process of reflection.

**Task Lighting:** The lighting, or amount of light, that falls on a given visual task.

**Vehling Reflection:** Also known as a reflected glare, a reflection of a light source that partially or totally obscures details by reducing the contrast between task details and their background.
Acknowledgments

**Chain Store Age Executive**

Chain Store Age Executive is the leading publication serving retail headquarters management. A monthly newsmagazine, *Chain Store Age Executive* reports and analyzes trends and strategies in the following areas:

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For more information on *Chain Store Age Executive*, contact John S. Rapuzzi, vice president/publisher, 425 Park Avenue, New York, N.Y. 10022, (212) 756-5253.

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