

Store Lighting Guidelines Best Practices for Efficiency

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Introduction

Commercial office buildings use about 25% of all the electricity consumed in the country for lighting. Advances in state-of-the-art lighting technology can significantly reduce energy use and costs while providing light levels and quality recommended by the Illuminating Engineering Society of North America. In order to ensure compliance with applicable energy codes, achieve typical lighting energy levels substantially less than the energy code allowance, and contribute to regional energy and demand management, the following guidelines for office lighting are strongly recommended. Note that these guidelines generally provide substantial benefits from utility incentive programs and through LEED and other certification programs and may offer significant tax deductions and other benefits.

Facilities Affected

These Guidelines are intended to be used by contractors, architects, engineers, and others responsible for designing, specifying and/or building new lighting systems, including new buildings, tenant fit-out, remodeling, and/or energy-upgrade initiatives.

In general, these Guidelines should be applied to the following:

- General merchandise stores
- Specialty merchandise stores
- Discount merchandise stores
- Jewelry and fine gift stores
- Grocery and Specialty Food Stores
- Showrooms

Note: these Guidelines are for the sales area only. For information about common areas such as locker and dressing rooms, or for attached facilities such as offices, please refer to the appropriate Guidelines for these space types.

Facilities Less Affected

These Guidelines are not necessarily intended to address any of the following space types.

- Big box retail and wholesale stores

However, the principles of cost effective, energy efficient design expressed by these Guidelines should be employed in these or other space types whenever possible.

Implicit Considerations

These Guidelines were developed in consideration of applicable codes and standards in the U.S., including the following:

- Standards of the Illuminating Engineering Society of North America, including IESNA RP-2, Recommended Practice for Lighting Merchandising Areas. IESNA Standards apply in the USA, Canada and Mexico
- Standards of Underwriters Laboratories.
- Energy efficiency standards of the States of Connecticut, Massachusetts, and IESNA/ASHRAE/ANSI 90.1-2001.

General Design Requirements

All designs must comply with applicable codes and ordinances. Note that in general, the following requirements will result in lighting designs that demand less power (watts per square foot floor area) than mandated by the energy code. The energy cost savings realized by this practice will often pay back the incremental cost for the more efficient system within 3 years. Additionally, in many cases the first cost of lighting may be less than traditional designs because these Guidelines optimize the amount and type of lighting equipment than can be used.

Lighting Systems

General Requirements

A complete, hardwired lighting system must be installed complying with the following lighting power density requirements:

- a. For jewelry, china and similar merchandise, a general lighting allowance of 1000 watts plus 1.4 w/sf; a decorative lighting allowance of 0.7 w/sf; and display lighting allowance of 2.5 w/ sf.
- b. For Furniture, clothing, cosmetics and artwork and similar merchandise, a general lighting allowance of 1000 watts plus 1.4 w/sf; a decorative lighting allowance of 0.7 w/sf; and display lighting allowance of 1.6 w/ sf.
- c. For Sporting Goods, small Electronics and similar merchandise, a general lighting allowance of 1000 watts plus 1.4 w/sf; a decorative lighting allowance of 0.7 w/sf; and display lighting allowance of 1.2 w/ sf.
- d. For all other merchandise, a general lighting allowance of 1000 watts plus 1.4 w/sf; a decorative lighting allowance of 0.7 w/sf; and display lighting allowance of 0.6 w/ sf.

In each condition (a.) through (d.) above, the general lighting allowance may be applied to any lighting load. The decorative lighting allowance must be applied solely to decorative lighting fixtures such as chandeliers or sconces, or to special lighting effects such as cove lighting; color effects or projections; and the display lighting allowance must be applied to lighting equipment suitable for sales or merchandise display.

Portable lighting, such as lighting within display cases, is often also used, especially for jewelry stores and other fine merchandise. This lighting must be accounted for in the total power calculations. For refrigerated cases, lighting should not exceed 15 watt per lineal foot of case as measured along the floor line.

In addition, lighting controls shall be provided as follows:

- A separate programmable time of day on/off lighting control with manual override shall be provided for at least each of the following: approximately ½ of the general lighting system for periods of cleaning and maintenance; the balance of the general lighting system; display lighting except store windows; store window displays; case lighting; and decorative lighting.
- In addition, if the store employs skylights, areas under them shall be provided with a separate control.

Compliance Documentation

Designs shall be certified using COM-CHECK 3.1 release 1 or higher. For the Code to be used, select ASHRAE/IESNA 90.1-2004. If these guidelines are followed closely, the resulting designs should achieve approximately 25-35% better than 90.1-2004 and 40-50% better than 90.1-2001.

NOTE: Achieving performance significantly better than these target values is very difficult and not recommended without design involving considerable expertise.

Note that the General Requirements listed above are different than 90.1-2001 and 90.1-2004. These General Requirements are based on 90.1-2007's new retail methodology. In 2001 and 2004, 90.1 allowed the same additional display lighting power for clothing as for jewelry stores. To better match the allocation to the need, in 2007 90.1 will employ this four tier system, returning to a differentiation used in 90.1-1989 and prior standards. This program is based on effectively bettering the 90.1-2007 values, as well as the 2001 and 2004 values, thus achieving significant energy efficiency.

Design Theory

In retail lighting, "layering" of lighting is essential:

- General lighting provides relatively uniform illumination throughout the space. The amount and quality of this lighting sets the basic ambience of the space. If the light levels are high enough, additional highlighting is relatively unimportant. However, if the ambient lighting system is relatively low, then additional display lighting is necessary.
- Floor display lighting provides highlighting for most of the store. The extent of highlighting depends on the general lighting and intended ambience. If the general lighting levels are high, floor display lighting is used only occasionally for a few feature displays. However, with low ambient light levels, floor display lighting systems are generally used to light all of the merchandise, and systems such as track lighting are used extensively.
- Wall display lighting is necessary regardless of general lighting level. The simplest wall display lighting types include valance lighting, lighting for display shelving and lighting inside of display cases. Multiple layer display lighting, including both valance and accent lighting or wall washing from track, is often called for when displaying better quality merchandise.
- Display case lighting is used whenever the case enclosure prevents appropriate lighting from outside of the case. Lighting inside of cases from jewelry display to frozen foods is fundamental to good retail design.
- Ornamental and special effects lighting is used to establish style or motif, or simply to draw the customer into the store. Usually ornamental lighting contributes very little useful lighting, and for this reason alone it is given its own separate allocation.

A complete retail lighting design is a combination of all these layers. Some layers, such as lighting within refrigerated cases and store windows, are exempt from energy code calculations. Because energy codes only regulate permanently installed lighting, there is an argument that lighting inside of display cases, if powered from cord and plug, are exempt. This is not true. The lighting inside of a non-refrigerated case is required to be included in the calculations.

General Lighting Systems

As a general rule, higher light levels are associated with modest quality goods, and low general lighting levels are associated with best quality goods. But also, the emphasis on glare control and quality of appearance increases as the light levels drop for the better goods. In other words, use high efficiency troffers and other common lighting systems for general merchandise; for slightly upscale merchandise, use dressier general lighting systems such as indirect lighting and basket troffers; and for very upscale merchandise, use lighting systems with a very finished appearance like downlights and track.

Because the efficiency of lighting systems tends to fall as the lighting system becomes dressier, it's always good idea to use 1 w/sf as a design target. For most spaces, designers should employ lighting layouts that conform to the criteria presented in Table A. Spacing measurements are taken from the plan view center of the luminaire. Luminaires should be mounted at least 1/3 of the indicated mounting distance away from any ceiling-high partition. If more than one type of luminaire (excluding exit signs) is to be located within one space enclosed with ceiling high partitions, the spacing between different luminaires must be the larger of the required spacings for the two luminaires in Table A.

Do NOT use incandescent lighting, halogen lighting, or track lighting systems or monopoints of any kind or voltage of operation. The one exception is track lighting using current limiting as discussed below.

Display Lighting

As the general lighting level drops, the emphasis on specialized display lighting increases. For this reason, the power allowance for display lighting increases with the quality of the merchandise. Part of this is due to the need to create ambience, and part of it is due to the needs of merchandising, such as the higher light levels needed for the inspection and sale of jewelry.

The most important type of display lighting is track. Track lighting systems offer considerable flexibility, but too often the flexibility is abused, and tracks are loaded up with inefficient lighting after the certificate of occupancy. Today, track lighting systems can be exactly designed for the amount of lighting to be installed, and "current limiting" systems prevent too much lighting without denying the inherent flexibility track lighting systems offer.

Other types of display lighting systems will also be a part of these projects. These include recessed accent lights (both single and multiple lamp), monopoints, and a variety of specialized systems for valances and use inside display cases and other retail-specific applications.

To meet these advanced efficiency targets, traditional light sources simply won't do. Modern accent lighting systems will need to be employed, principally including

- Ceramic metal halide accent lights including track, monopoints and recessed lighting
- Compact fluorescent wallwashers and floodlights
- Linear fluorescent, LED and fiber optic lighting for display cases and enclosures

Carefully applied, efficient display lighting sources can achieve all but the most extravagant designs in modern retailing.

Decorative and Accent Lighting

In order to permit architects, interior designers, and lighting designers the ability to add lighting for aesthetic effects or décor, applicable energy codes permit decorative and accent lighting and provide an additional power allowance. Properly applied, these allowances permit significant additional lighting power and still permit a project to meet the energy code. However, for the purposes of this program, such additional power is not consistent with exceptional energy efficiency. This program has chosen to limit the use of this added energy to 0.7 watts per square foot for the entire building or the amount permitted by the code, whichever is less.

Technology

General

There are four principal lighting technologies needed to achieve high efficiency in retail lighting.

T-8 and T-5 Lamps and Ballasts

Depending on the application, employ linear T-8 and T-5, U-bent T-8 and twin tube T-5 lighting systems wherever possible. In retail, there is relatively little switching and long hours of operation, so use instant start ballasts as they are both the most efficient and least costly. Four-foot T-8 fluorescent lighting systems must employ “high efficiency” electronic ballasts and high lumen lamps. For T-5, T5-HO and all other fluorescent and compact fluorescent lamps, standard electronic ballasts are used with instant start ballasts preferred.

Compact Fluorescent Lamps and Ballasts

The compact fluorescent triple and quad tube lamps and other types of compact fluorescent lamps are good choices where the lighting is intended to look as “incandescent” as possible. Typical good applications include downlights, wallwashers and decorative lighting.

In most cases, use of pin-based lamps and separate electronic ballasts are preferred. However, in a few cases medium screw based compact fluorescent lamps with integral ballasts might be considered. For instance, when using track lighting and current limiters, use PAR38 compact fluorescent lamps as general lighting and wide flood accent lights. It may also be desirable to use screw based compact fluorescent lamps in traditional incandescent fixtures, especially if the fixture has no room for separate ballasts, but unless pin based lamps are used the fixture must be counted as if it were using incandescent lamps. Note that new adaptors using a special base that fits only compact fluorescent lamps is now being developed, and it may make it possible for the compact fluorescent lamps to be counted in energy code calculations in the future..

Ceramic Metal Halide Lamps and Ballasts

Ceramic metal halide lamps make highly efficient display lighting possible. With superior color and high efficiency, it is possible to use these light sources in virtually all traditional display lighting applications. As an added bonus, in some lamps is it possible to choose between 3000K and 4000K lamps, giving the designer an added option with high color temperature lighting.

Lamps are now available in a wide range of shapes and wattages. At 20 watts, choose from MR16-style lamps, PAR-20 lamps or small lamp “buds”. At 39 watts, added choices include PAR-30 long neck lamps. At 50 watts, it’s possible to choose the larger ED-17. And at 70 watts and above, there is a full range of lamps including PAR 30, PAR 38, ED-17, G-12, and even horizontal T-7. With this range of lamps there is considerable choice in luminaires, too. All metal halide ballasts for indoor use should be electronic.

Also, in track lighting applications where current limiters can be used, consider the self ballasted PAR38 ceramic metal halide lamp. Presently limited to 25 watts, this product is a low cost way to employ the state of the art in efficient lighting for retail.

LED

Light emitting diodes (LED) are a new source with several excellent retail lighting uses. In addition to being used as ornamental lighting, LED lighting is an excellent choice for illuminating display cabinets and a number of other close-proximity display applications. Presently not high efficacy, LED’s can be efficient by illuminating a small area using very little power.

Application Notes

Track Lighting

Track is a perfect source for retail lighting. It permits locating – and relocating – luminaires where needed. However, in order to offer this versatility, track systems often permit much more power than the space actually needs. Historically, this has been a “loophole” in which a code complying design is changed after inspection, and much more power than permitted is used. So, to mitigate this abuse, 90.1 requires track to be counted at the larger of 30 watts per foot or the actual installed lighting. Still, it is technically possible to actually install much more lighting on the track.

Modern energy codes now allow some form of current limiter to tune the rating of the track for energy code purposes. This allows the entire track to be rated at the watts permitted by the current limiter. For example, 20 feet of track on a 20 amp circuit is capable of having 1920 watts (legally) and is rated at 600 watts for energy code purposes. But if connected to a 2 amp current limiter, the track is rated at 240 watts for both purposes.

Use current limiters with ordinary track lighting. This permits the use of virtually any track luminaire and still meets the energy code. Two current types of current limiter include an inline device that is part of the track, and the use of a secondary overcurrent protection panel.

Decorative Lighting

Decorative lighting can be used to generate ambient light, as long as the fixture is decorative. In addition to its design appeal, this method also makes it easier to design better than code. The best solutions of this type of course will be decorative lighting using compact fluorescent or ceramic metal halide lamps, rather than incandescent. A classic design solution uses decorative pendant lights over sales counters and points of sale, and many appealing fixtures are available today with compact fluorescent sources.

Lighting Walls

Wallwashing is commonly used to illuminate display wall surfaces. These are very good applications for ceramic metal halide, fluorescent or compact fluorescent luminaires. In fact, even a medium based compact fluorescent PAR-38 lamp on track can perform acceptably well.

But often walls are complex display environments in which there is also a valence or shelf requiring lighting. This is where T-5 and T-8 lamps excel, and the use of ballast factor to reduce power is a smart way to manage power. For instance, a T-8 lamp operating on a low ballast factor instant start ballast only uses about 6 watts per foot. Also investigate LED lights for certain linear lighting applications.

Display Cases

As with valence lighting, first consider T-5 or T-8 fluorescent lamps with low ballast factor instant start electronic ballasts. Other more expensive options include fiber optics and LED lighting.

Lighting Controls

By code, each interior space enclosed by ceiling high partitions must have separate local switching and some form of automated-off control (occupancy sensing, time based scheduling, or other). In addition, wherever possible, provide separate switching for lights in daylighted zones. Retail spaces are also required to have separate switches for store windows, display lighting circuits, and display cases.

A well designed store will employ lighting controls with programmable on/off time controls and manual override switches. Note that the manual switches should be located in a secure location, such as the manager's office, to prevent unauthorized use or tampering. Separate control groups should include:

- Part of the general lighting system sufficient for cleaning and stocking. This group will operate the most hours, so energy efficiency and long lamp life are important.
- The balance of the general lighting system, operating during normal business hours.
- Display lighting, operating only during normal business hours.
- Display case lighting, operating only during normal business hours.
- Store windows, operating during useful hours. Some stores operate windows 24 hours, but reducing hours will save energy and maintenance costs. Take into account the location; in a mall, for example, the useful hours might correspond to the hours that the mall is open to the public.
- Exterior lighting, operating at night

There are a number of ways to design these controls, depending on the size of the store and circuit loads. The simplest solution is to employ a relay panel with internal programmable controls. For large stores, several such panels can be networked together to simplify programming functions.

TABLE A – General Lighting Systems at ~1.0 w/sf

<i>Primary Application</i>	<i>Luminaire Type</i>	<i>Lamps and Lamp ballast system watts</i>	<i>Results (RCR=1)</i>
High General Light Level <i>Suitable for Discount Mass Merchandise Stores, Grocery Stores, Supermarkets, Super Stores, and Self Service Convenience Stores</i>			
PATTERN 1 General use –spaces of all types (ceilings up to 12')	2' x 4' recessed extra high efficiency fluorescent troffer 8' x 10' on centers	(2) F28T5 lamps electronic ballast with 1.15 ballast factor at 72 watts	Approx. 60-70 footcandles maintained with excellent uniformity and minimum shadowing
PATTERN 2 General use –spaces of all types (ceilings at least 11- 12')	2' x 4'' recessed low cost high efficiency fluorescent troffer 12' x 10' on centers	(3) F32T8 lamps High efficiency T-8 electronic ballast with high ballast factor (108 watts)	Approx 55-65 footcandles maintained with good uniformity but some shadowing
PATTERN 3 General use –spaces of all types (ceilings up to 14')	Continuous Row Surface or recessed strip lighting; suspended continuous row high efficiency direct/indirect fixtures Continuous Rows approximately 12' OC	(2) F32T8 lamps per 4' unit; High efficiency electronic ballast with normal ballast factor (54 watts)	Approx 55-65 footcandles maintained with good linear uniformity but some shadowing
Medium General Light Level <i>Suitable for Department Stores, Better Mass Merchandise Stores, Specialty Stores, and Life Style Stores</i>			
PATTERN 4 General use –spaces of all types (ceilings up to 12')	2' x 4' recessed parabolic troffer or basket troffer, 8' x 10' OC spacing	(3) F32T8 lamps; high efficiency electronic ballast with normal ballast factor at 82 watts	Approx 35-50 footcandles maintained with excellent uniformity and minimum shadowing
PATTERN 5 General use –spaces of all types (ceilings up to 12')	2' x 2' recessed parabolic troffer or basket troffer 8' x 10' OC spacing	(2) CF40T5 twin tube lamps with instant start ballast (72 watts) (2) F32T8U lamps with high efficiency high ballast factor ballast (72 watts)	Approx 35-50 footcandles maintained with excellent uniformity and minimal shadowing
PATTERN 6 General use –spaces of all types with light ceilings 10' to 14'	Indirect, semi-indirect or direct/indirect lighting system. Continuous rows of luminaires 12' OC	(2) F32T8 lamps per 4' unit; High efficiency electronic ballast with normal ballast factor (54 watts) (1) F54T5/HO per 4' unit (60 watts)	Approx 35-50 footcandles maintained with good linear uniformity but some shadowing
Low General Light Level <i>Suitable for Upscale Specialty Stores, Jewelry and Precious Goods Stores, Designer Boutique Stores, and Upscale Life Style Stores</i>			
PATTERN 7 General use – spaces of all types and ceilings up to 12'	Compact fluorescent or HID downlights, high quality, well shielded. Spacing 6' x 8' OC	(1) CF42 triple tube downlight (1) M39 ceramic metal halide downlight	Approx 25-40 footcandles maintained with excellent uniformity and minimum shadowing
PATTERN 8 General use – spaces of all types and ceilings over 10'	Compact fluorescent or HID downlights, high quality, well shielded. Spacing 10' x 8' OC	(1) CF70 quad tube downlight (1) M70 ceramic metal halide downlight	Approx 25-40 footcandles maintained with good uniformity but some shadowing
PATTERN 9 General use – spaces of all types with white ceilings over 10' high	Decorative pendant upright nom 12' OC. Requires minimum 10 ft ceiling	(4) CF40T5 twin tube lamps with instant start ballast (144 watts)	Approx 20-35 footcandles maintained with excellent uniformity and minimum shadowing

Examples

Specialty Clothing Store

Specialty retail stores are often designed with lighting loads as high as 20 watts per square foot, so achieving the expected results for comparatively low power is challenging. Avoiding tungsten lighting is the key; with some care, very high end results can be achieved using energy efficient light sources.



In this example, a 4000 square foot specialty clothing area is shown. Begin with a general lighting system – 42 watt compact fluorescent downlights on 6' x 8' centers throughout the space. They are laid-out in a simple grid, not too close to the walls. Using 42 watt lamps will produce about 30 footcandles; for a lower ambient light level, simply use a lower wattage.

Next, around the perimeter are wall displays requiring a valance fluorescent light and separate accent lighting for hanging clothes. The valance works fine with a single T8 lamp using a low ballast factor, high efficiency ballast. The accent lighting for the walls consists of monopoints using either 39 watt metal halide floods or 40 watt compact fluorescent lamps.



Throughout the center of the space, there are floor displays having both flat and vertical display elements. In order to light the floor displays from all four sides, a grid of track is installed. Eight track luminaires - two from each side – illuminate the display, one flood (for the flat displays) and one narrow flood (for the vertical display such as a mannequin). In this design, a 10' ceiling is assumed, and each display luminaire is a 20 watt ceramic metal halide.

General Merchandise Store

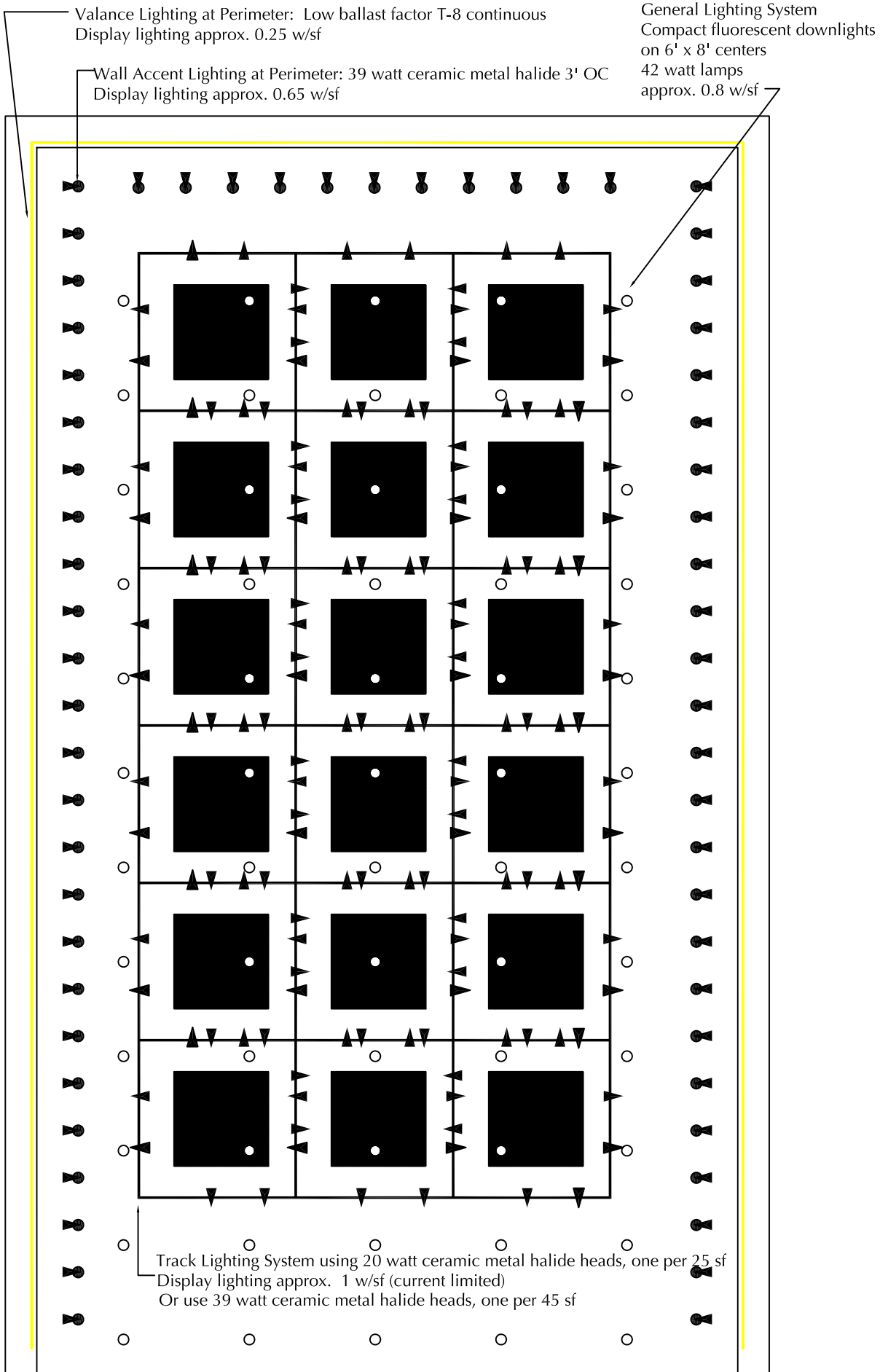
There are two primary types of displays of general merchandise; stores that employ organized aisles, and those that don't. Aisles are used in many store types including grocery stores, small electronics stores, and super stores. When aisles are used, the shelving displays are either normal height (approx 7' to 8' high) or short (4' to 5' high). This example has normal height shelving displays. These spaces generally require 12-15' high ceilings.



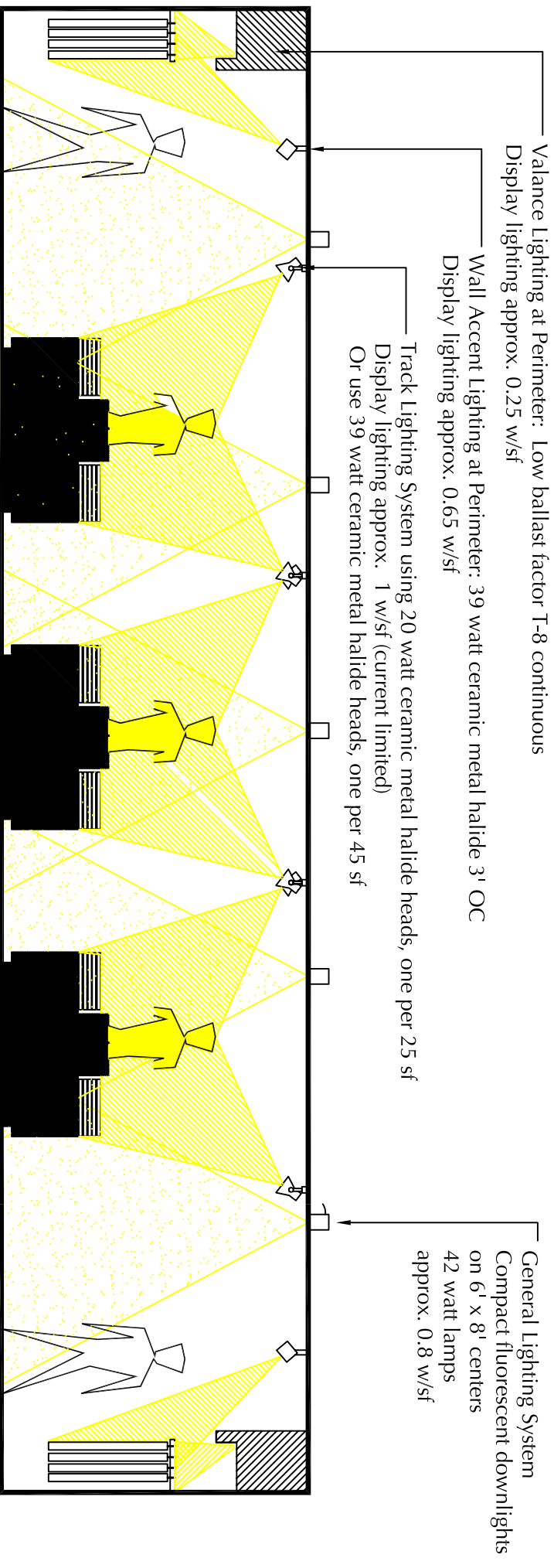
The general lighting system runs parallel and above the center of the aisle. This is by far the most efficient and cost effective way to illuminate shelving aisles. A two lamp fluorescent fixture using either two T8 or T5 lamps, overdriven with a high light output ballast. This combination produces as much light per unit length as traditional 8' lamps, but using 20% less power. Choose the luminaire carefully, and very high light levels can be achieved. The design shown here uses a suspended fluorescent fixture, which will generally work best.



Around the perimeter, a valance lighting system is used for the wall display below, and again a high light output ballast is used to increase the light level. For the shelf above, monopoint accent lights are located all around the perimeter. In addition, monopoint accent lights illuminate the ends of the shelving displays, which is often a key merchandising spot.



Example: Upscale Specialty Clothing



Example: Upscale Specialty Clothing

Power Limits for Clothing

GENERAL LIGHTING 1000 WATTS + 1.4 W/SF = 6600 WATTS

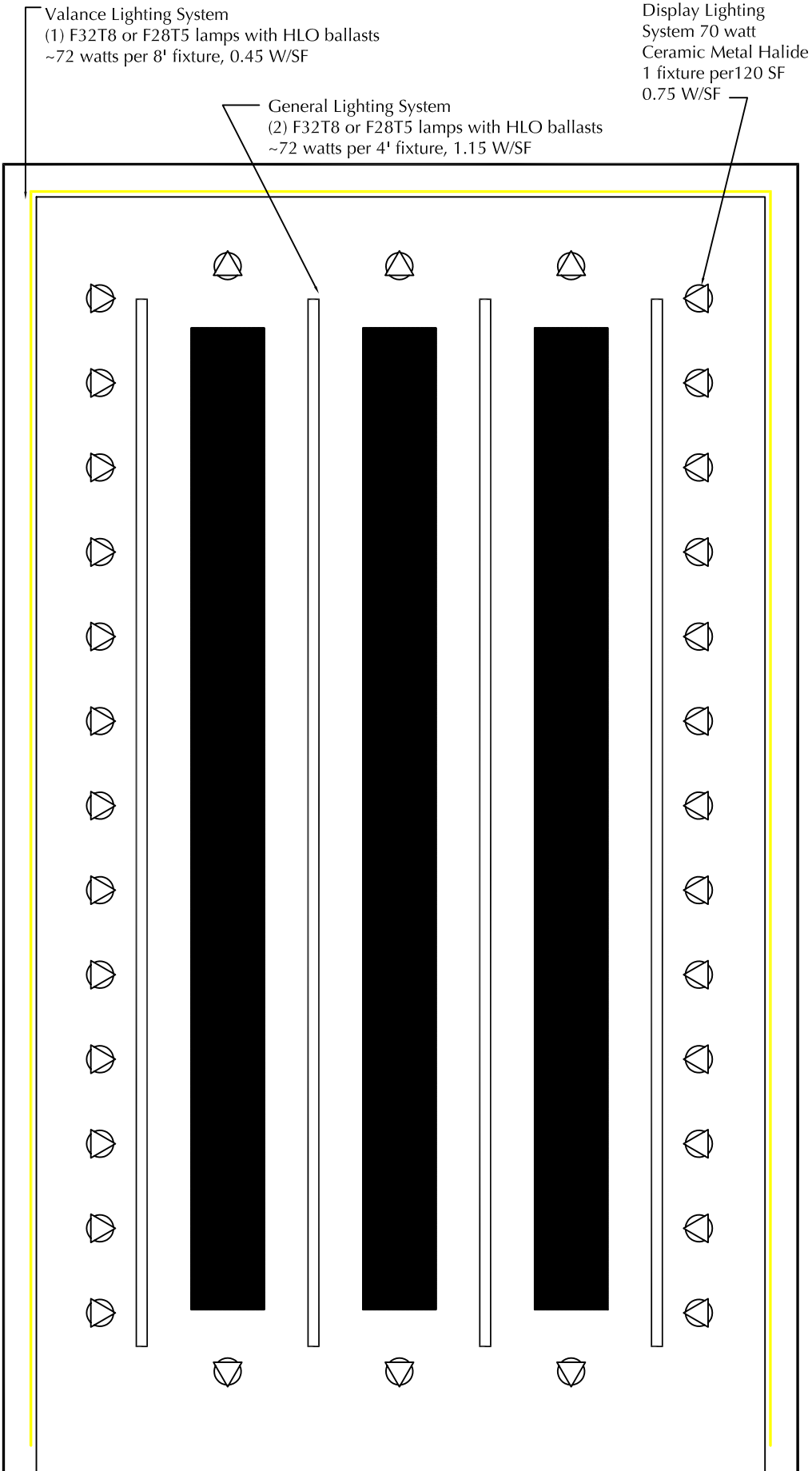
DISPLAY LIGHTING 1.6 W/SF = 6400 WATTS

Actual Design

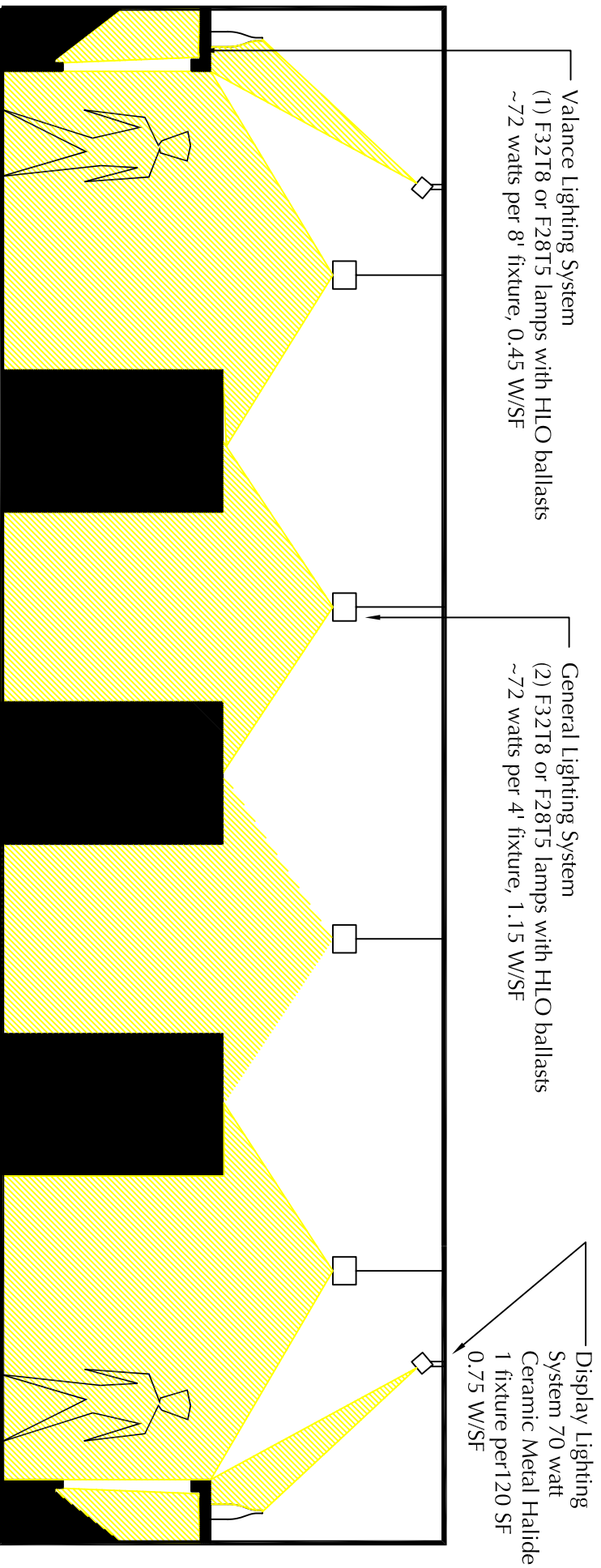
DISPLAY LIGHTING: VALANCE 1000 WATTS + TRACK LIGHTS 4000 WATTS + WALL ACCENTS 2600 WATTS = 7600 WATTS

GENERAL LIGHTING 3200 WATTS

Design COMPLIES with program for Clothing



Example: General Merchandise, Tall Shelves, Stack Aisles



Example: General Merchandise, Tall Shelves, Stack Aisles

Power Limits for Sporting Goods and Small Electronics
 GENERAL LIGHTING 1000 WATTS + 1.4 W/SF = 6600 WATTS
 DISPLAY LIGHTING 1.2 W/SF = 4800 WATTS

Power Limits for All Other Merchandise
 GENERAL LIGHTING 1000 WATTS + 1.4 W/SF = 6600 WATTS
 DISPLAY LIGHTING .6 W/SF = 2400 WATTS

Actual Design
 DISPLAY LIGHTING: BALANCE 1800 WATTS + ACCENT LIGHTS 3000 WATTS = 4800 WATTS
 GENERAL LIGHTING 4600 WATTS

Design COMPLIES with program for Sporting Goods and Small Electronics
 Design COMPLIES with program for All Other Merchandise By Reducing Load by 400 watts

Option: reduce display lighting by 15%
 Option: change general lighting from high light output ballast to standard ballast