Grocery Store Lighting Guidelines
Best Practices for Efficiency

December 27, 2006

Drafted by

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Commissioned by

UI and CL&P

Photos (left) Benya Lighting Design (right) Finelite

Introduction

Commercial buildings use about 50% 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 grocery store 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 mass merchandise and grocery buildings with finished ceilings 14' or less including spaces with partially finished ceilings. The following are applicable building types:

- Grocery Stores
- Discount Mass Merchandise Stores (not big box)
- Discount mega stores (not big box)
- 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
- Specialty retail 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. In addition, separate Guidelines are provided for both building types.

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 that has total lighting power equal to or less than 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. 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 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 Approach

In grocery lighting, there are six principal layers of lighting:

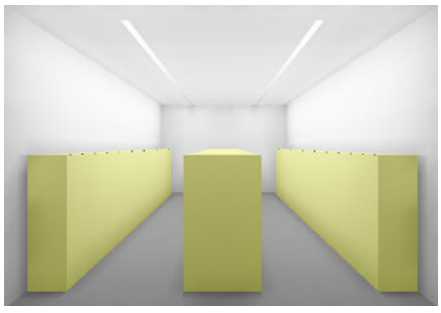
- Stack aisle and general lighting provides relatively uniform illumination throughout the space. Direct or semi-direct lighting systems are strongly recommended due to superior efficiency and ability to "punch" light between stack aisles. Typical light levels are a minimum of 50 footcandles 30" above the floor in the center of the aisle, and at least 20 footcandles on the face of goods 18" above the floor on stack shelves.
- Display lighting for freestanding produce displays. There are a number of ways to do this, including track lighting, recessed accent lighting, and pendant lighting. The light level should be about 50 footcandles in both the horizontal and vertical planes.
- Display lighting for the ends of the aisles. This usually requires a monopoint accent light unless the aisle has adequate general lighting.
- Lighting at the checkout counter. Solutions vary from general lighting systems similar to the rest of the store, to special and decorative lighting. The preferred light level is about 50 footcandles on the checkout counter itself.
- Lighting inside of refrigerated cases.
- Perimeter lighting for displays and/or upper wall illumination.

In addition, decorative lighting is sometimes used in conjunction with special elements around the store. A good example is the trend to have a name-brand coffee shop in the store, and often a few decorative lights are suspended over the coffee point of sale as branding and identity.

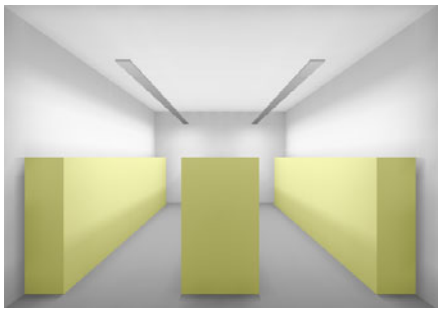
A complete store lighting design is a combination of all these layers. Some layers, such as lighting within refrigerated cases, are exempt from energy code calculations.

Stack Aisle and General Lighting Systems

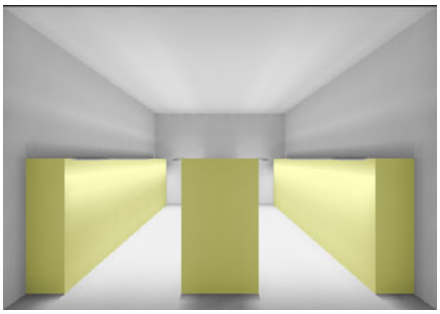
There are three primary ways to light stacks:



Surface mounted strip lights generate at least 60 footcandles in the center of the aisle and 25 footcandles on the shelf at 18" at 1.25 w/sf.



Suspended pendant direct luminaires lights generate at least 65 footcandles in the center of the aisle and 30 footcandles on the shelf at 18" at 1.25 to 1.35 w/sf.



Lights mounted at the top of the shelf row generate at least 50 footcandles in the center of the aisle and 25 footcandles on the shelf at 18" at 1.35 w/sf.

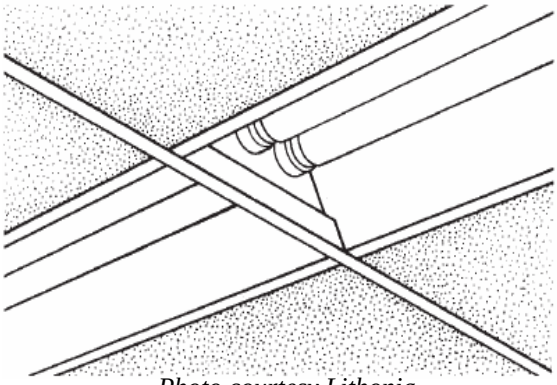


Photo courtesy Lithonia

From a design standpoint, surface mounted strip lights are quite efficient (as long as the ceiling is white) and as a side benefit, they illuminate the upper walls and ceiling of the space. But ceiling strips also create glare, and their appearance tends to convey a budget-minded design. The biggest advantage of strips is that the floor layout can be rearranged without also tending to the lighting. Supermarket trough fixtures (left) perform similarly, and look at little better. These lighting systems work best in designs of moderate cost.

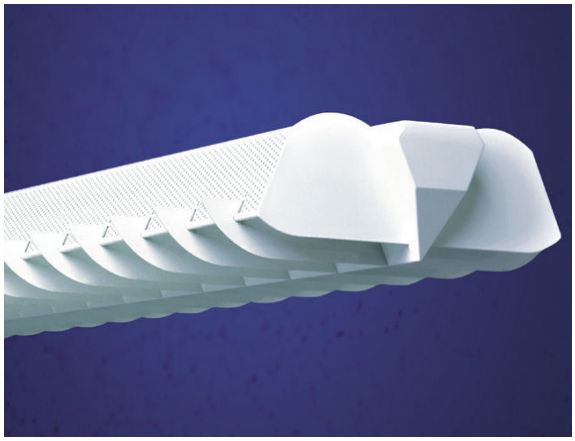


Photo courtesy Finelite

Suspended pendant lights, centered over the aisle, are very efficient, too, typically providing the highest lighting levels per unit of energy. The designer can choose from very inexpensive industrial fixtures to comparatively attractive linear lighting with cross baffles for better glare control. Also, consider semi-direct fixtures if a little bit of uplight is desired (the luminaire at left is 85% downlight). The drawbacks are increased cost, and if stacks and shelving are rearranged, so must be the light fixtures. These lighting systems are preferred for better quality stores.

Photo courtesy Finelite

Building a light into each side of the top of the stack is not as efficient, but it creates an extremely dramatic appearance for the shelves. The light levels are reduced quite a bit, but the contrast of lighting on the merchandise is by far the highest. In addition to costs associated with lighting mounted to the shelving system, power must be brought into the stack, preferably from below. These lighting systems are especially good for the "marché" design, where the design intent is to create an upscale shopping experience. However, as in the photo at left, an overhead lighting system is used as well, it's not possible to meet the energy efficiency criteria of this program.

Note that linear lighting systems are best with linear stack layouts. No design using round fixtures can even come close in efficiency. Be sure to employ "super" T8 and T5 lighting systems and ballasts.

Display Lighting

Photo courtesy Benya Lighting Design

There are four areas where display lighting is typically used today:

1. Over the produce area. Because produce stands are often laid out in an open area, they lend themselves to track lighting (upper left) and other dramatic lighting systems much the same as valuable merchandise in department stores.
2. Refrigerated and freezer cases
3. In upscale part of the store such as wine, floral, or delicatessen (lower left).
4. As accent lighting for the ends of stacks and other specialty displays and above the top shelf, especially at the perimeter of the store.

Photo courtesy Lightolier

The most common 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.

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 and LED lighting for display cases and enclosures

Carefully applied, efficient display lighting sources can achieve all but the most extravagant designs in modern retailing. In the photo at left, the work area and menu board of a deli are lighted using track-mounted compact fluorescent wallwashers. Judicious use of sources like these can result in spectacular display lighting while meeting the targets of this Guideline. Avoid low voltage lighting and other tungsten sources.

Decorative Lighting

Grocers have considerable professional marketing technology, and they vary store designs to address the expectations of the store's community as well as to compete with other stores in the market. Decorative lighting, in combination with the quality of the display and general lighting

layers, is one of the more powerful design tools that can be used to add pizzazz or "brand" the store.

For example, an international coffee store chain often has mini-store franchises inside the grocery store. One of its most powerful branding tools is a group of red decorative pendant lights, hanging over the coffee point of sale. This same technique can be used to brand the floral shop, take-out counter, or bakery. The energy code provides additional lighting power for this lighting because it is inherently inefficient and often produces little useful light. That said, it's smart to employ compact fluorescent lamps in decorative lighting anyway.

Photo courtesy Lightolier

A current design style, called ***marché*** (French for market) has been made popular by grocers promoting natural foods. Marché breaks all of the rules of lighting, turning to theming and other design techniques not previously common in larger grocery stores. Most marché designs employ classic industrial style luminaires like the RLM in both an effective and decorative way.

Specialty Lighting

Grocery stores are unique in having refrigerated and frozen food cases. As sales cases, they require interior lighting. However, at low temperatures, the behavior of lighting systems changes. Incandescent lamps are relatively unaffected, but their heat is a detriment to cooling the case. Fluorescent lamps perform poorly at low temperatures, and require special fixtures and tube heating shields, both of which are relatively inefficient. However, the latest light source, LED, performs best when cool, and the latest lighting systems for refrigerated cases use white LED lamps.

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 display 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. The marché design (left) uses themed industrial pendant lights for ambient light, with display lighting from track or integrated into displays. For integrated lighting, use T-5 or T-8 fluorescent lamps with instant start electronic ballasts. Other more expensive options include fiber optics and LED lighting.

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.

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.

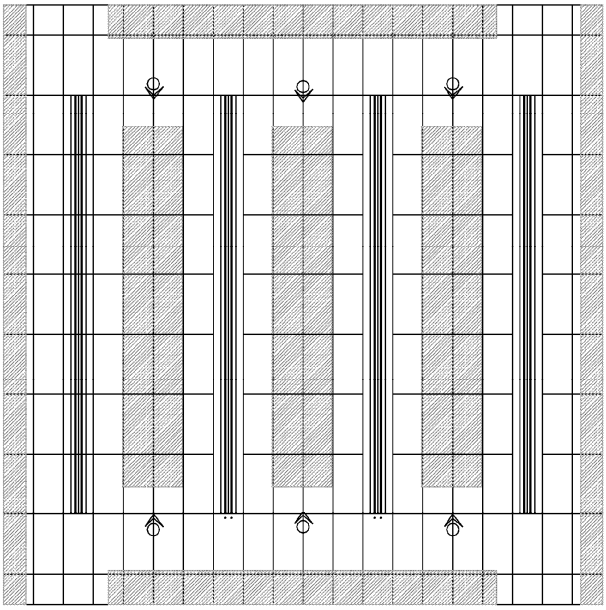
A well designed store will employ lighting controls with programmable on/off time controls and manual override switches. Note that the manual switches should be located in a secure location, such as the manager's office, to prevent unauthorized use or tampering. Separate control groups should include:

- 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.

Examples

The following two pattern designs show how these concepts can easily be applied to achieve the intended results. In Pattern 1, a stack area is shown. Two lamp strips or trough fixtures are centered above the stack aisles. The illustrated concept works with stacks on multiples of 2' increments; with strip lights, the stack aisle distance doesn't matter. You'll get plenty of light and still be very efficient. Want more light? Use high ballast factor ballasts for the ceiling strips, and the design will still comply with program criteria.



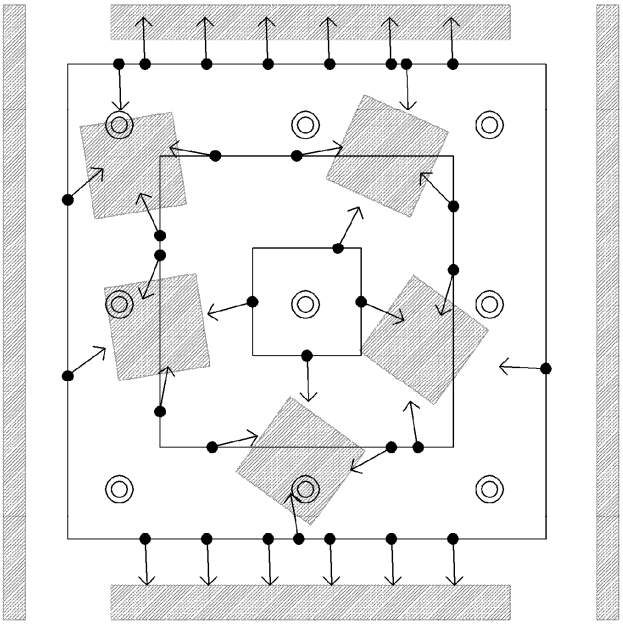
PATTERN 1
GENERAL LIGHTING: 3240 W ALLOWED / 1510 W USED
DISPLAY LIGHTING: 960 W ALLOWED / 270 W USED
DECORATIVE LIGHTING: 1120 W ALLOWED / 400 W USED

STACK AISLE LIGHTING
SUITABLE FOR 10-14' CEILINGS
STRIPS OR OPEN TROUGH
HIGH PERFORMANCE T8
LUMINAIRE WITH (2) T8
LAMPS AND 0.88 BALLAST
FACTOR BALLAST
40 FC MAINTAINED ON SHELVES (MIN 25 AT 24")
65 FC MAINTAINED IN AISLE AT 30"
0.945 WATTS PER SQUARE FOOT

STACK AISLE LIGHTING
>50 FC ON END OF STACK
CERAMIC METAL HALIDE
ACCENT LIGHT 39 W
0.169 WATTS PER SQUARE FOOT

PORTION OF WALL LIGHTING
COVE ALONG ENDWALLS
HIGH PERFORMANCE T8
LOW BALLAST FACTOR BALLAST
ALLOW 0.25 W/SF

In Pattern 2, a produce area is shown. This design uses the "marché" approach with a few decorative fixtures to set the style, but the real work is being done by the track lights. This design pushes the limit of this Guideline – but still meets it. It uses all 70 watt ceramic metal halide display lights, which will ensure display lighting levels of 50-100 footcandles everywhere. Note that beamspread is critical – a 70 watt ceramic metal halide spot mounted at 12 feet will produce an hot spot of 500 footcandles about 18" in diameter! A flood lamp (40° beam) will produce 60-120 footcandles over a 7 foot diameter area. This will easily achieve the intended result of a very dramatic produce department.



PATTERN 2
GENERAL LIGHTING: 3240 W ALLOWED / 3240 W USED
DISPLAY LIGHTING: 960 W ALLOWED / 120 W USED
DECORATIVE LIGHTING: 1120 W ALLOWED / 972 W USED

DECORATIVE LIGHTING
SUITABLE FOR 10-14' CEILINGS
INDUSTRIAL STYLE PENDANT LIGHTS
(4) 26 WATT CFL PER FIXTURE
20 FC MAINTAINED GENERAL LIGHT LEVEL
0.608 WATTS PER SQUARE FOOT

GENERAL AND DISPLAY LIGHTING
(31) 70 WATT METAL HALIDE
CERAMIC METAL HALIDE
TRACK CIRCUITS 15 AMP 9 AMP 4 AMP
3360 TOTAL DISPLAY WATTS
3240 W COUNTS AGAINST GENERAL LIGHTING
120 W COUNTS AGAINST DISPLAY LIGHTING