



PIER Lighting Research Program



**California Energy Commission
Contract # 500-01-041**

Draft Lighting Applications Evaluation Report

Deliverable 2.3.3b

May 23, 2003

Submitted To:
Accounting Office, MS-2
California Energy Commission
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Table of Contents

Introduction	3
Lighting Application Evaluation	3
1. Under Cabinet Lighting.....	4
2. Jewelry display applications.....	5
3. Elevator lighting.....	6
4. Museum Lighting	7
5. In-shelf Lighting.....	8
6. Cove lighting	9
7. Linear step lighting.....	9
Most promising applications	10

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Draft Lighting Applications Evaluation Report

Introduction

This report for Project 2.3 Light Emitting Diode (LED) Low Profile Fixtures evaluates a list of applications selected as potential applications for the design of a low profile luminaire based on the quantity and the quality of lighting requirements for the application.

The research team for this project includes Nadarajah Narendran and Ramesh Raghavan, both with the Lighting Research Center (LRC). The information in this report has been gathered to assist the LRC in short-listing four applications for the low profile LED luminaires that will be designed in this PIER Project.

Lighting Application Evaluation

The applications listed in deliverable 2.3.3a were systematically analyzed based on the tasks in the application and the parameters of the light fixtures such as required levels of illuminances, recommended correlated color temperature (CCT) and color rendering index (CRI) of the source, typically used sources, total lumens used and the energy consumption of a typical source. All these parameters are adapted from the recommended values in the Illuminating Engineering Society of North America's (IESNA) *Lighting Handbook*.

Each application listed requires low profile luminaires for efficient task performance because the space available for mounting a luminaire is very limited.

1. Under Cabinet Lighting

The most common use of under cabinet lighting is in a residential kitchen. Typical tasks include reading controls, instructions, fine print on packages and cookbooks and handwritten recipes. The lighting also helps determine the condition of foods in all stages of the cooking process (color and texture evaluation) and other tasks such as measuring and mixing, safe operation of small appliances, and cleanup.



Under cabinet lighting

Recommended Illuminance levels	
Horizontal	500 lux
Vertical	100 lux
Correlated Color Temperature (CCT)	3000 – 6500 K
Color Rendering Index (CRI)	>85
Typically used source	Fluorescents, halogens
Lumen per fixture	800 - 2100
Typical energy use	30 - 100 W

The light fixture should have a well controlled distribution in the task area. It should be easy to plug in and use from a common 110V power source. An optional dimmer could be attached so it can be dimmed and used as an ‘all night’ kitchen light along the counter.

2. Jewelry display applications

According to the IESNA lighting handbook, there are three specific goals to retail lighting: to attract the customer, to allow the customer to evaluate the merchandise and to facilitate the completion of the sale. Of these, the first two are achieved by light within the display case. Issues to consider are the visibility of the displayed object, space appearance, energy consumption and maintenance. The illuminance on the displayed object should be three times the ambient light. ^[1]



Jewelry Display Case

Recommended Illuminance levels	
Horizontal	1000 lux
Vertical	300 lux
Correlated Color Temperature (CCT)	2800-3500K
Color Rendering Index (CRI)	>85
Typically used source	Fluorescents, halogens, MR, PAR lamps
Lumen per fixture	500-1000
Typical energy use per fixture	30-75W

The fixture should be easily adjustable for highlighting different merchandise and should be configured to be used in a track application.

3. Elevator lighting

Elevators are mostly used in public buildings and office buildings and are often shared by strangers when in use. More over they are small confined spaces, so the lighting should help people feel comfortable. Bright ceilings and walls can give a feeling of increased size and will also indirectly illuminate peoples faces. The light levels should be approximately equal to light levels in the corridors.



Elevator interior

Recommended Illuminance levels	
Horizontal	500 lux
Vertical	300 lux
Correlated Color Temperature (CCT)	2800-3500K
Color Rendering Index (CRI)	>80
Typically used source	Fluorescents, PAR lamps, Compact Fluorescent lamps
Lumen per fixture	800 - 2100
Typical energy use per fixture	30-60W

4. Museum Lighting

The primary visual task in a museum is for the public to view the displayed natural artifacts and examples of human achievement. According to the IESNA lighting handbook, there are four types of museum displays: flat displays on vertical surfaces (painting on walls), display cases (rare artifacts), three-dimensional objects (sculptures), and realistic environments. Each of these have unique challenges which can be addressed by the luminaire design as a part of the lighting design. The focus for this evaluation will be on flat panel displays and three dimensional objects to an extent.

One of the critical issues in museum lighting is the deterioration of the object on display due to the radiated heat from traditional light sources like halogens and PAR lamps.

There is virtually no radiated heat from LED sources, making them a perfect source for lighting museum objects. In addition, a properly deigned low profile, LED luminaire can be easily concealed within a slot in the ceiling avoiding obtrusive traditional fixtures.

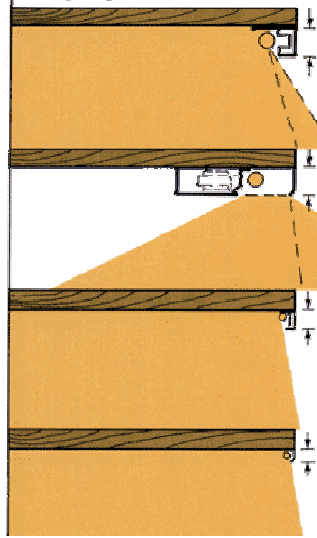


Museum lighting

Recommended Illuminance levels	
Horizontal	50-500 lux
Vertical	50-500 lux
Correlated Color Temperature (CCT)	2800-6500 K
Color Rendering Index (CRI)	>90
Typically used source	MR, PAR, halogen lamps
Lumen per fixture	100-2000
Typical energy use per fixture	10-100 W

5. In-shelf Lighting

Lighting shelves in a cupboard or a closet is another place where a low profile luminaire is most required. The luminaire size is critical as it would be in the way of viewing the shelf, reducing shelf space. The color rendering of the source is of importance too depending on the material stored on the shelves.



In-shelf Lighting

Recommended Illuminance levels	
Horizontal	100 lux
Vertical	100 lux
Correlated Color Temperature (CCT)	2800-3500 K
Color Rendering Index (CRI)	>80
Typically used source	Fluorescent lamps
Lumen per fixture	500-1000
Typical energy use per fixture	15-30W

6. Cove lighting

Cove lighting for ceilings is commonly done as a decorative element within a space. There are no set criteria for the illuminance levels as no tasks are performed. It could be employed as a source of ambient light in darker environments such as bars and pubs. Colored cove lighting is also a common feature. The most common light sources used currently are neon, cold cathode lamps and fluorescent lamps.



Cove lighting

7. Linear step lighting

Step lighting is used as a decorative element as well as a way to illuminate steps in low ambient light conditions. It is positioned along the tread of the steps lighting down or from the side. Care should be taken to prevent breakage while using the steps. The most common light sources currently used are fluorescents, neon (along tread) and incandescent, CFLs (from the side).



Linear step lighting

Most promising applications

The most promising applications here in were chosen based on criteria such as potential interest from luminaire manufacturers, potential interest from end users and maximum energy savings.

The following are short-listed as potential applications for optical modeling and prototyping of the low profile luminaires

- Under-cabinet lighting fixture
- Down light for elevators
- Museum display lighting fixture
- Jewelry display lighting fixture

These are in no particular order. Two of these will be chosen for final prototyping based on input from manufacturers, lighting designers and other major players.

References

1. Rea M, (2000) IES Lighting Handbook IESNA, NY