## Advances in Non-Residential Lighting Technologies

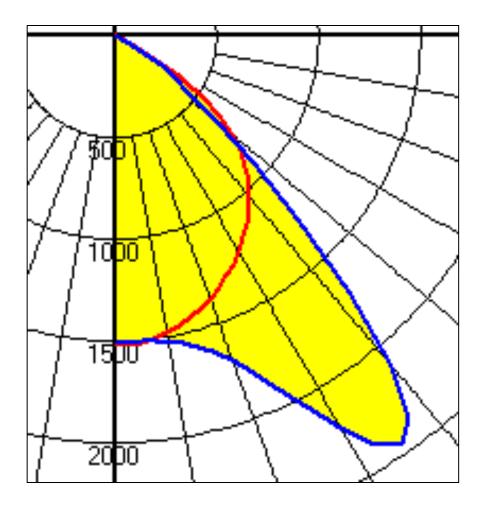
CABEC conference – San Diego, CA October 21, 2011

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# **Copyright Materials**

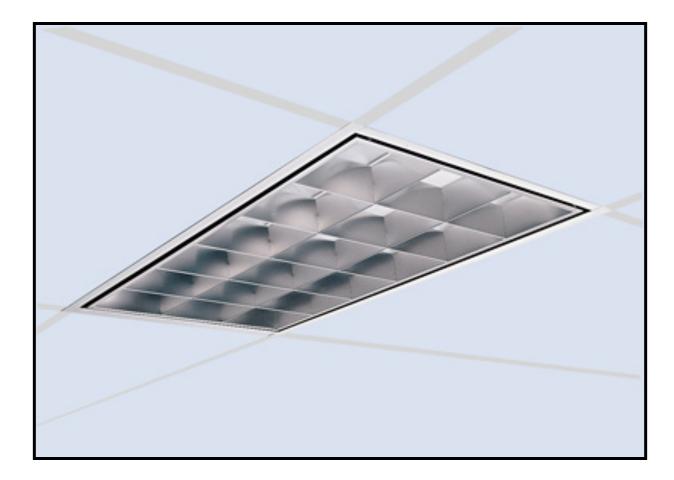
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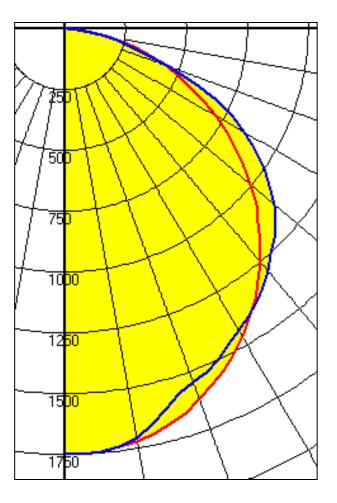
# Candlepower distribution & efficiency



Efficiency: 70.9%

### 2'x4' recessed parabolic troffer

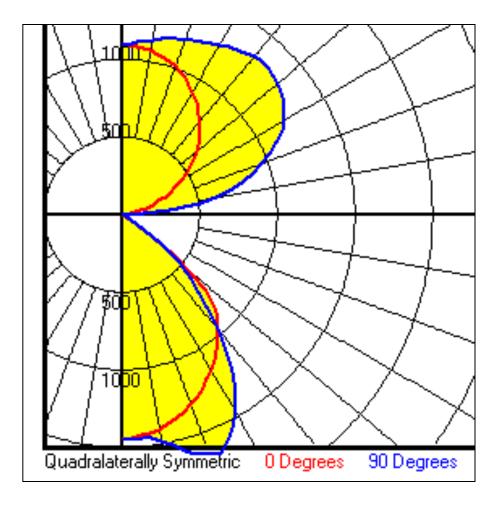




Efficiency: 54.5%

### 2'x2' direct-indirect troffer

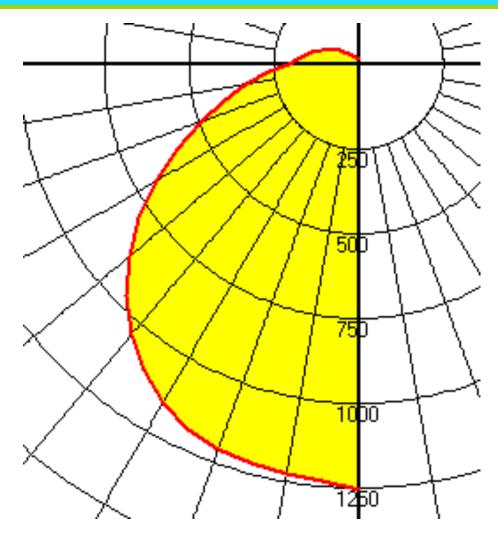




Efficiency: 89.9%

### **9"x4' pendant direct-indirect**

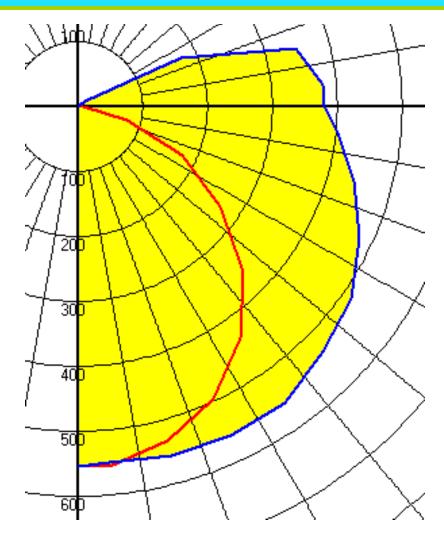




Efficiency: 36.1%

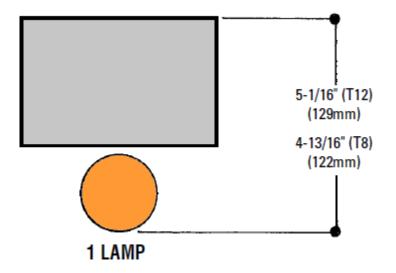
### **Pendant decorative**

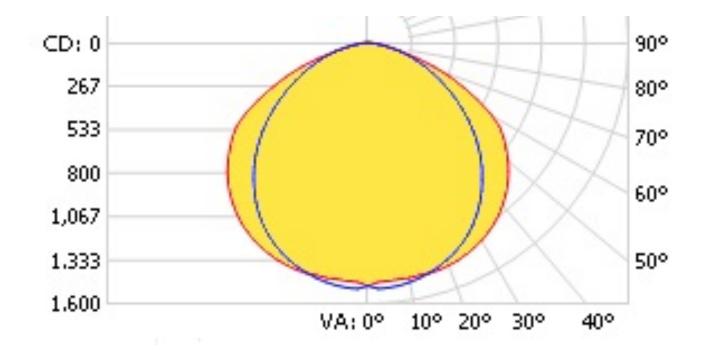




Efficiency: 93.3%

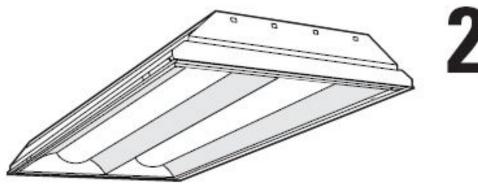
### **Single-lamp fluorescent strip**





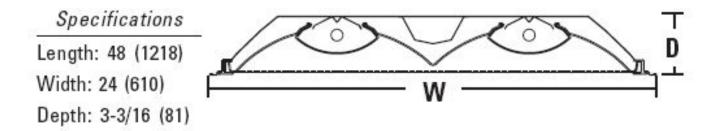
Efficiency: 80.6%

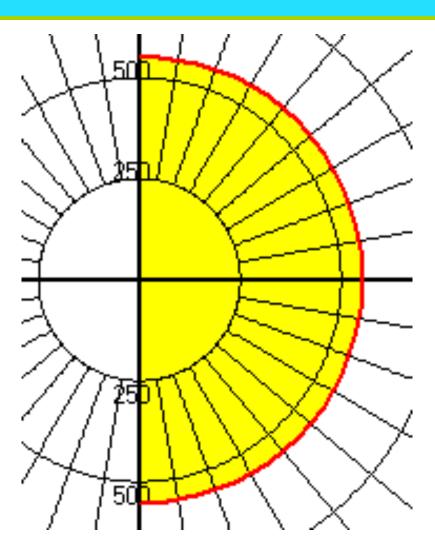
### **Non-planar lensed troffer**



**2RT8B** 

2'x 4' 2 Lamps T8





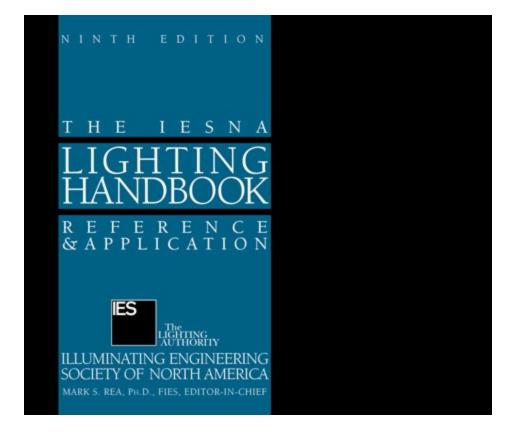
# Best practices for retrofitting

**Light levels & wattage** 

### How much light do you need?

### >How much wattage can you legally use?

### **Illuminating Engineering Society of North America**



### **Illuminance recommendations**

Orientation and simple visual tasks. Visual performance is largely unimportant. These tasks are found in public spaces where reading and visual inspection are only occasionally performed. Higher levels are recommended for tasks where visual performance is occasionally important.								
A	Public spaces	30 lx (3 fc)						
B C	Simple orientation for short visits Working spaces where simple visual	50 lx (5 fc)						
	tasks are performed	100 lx (10 fc)						
are for Record chara- record	non visual tasks. Visual performance is imp und in commercial, industrial and residenti mmended illuminance levels differ because cteristics of the visual task being illuminate mended for visual tasks with critical eleme all size.	al applications. e of the ed. Higher levels are						
D	Performance of visual tasks of high contrast and large size	300 lx (30 fc)						
E	Performance of visual tasks of high contrast and small size, or visual tasks of low contrast and large	500 ly (50 fc)						
-	size	500 lx (50 fc)						

F Performance of visual tasks of low contrast and small size 1000 k (100 fc)

#### **IESNA** "Lighting Design Guide" – Chapter 10 in the handbook

I. INTERIOR LOCATIONS AND TASKS		Ver	y Im	port	ant		Im	porta	ant		So	mev	vhat	imp	orta	nt		Blank =	Not	imp	orta	nt o	r not	applicable
Design Issues	Appearance of Space and Luminaires	Color Appearance (and Color Contrast)	Daylighting Integration and Control	Direct Glare	Flicker (and Strobe)	Light Distribution on Surfaces	Light Distribution on Task Plane (Uniformity)	Luminances of Room Surfaces	Modeling of Faces or Objects	Point(s) of Interest	Reflected Glare	Shadows	Source/Task/Eye Geometry	Sparkle/Desirable Reflected Highlights	Surface Characteristics	System Control and Flexibility	Special Considerations	Notes on Special Considerations	Illuminance (Horizontal)	Category or Value (lux)	Illuminance (Vertical)	Category or Value (lux)	Notes on Illuminance - see end of section	Reference Chapter(s)
Offices (13)																								Ch. 11
Filing (see Reading)																				E		С		
General and private offices (see																								
Open plan office																								
Intensive VDT use																		(14,15)		D		В		
Open plan office																				=		В		
Intermittent VDT use																		(14,15)		E				
Private office																				E		В		
Libraries (see Libraries) Lobbies, lounges, and receptio																				С		A		
Mail sorting																				E		A		
Copy rooms																				E C		A		
																						A		

**Light levels & wattage** 

## New IES Handbook!!!

Office lighting target light levels based on display type
Where do you need to achieve the "target light level"?

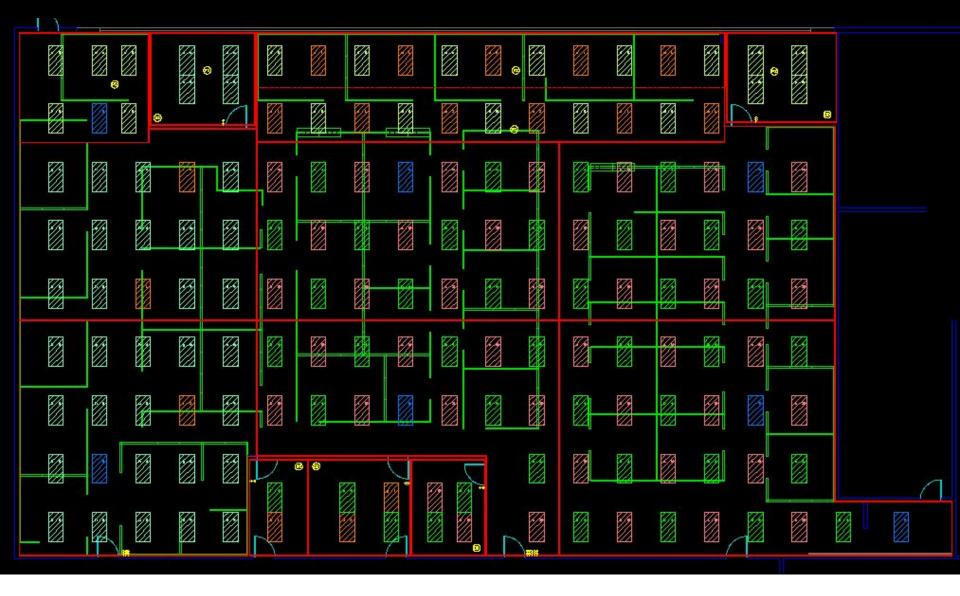
### **Lighting Power Density (from Title 24-2008)**

#### Table 146-E in Title 24-2008 **Allowed lighting** power (w/sq. ft.) Type of use Auditoriums 1.5 Classroom building 1.1 Commercial and industrial storage buildings 0.6 Convention centers 1.2 1.1 Financial institutions 1.0 General commercial and industrial work building (High bay) General commercial and industrial work building (Low bay) 1.0 1.5 Grocery stores 1.3 Library 1.2 Medical building and clinics Office buildings 0.85 Parking Garages 0.3 1.6 Religious facilities 1.2 Restaurants 1.0 Schools Theaters 1.3 All others 0.6

### "Office of the Future"



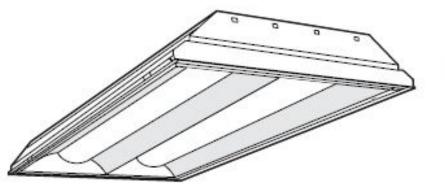
### **Existing lighting layout**



### **Proposed lighting layout**

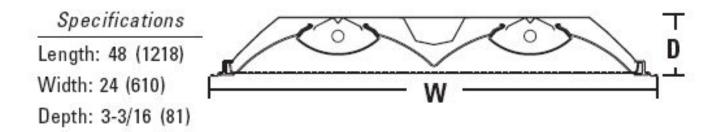


### Lithonia retrofit 2x4 fluorescent troffer



# **2RT8B**

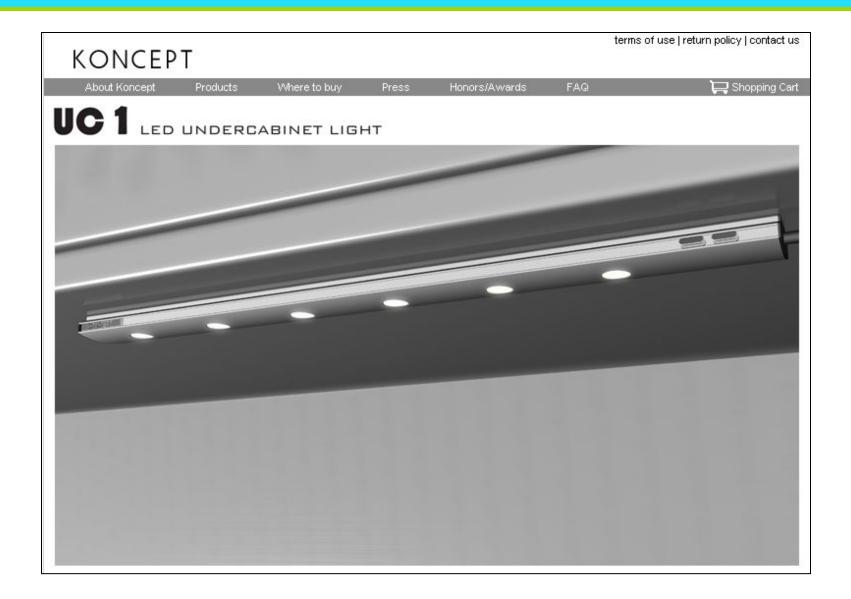
2'x 4' 2 Lamps T8



### **Application photo of Lithonia "Relight" 2x4**



### **Koncept undercabinet LED strip**



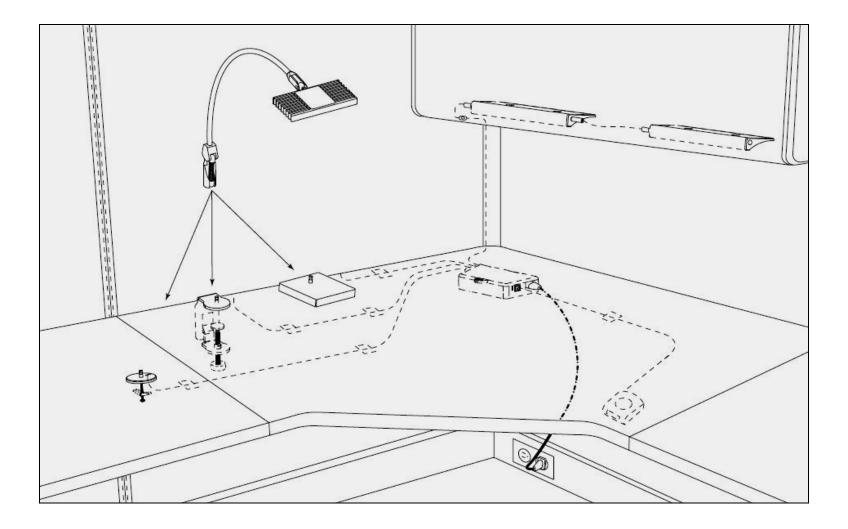
### **Finelite 7.6-watt undercabinet LED strip**



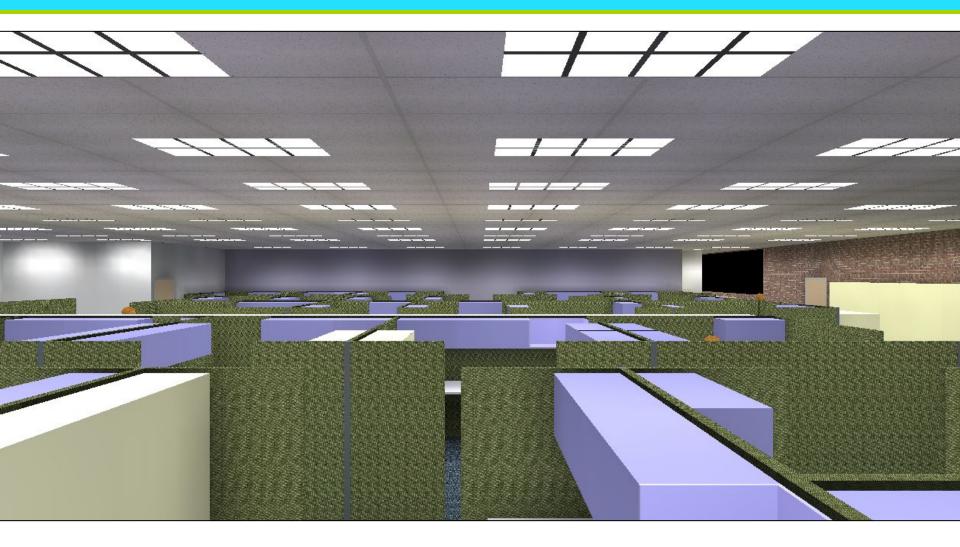
### **Finelite 3-watt LED desk lamp**



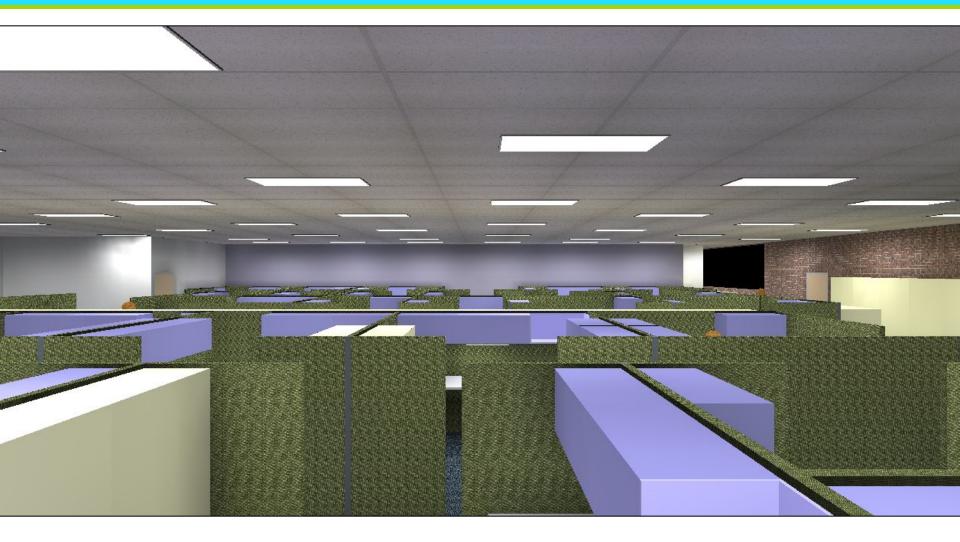
### Finelite "system" w/power supply & OS



### Rendering of existing lighting (2x4 parabolic troffers)



# **Rendering of proposed new lighting** (2x4 "Relight" volumetric troffers)



### **Light level comparisons**

Exis	ting	Lithonia Relight	Γ8 (ambient only)	Lithonia Relight T8 w/Finelite LED undercabinet (task + ambient)					
Average fc.	Maximum fc.	Average fc.	Maximum fc.	Average fc.	Maximum fc.				
55	134	32	83	35	85				

### Lighting power density (watts/sq. ft.)

	Without task lights	With task lights
Existing watts/square foot	1.23	1.49
Proposed watts/square foot	0.62	0.7
Reduction from existing layout	50%	53%
Title 24-2008 limits	0.85	1.05
Proposed / Title 24-2008 limits	73%	67%
Reduction from Title 24-2008 limits	27%	33%

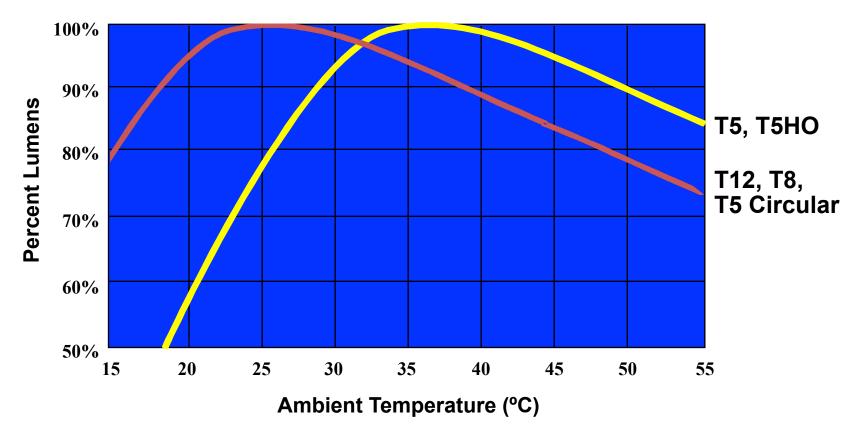
## **Comparison of fluorescent lamp technology** 1980s versus now

System	Maintained lumen output	Input power	Lamp life
(2) F40T12/ES + magnetic energy efficient ballast <i>(34-watt lamp)</i>	4040 lumens	72 watts	20,000 hours
(2) F32T8 + "Premium" reduced light output ballast	4774 lumens	48 watts	36,000 hours
	18% increase	33% decrease	80% increase

Diameter	Watts	Lumens	Lumens/Watt
Т5	28	2900	104
T8 (super)	32	3100	97
T5/HO	54	5000	93
T8/741	32	2850	89
T12/WM	34	2650	78
T12/CW	40	3050	76

### Linear fluorescent lamp performance As a function of ambient temperature





### **Issues with low-wattage T8 lamps**

- F30T8 (30 watts)
- F28T8 (28 watts)
- F25T8 (25 watts)
- Minimum 60° starting temperature
- Some can't dim and/or don't work well with reducedlight-output ballasts, etc.
- Strategic issue how can we most easily get the light levels we want with the least complication for the user? Answer: ballast factor.

### **Ballast factor**

2-Lamp Systems with 3100 Lumen Premium T-8 Lamps & Generic Electronic Ballasts				
Ballast Factor	Initial Light Output	Input Power		
0.77 (reduced light output)	4774 lumens	48 watts		
0.88 (normal light output)	5456 lumens	58 watts		
1.13 (high light output)	7006 lumens	76 watts		

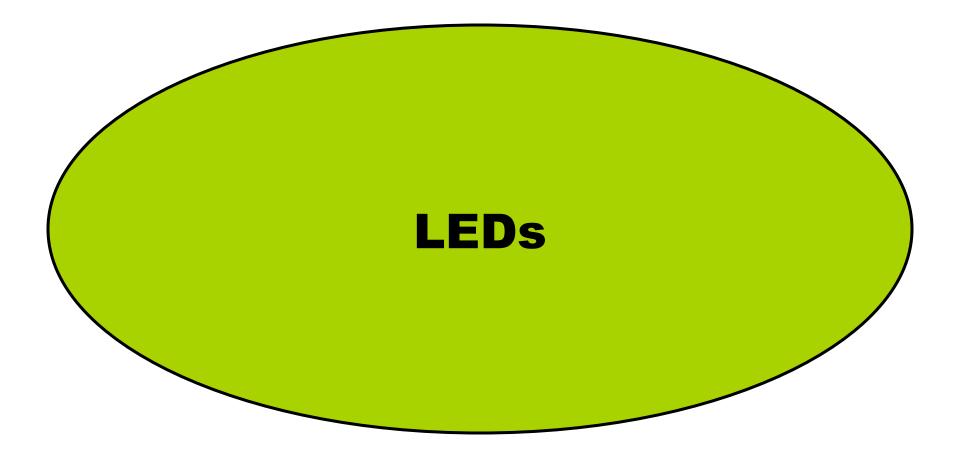




Lighting study #1 – pendant-mounted decorative bowls with CFLs and LED downlights



Lighting study #2 – pendant-mounted decorative bowls with CFLs, CFL downlights and CFL lensed wallwashers



## **Evaluating LEDs: The CALiPER Program**

- <u>Commercially Available LED Product Evaluation & Reporting</u>
- Developed & managed by DOE Solid State Lighting Program
- Tests specific LED products under real-world conditions for light output, color performance, etc.
- Frequently, the reality doesn't live up to manufacturers' claims.
- http://www1.eere.energy.gov/buildings/ssl/caliper.html

## **No-brainer applications for LEDs**

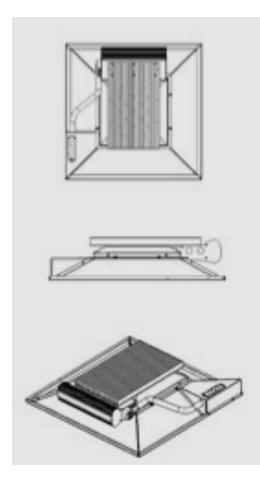
- Special effects
- Color accents
- Step lighting
- Decorative lighting
- Traffic signals
- Cold environments (refrigerator cases)



### **New applications for LEDs**

- Street lighting
- Office lighting
- "Replacement lamps"
- Round downlights

## **LED troffers; desk lamps**





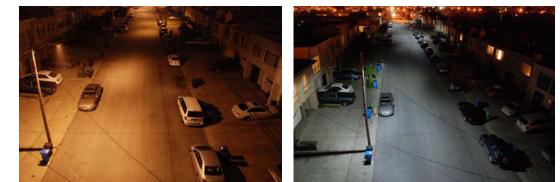


### **LED troffers**



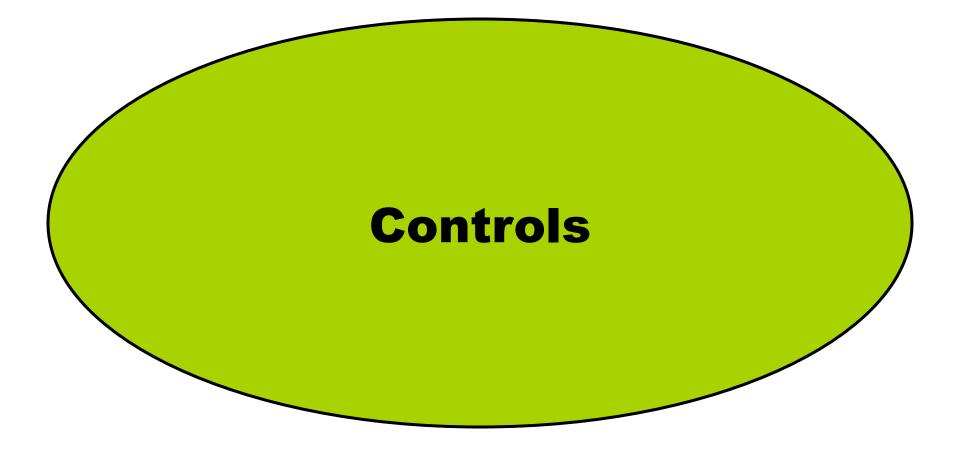
## **LED street lights**





#### LED

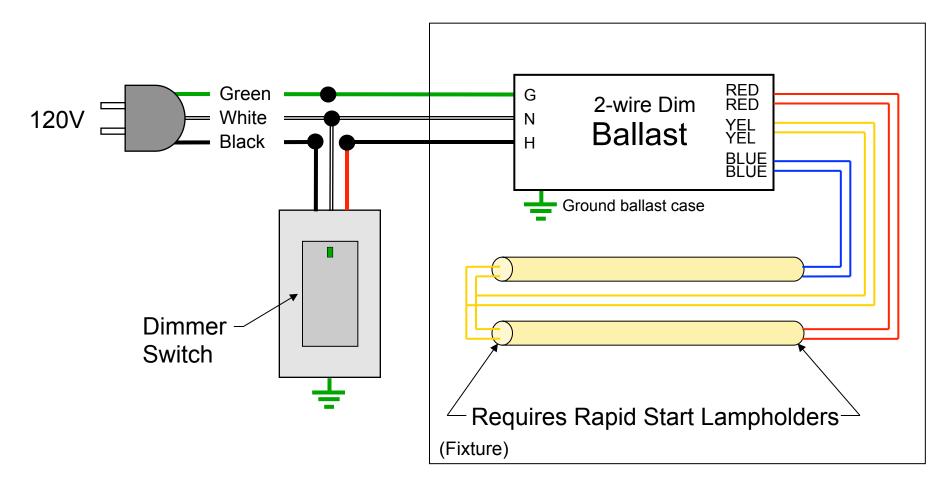
#### HPS



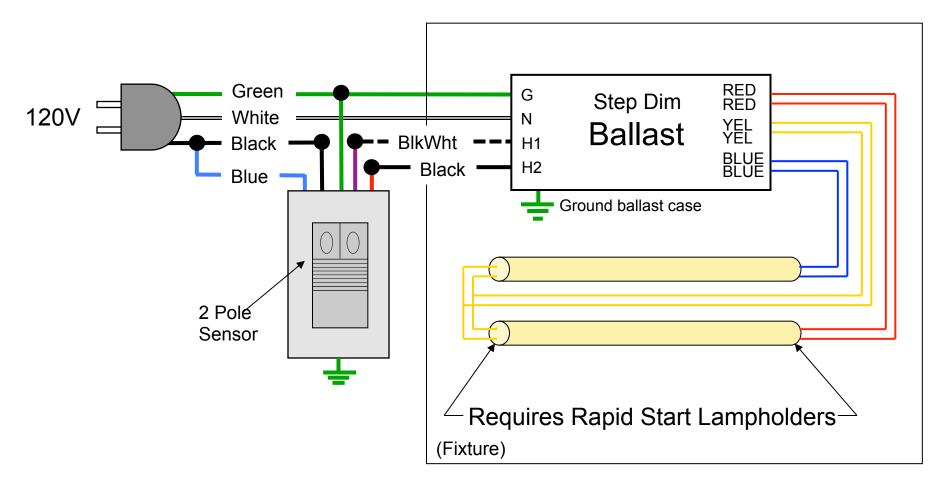
## **Control strategies**

- >Scheduling (time clock)
- >Occupancy/vacancy sensors
- Daylight harvesting
- >Multi-level switching or "step-dimming"
- Dimming (continuous or partially continuous range)
- ►Tuning
- Adaptation compensation

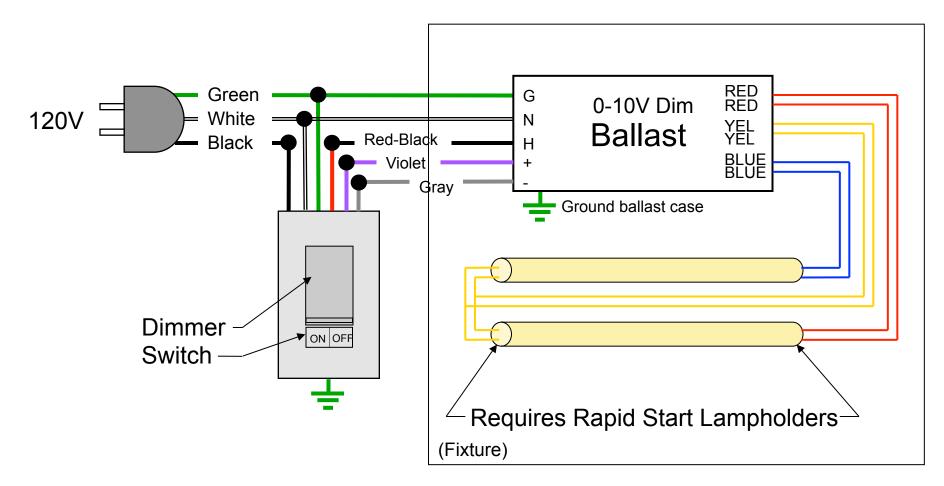
## **2-Wire Phase Control Dimmer**



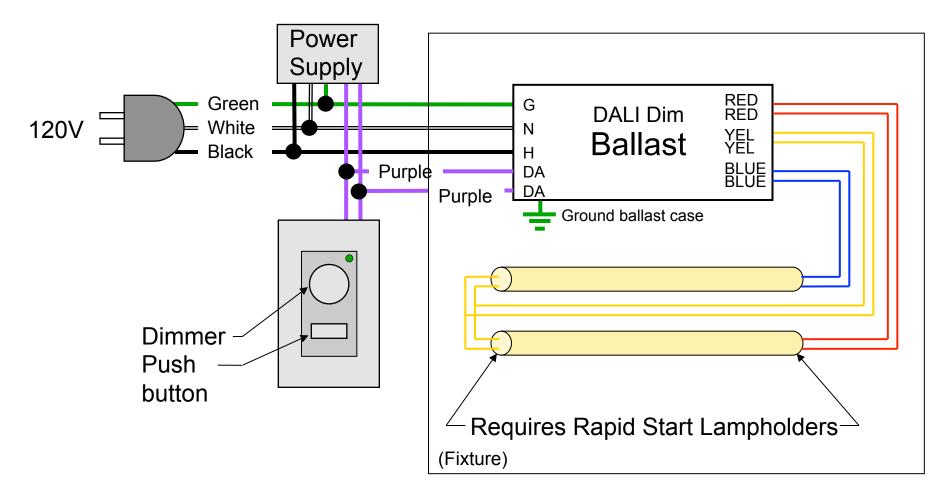
## **Step Dim Ballast**



## **0-10VDC** Dimming



## **DALI** Dimming



# **Strategies for Room Types**

• From the New Building Institute:

-Advanced Lighting Guidelines

-www.algonline.org

# **Advanced Lighting Guidelines**

- Large Private Office
- Medium Private Office
- Small Private Office (2)
- Open Office
- Conference Room (3)
- Classroom (4)
- Warehouses (2)
- Big Box Retail

## **Advanced Lighting Guidelines**

#### Office Example #3A: Private Office

	CONTROL WIRING
	PANEL
OFFICE	WIRING FROM POWER PACK TO SWITCH
P2-06 VEST.	WIRING BETWEEN LUMINAIRES
	® 🖞
	SENSOR POWER PACK

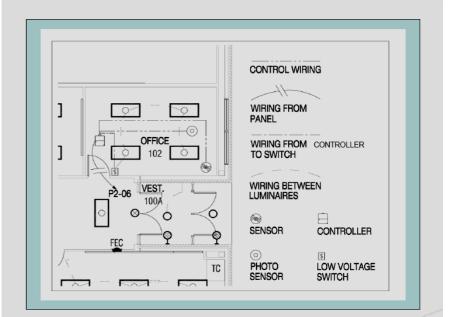
#### Application

Shown here is a 17-ft X 12-ft private office. Occupants within this space may spend extended amounts of time working making very slight movements. As such, a dual-technology ceiling-mounted sensor is ideal because of an excellent mounting location and use of both passive infrared and ultrasonic detection technologies.

#### **Control Strategy**

Upon entering the room, the sensor will detect the occupant and trigger the lights ON. Once the room is vacated, the sensor will turn the lights OFF after the user-defined time-out has expired. The dual-technology sensor is designed to detect occupancy once a person has moved between "rays" of PIR detection. Once the lights are ON, the ultrasonic technology will detect both large and slight movements, thus keeping the lights ON.

#### **Office Example #3B: Private Office**



#### Application

Shown here is a 17-ft X 12-ft office. The occupancy sensor selection remains the same for this office as in Example #3A, but daylight harvesting controls have been added for further energy savings.

#### **Control Strategy**

Upon entering the room, the sensor will detect the occupant and trigger the lights ON. The photocell shown in this figure will report the level of daylight within the space to the controller, which will in turn dim or increase the ambient electric light level in the room. As before, the lights will be triggered OFF after the userdefined time-out has expired.





#### OALG

Example courtesy of Leviton

## **Sample Narrative from ALG**

- <u>Control Strategy Office Example #3A</u>
  - Upon entering the room, the sensor will detect the occupant and trigger the lights ON. Once the room is vacated, the sensor will turn the lights OFF after the time-out has expired. The dual-technology sensor is adjusted to turn ON using PIR detection, and once the lights are ON, the ultrasonic technology will keep the lights ON.

## **Sample Narrative from ALG**

- <u>Control Strategy Office Example #3B</u>
  - Upon entering the room, the sensor will detect the occupant and trigger the lights ON. The photocell will report the level of daylight within the space to the controller, which will in turn adjust the ambient electric light level in the room. As in #3A, the lights will be triggered OFF after the user-defined time-out has expired.

## References

- Lighting Control Association
- LCA: Education Express: <u>http://www.aboutlightingcontrols.org/</u> Education\_Express/welcome.php
- New Buildings Institute
- NEMA
- DOE

## Clanton & Associates Control Study