



A Northwest utility funded lighting education facility promoting commercial and industrial energy conservation.



Energy Efficient Office Lighting Design. Aiming for Low Power Densities.

Presented by
Eric Strandberg - LC



Posted originally, 4/28/11

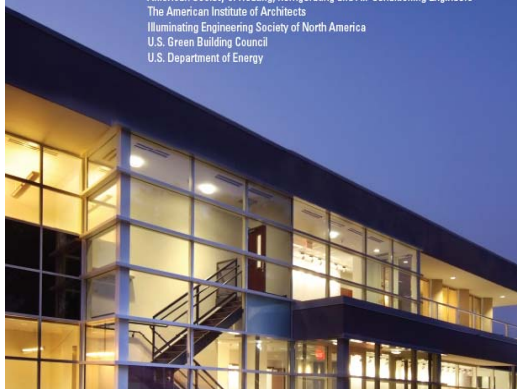


Advanced Energy Design Guide for Small to Medium Office Buildings

Achieving 50% Energy Savings
Toward a Net Zero Energy Building

50 is the new 30

Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy



<http://www.ashrae.org/aedg>



Posted originally 4/28/11



Designed to provide recommendations to achieve 50% energy savings when compared with the minimum code requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004.

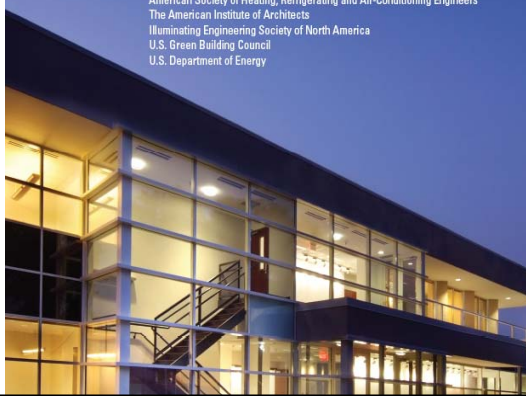
Advanced Energy Design Guide for Small to Medium Office Buildings

Achieving 50% Energy Savings Toward a Net Zero Energy Building

This guide applies to small to medium size office buildings with gross floor areas up to 100,000 ft².

Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy

For the *whole* building...
Integrated Design

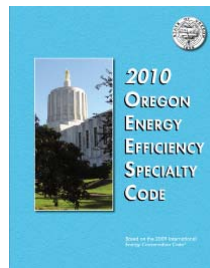
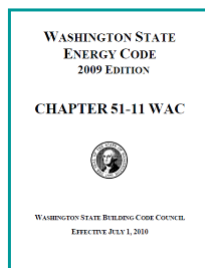


<http://www.ashrae.org/aedg>



Allowed lighting power densities for office buildings compared to ASHRE

ASHRE-90.1 2004	ASHRE-90.1 2007	WA/Sea Energy-2009	OR Energy-2010	IECC 2012
1.0 w/sq'	1.0 w/sq'	.91 / .90 w/sq'	0.91 w/sq'	0.9 w/sq'





Light level recommendations and power density allowance are not directly related.

II. INTERIOR LOCATIONS AND TASKS	Legend: ■ Very Important ■ Important ■ Somewhat important Blank = Not important or 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	Locations of Fixtures or Objects	Quality of Illuminant	Reflections	Shadows	Source/Task/Eye Geometry	Sparkles/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
Offices (13)																								Ch. 11
Filing (see Reading)																								
General and private offices (see Reading)																								
Open plan office																								
Intensive VDT use																								
Open plan office																								
Intermittent VDT use																								
Private office																								
Libraries (see Libraries)																								
Lobbies, lounges, and reception areas																								
Mail sorting																								
Copy rooms																								

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/m ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar/Lounge/Lecture	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare—clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ^b	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4



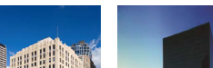
Existing Buildings

- Case Studies
- Taking retrofits to the next, *next*, level.

Seven of the nine save 50% more energy than the national average (CBECS1)*

All the buildings participated in U.S. Green Building Council (USGBC) Leadership in Energy & Environmental Design (LEED)

* Commercial Buildings Energy Consumption Survey 2003



August 2011
META REPORT

A Search for Deep Energy Savings

NEEA's Study of Existing Building Energy Efficiency Renewals

Final Report

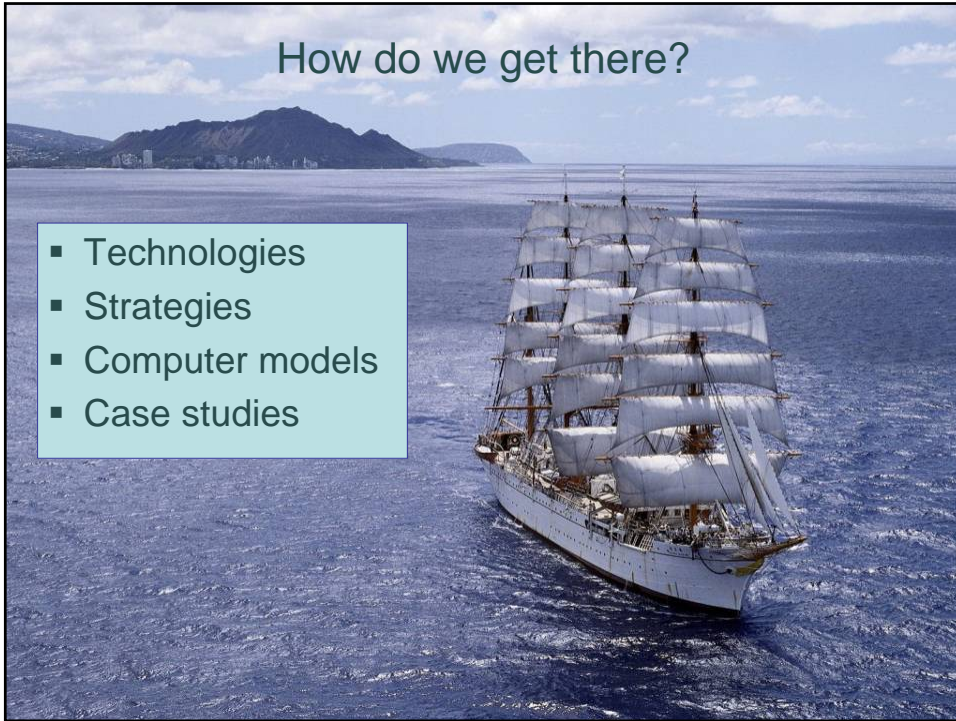
Prepared for:
Northwest Energy Efficiency Alliance
www.neea.org
(503) 827-8416
Contact: Mark Rehley

Prepared by:
New Buildings Institute www.newbuildings.org
Contact: Cathy Higgins



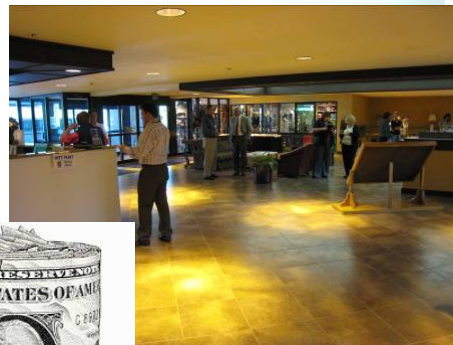
How do we get there?

- Technologies
- Strategies
- Computer models
- Case studies



Project Goals

- **Improve lighting**
 - Safety, productivity, aesthetics
- **Save money**
 - Energy costs, payback, maintenance costs
- **Save energy**
 - Pollution, LEED, PR
- **Use the latest technology**
 - LED, "Smart Controls"



Be sure everyone is on the same page



Interior Lighting

“The **primary lighting goals** for office lighting are to;

-optimize the open office spaces for **daylight integration** and to

-provide **appropriate lighting levels** in the private and open office spaces while

-**not** producing a **dull** environment.”

© 2011 ASHRAE

<http://www.ashrae.org/aedg>

Posted originally 4/28/11

50%

Advanced Energy Design Guide for Small to Medium Office Buildings

Achieving 50% Energy Savings
Toward a Net Zero Energy Building

Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy



Progressive Planning

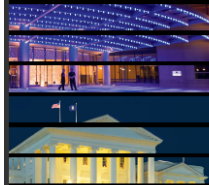


“...sustainable design is epitomized by efficient daylighting and electric lighting, so, progressive planning is an obvious and desirable tack and an approach to a *high performance building*.”

IES 10th Ed. 11.2.1

Illuminating Engineering Society

THE LIGHTING HANDBOOK Tenth Edition | Reference and Application



David L. DiLaura
Kevin W. Houser
Richard G. Mistrick
Gary R. Steffy



Office building mix



Table 3-3 Standard Percentage Assumptions by Space Type (Thornton et al. 2010)

Space Type	Percentage of Floor Area	Standard Baseline LPD, W/ft ²	Adjusted Baseline LPD, W/ft ²
Office—open plan	15%	1.1	0.68
Office—private	29%	1.1	0.8
Conference/meeting room	8%	1.3	0.77
Corridor/transition space	12%	0.5	0.5
Active storage area	14%	0.8	0.64
Restroom	4%	0.8	0.82
Lounge/recreation area	2%	1.2	0.73
Electrical/mechanical room	2%	1.5	1.24
Stairway	3%	0.6	0.6
Lobby	6%	1.3	1.09
Other	5%	1.0	0.82
Weighted LPD for the whole building	100%	1.0	0.75

© 2011 ASHRAE 11



How to optimize a system for maximum light w/ least power.



- Modern equipment
- Optimize room reflectance.
- Optimize for daylight
- Integrated; control / luminaire placement strategy

▪ New construction or existing buildings

12



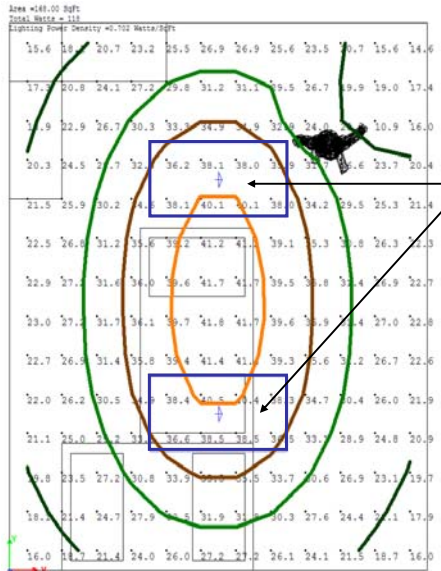
Baseline private office room analysis



12'x 14'
9'6" ceiling



Baseline- 2'x4' "troffer" fixture w/ 2 T8 lamps



Fixtures



Statistics

Project 1
Calc Pts

Room_Workplane
Illuminance (Fc)
Average=28.80 Maximum=41.8
Minimum=10.3 Avg/Min=2.64
Max/Min=3.83

LPD-UWLR Areas

LPDArea
Area(SqFt)=168 Total Watts=118
LPD(Watts/SqFt)=0.702



Baseline- 2'x4' "troffer" fixture w/ 2 T8 lamps

The screenshot shows a software interface for configuring a lighting fixture. The 'General' tab is active, displaying the following information:

- Label:** 2AV_G_2_32_MDR-735-ml-nbf
- Description:** 2AV G 2 32 MDR
- Definition:**
 - Lumens Per Lamp: 2680
 - Number Of Lamps: 2
 - Luminaire Lumens: 3651
 - Efficiency (%): 68
 - Luminaire Watts: 59
 - Total LLF: 1.000
- Arrangement:** SINGLE
- Arm Length:** 0
- Luminous Box:**
 - LLHC: X: -1.96, Y: -0.95, Z: -0.01
 - URHC: X: 1.96, Y: 0.95, Z: 0
- Photometric File:**
 - Filename: C:\Documents and Settings\All Users\Application Data\...
 - [TEST] LTL10121
 - [ISSUE DATE] 1/31/2008
 - [MANUFACT] Lithonia Lighting
 - [LUMCAT] 2AV G 2 32 MDR
 - [LUMINAIRES] 2x4.4Vario, recessed, 2 lamp T8 32 watt, Metal D
 - [LAMP CAT] F032/735
 - [LAMP] TWO 32 WATT T8 LINEAR FLUORESCENT.
 - [IESNA91]
 - [TEST DATE] 1/31/2008
 - [BALLAST CAT]

On the right side, there is a 3D rendering of the fixture and a photometric diagram showing light distribution. The number '15' is visible in the bottom right corner of the software window.



Not all T8 lamps perform equally

Lamp Type	Nominal wattage	Light output (Mean Lumens)	Lumens per Watt	CRI
F32/735	32	2800 (2660)	87.5	78
F32/835	32	2950 (2800)	92.2	86
F32/835 High Lumen	32	3100 (2915)	96.9	86
F28/835	28	2725 (2560)	97.3	86

16



Modern energy efficient ballasts*

- Save 3-5 watts over standard electronic ballasts.
- Program Start extends lamp life.
- Manipulating Ballast Factor (BF) offers many possibilities for light output and system wattage.
- Also, use delamping to manipulate system wattage and light levels. (Watch BF change from 3 to 2 on a 3/2 lamp ballast)
- For 2 T8 lamps=
 - 32 watts x 2=64 watts (nominal)
 - 2950 lumens x 2=5900 lumens (nominal)



*Be sure to use
Energy Saving
electronic NEMA
ballasts

BF	Watts 2-F32T8	Light**	L/W
Instant Start			
.88 "normal"	54	5192	96
.77 low	49	4543	93
1.29 high	85	7600	94



17

** = initial lumens x 2 / BF



Importance of luminaire efficiency*



Old style prismatic lens fixture



About 75%*

Room_Floor-WP
Illuminance Values
(Fc)
Average=27.04
Maximum=41.9
Minimum=9.6
Avg/Min=2.82
Max/Min=4.36



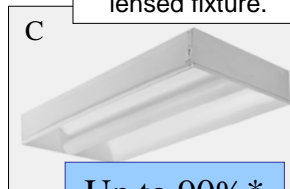
As low as 60%*

Room_Floor-WP
Illuminance Values
(Fc)
Average=18.53
Maximum=27.0
Minimum=11.2
Avg/Min=1.65
Max/Min=2.41

Less light

Same Power consumption

High Performance lensed fixture.



Up to 90%*

Room_Floor-WP
Illuminance Values
(Fc)
Average=30.68
Maximum=42.2
Minimum=19.1
Avg/Min=1.61
Max/Min=2.21

More light

*Percent of light getting out of the fixture.

18



Baseline fixture + 735 T8 “Perforated metal lens” type

68% luminaire efficiency

General
Label: 2AV_G_2_32_MDR-735-ml-nbf
Description: 2AV G 2 32 MDR

Definition:
Lumens Per Lamp: 2680
Number Of Lamps: 2
Efficiency (%): 68
Luminaire Lumens: 3651
Luminaire Watts: 59
Total LLF: 1.000

Photometric File
Description: [TEST] LTL10121 [ISSUEDATE] 1/31/2008 [MANUFAC] Lithonia Lighting [LUMPCAT] 2AV G 2 32 MDR [LUMINAIRE] 2x4 AVante, recessed, 2 lamp T8 32 watt, Metal D [LAMP] T8 32 WATT T8 LINEAR FLUORESCENT.

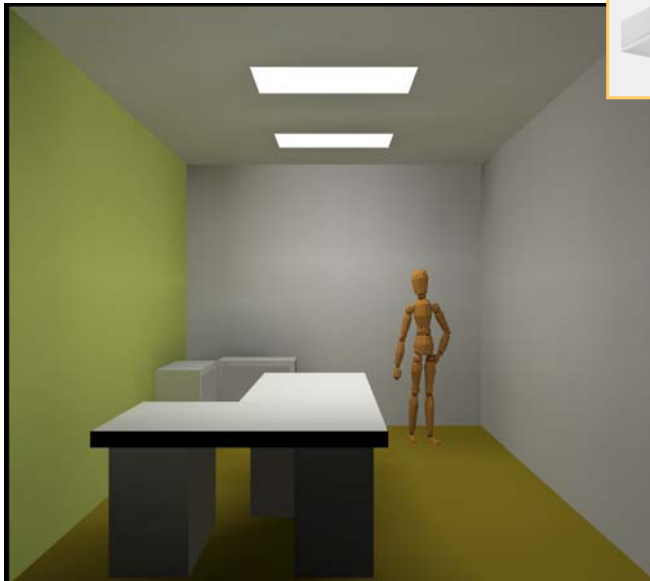
19



Baseline Room Hi-Performance Luminaire



12'x 14'
9'6" ceiling



20



High performance luminaire + 28 watt T8

General
Label: 2R180_232-025-20x4M
Description: 2R180 232

Definition
Luminaire Pole Lamp: F562
Luminaire Lumens: 4262
Luminaire Watts: 42
Total LUF: 1.000
Luminaire Efficiency (%): **83**

Arrangement: SINGLE
Symbol: 1200/300 MM RECESSED
Render Mode: Luminous
Model Mode: Line Width/Color
Arm Length: 0

Photometric File
Description: 2R180 232
Classification: LIS
LCS

2R180 Volumetric Recessed Lighting 2 x 4'

MOUNTING DATA

PROTOMETRICS

2R180 232 LIS 232, 2000lm per lamp, the L30 beam of 14 lumens, metric LUMENS

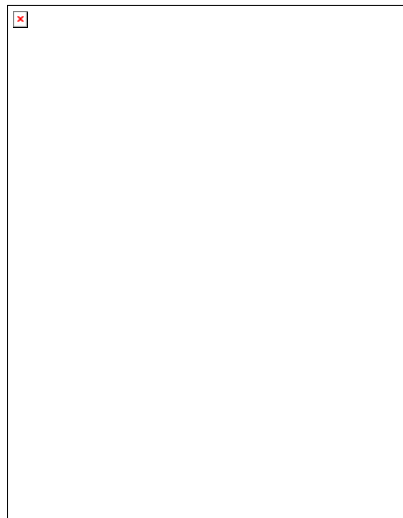
Efficiency: **83.0%**

LITHONIA LIGHTING

83% luminaire efficiency



High performance luminaire + 28 watt T8



Baseline

Statistics

Project 1
Calc Pts

Room_Workplane
Illuminance (Fc)
Average=28.80 Maximum=41.8
Minimum=19.2 Avg/Min=2.04

LPD-UWLR Areas
LPDArea
Area(SqFt)=168 Total Watts=118
LPD(Watts/SqFt)=0.702

Value (Fc)	Color	Value (Fc)	Color
5	Blue	35	Brown
10	Green	40	Orange
20	Yellow	45	Red
30	Purple	50	Dark Red

High Performance

Statistics

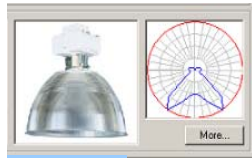
Project 1
Calc Pts

Room_Workplane
Illuminance (Fc)
Average=**34.97** Maximum=51.2
Minimum=2.5 Avg/Min=2.80
Max/Min=4.10

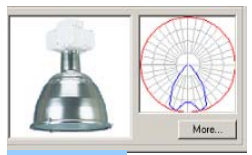
LPD-UWLR Areas
LPDArea
Area(SqFt)=168 Total Watts=84 LPD
(Watts/SqFt)=**0.500**



Luminaire efficiency- High bay metal halide



93% efficient



67% efficient



Similar fixtures, 25% less light out of the luminaire.

This applies to all applications and luminaire types.

23



If I want to really save energy shouldn't I use LEDs???





I love LEDs



- For **any** lighting measure to “Make Sense” it needs to:
 - **Perform.** Do the job that the incumbent could do.
 - **Be sustainable,** save energy and be maintainable.
 - **Be cost effective.**

LEDs can outperform many incumbent sources. Particularly when combined with inefficient luminaire types.

LEDs **save energy** and maintenance costs compared to many products with long life and high efficacy.

LEDs often **have high first cost**, but it is important to look at possible long term benefits.



3 better quality LED Troffers modeled by computer



Statistics
Project_1
Calc Pts
Room_Workplane
Illuminance (Fc)
Average=32.93 Maximum=48.1
Minimum=16.3 Avg/Min=2.02
Max/Min=2.95
LPD-UWLR Areas
LPD Area
Area(SqFt)=168 Total Watts=88 LPD
(Watts/SqFt)=0.524



Statistics
Project_1
Calc Pts
Room_Workplane
Illuminance (Fc)
Average=39.38 Maximum=60.2
Minimum=17.7 Avg/Min=2.22
Max/Min=3.40
LPD-UWLR Areas
LPD Area
Area(SqFt)=168 Total Watts=100
LPD(Watts/SqFt)=0.595



Statistics
Project_1
Calc Pts
Room_Workplane
Illuminance (Fc)
Average=36.66 Maximum=59.4
Minimum=14.5 Avg/Min=2.53
Max/Min=4.10
LPD-UWLR Areas
LPD Area
Area(SqFt)=168 Total Watts=89.8
LPD(Watts/SqFt)=0.535



How do LED troffers compare to high performance T8s in the computer model?

Product	Watts/Sq'	Avg FC	FC/Watt
T8-HP	.5	35	70
LED- Cr	.52	33	63
LED- Lith	.59	39	66
LED- LOL	.54	37	69



They deliver about the same light, for about the same power.
See the FC/Watt column



LEED Gold w/out LED



Excerpted from LD&A March 2013*

"...strategies and technologies that were responsive to the needs...cost effective, and easy to maintain."

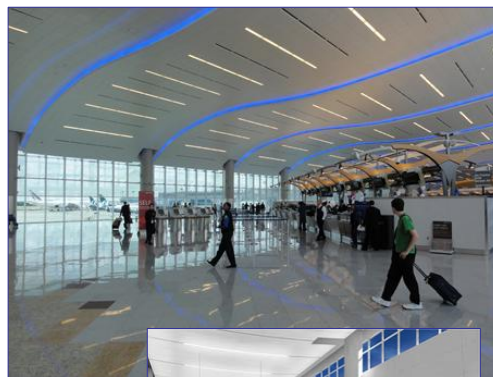
"LED was still evolving at that time."

DGA used a mix of fluorescent, CFL, and MH

Gonzalez says that if designed today the project would **feature LED point source and probably linear LED sources.**

Controls used throughout the project were; "hardly sophisticated but very effective...The lamp with the longest life is the one that is not on"

*Article by Diana Ventimiglia
Design by Domingo Gonzalez, DGA, NYC





How to optimize a system for maximum light w/ least power.

- Modern T8 lamps & ballast
- Efficient luminaire
- **Optimize room reflectance.**
- Optimize for daylight
- Integrated; control / luminaire placement strategy

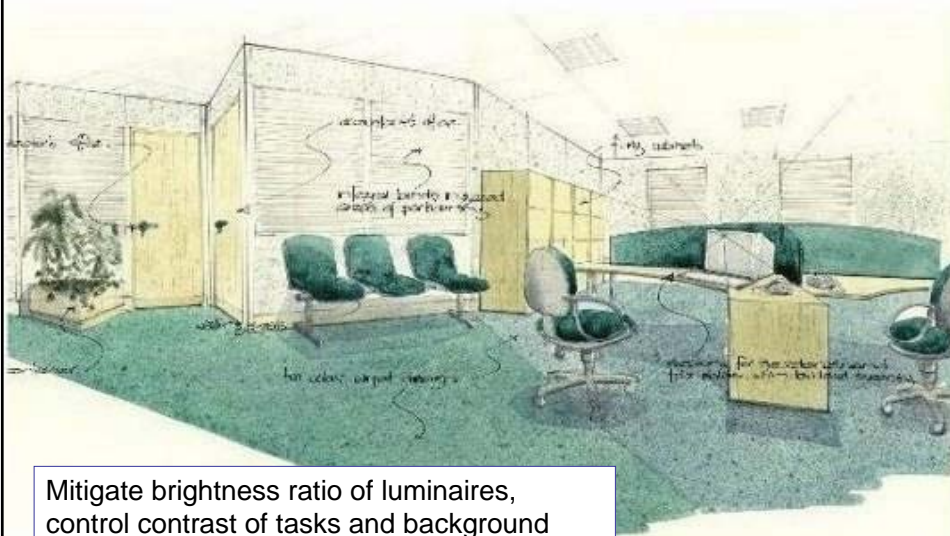


- **New construction or existing buildings**

29



Room Surfaces



Mitigate brightness ratio of luminaires, control contrast of tasks and background and, add to higher light levels.

30



An important part of a lighting design should be existing or proposed surface conditions



Above- same lighting on each floor, with different surface reflectances

31



Effect of surface reflectance on light delivered in the space



Surface Reflectance	Average FC	Maximum	Minimum	Max to Min Ratio
85/75/56 High	51.2	82.7	11.5	7 : 1
70/50/20 Med	35.0	61.1	5.4	11 : 1
35/25/11 Low	23.4	43.7	2.1	21 : 1

32



Note the dark surfaces



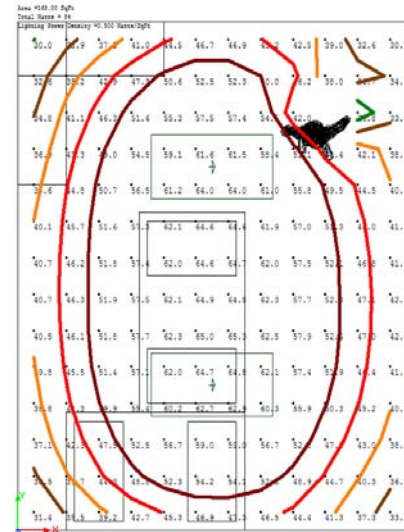
Be aware of where the contrasting surfaces are and how they will impact the task appearance.



34



High performance High reflectance (80/75/50)



Statistics

Project 1
 Calc Pts 70/50/20

Room_Workplane
 Illuminance (Fc)
 Average=34.97 Maximum=51.2
 Minimum=12.5 Avg/Min=2.80
 Max/Min=4.10

LPD-UWLR Areas

LPDArea
 Area(SqFt)=168 Total Watts=84 LPD
 (Watts/SqFt)=0.500

Value (Fc)	Color	Value (Fc)	Color
5	Blue	35	Brown
10	Light Blue	40	Orange
20	Green	45	Yellow
30	Dark Green	50	Red

Statistics

Project 1
 Calc Pts

Room_Workplane
 Illuminance (Fc)
 Average=49.22 Maximum=65.3
 Minimum=26.8 Avg/Min=1.84
 Max/Min=2.44

LPD-UWLR Areas

LPDArea
 Area(SqFt)=168 Total Watts=84 LPD
 (Watts/SqFt)=0.500

35



Case Study

Deep Energy Savings in Existing Buildings



THE BEARDMORE BUILDING

Site Details

- Owner: Brian Runberg
- Location: Priest River, ID
- Building Type: Office/Mixed use
- Project Description: Major Renovation Historic
- Size SF: 28,800
- Stories: 2
- Project Completion: 2009
- Year Built: 1922



Photos: Marie Dominique Verdier

Energy Performance

% Better than Baseline= 66%
 Baseline Average for U.S. Offices*
 Measured Energy Use (Kbtu/SF/yr) 32
 Energy Star= Score 90

* U.S. Commercial Building Energy Consumption Survey (CBECS) 2003

36



Case Study

Deep Energy Savings in Existing Buildings

nbi new buildings institute

BETTERBRICKS Powerful Energy Ideas. Delivered by NEEA.

THE BEARDMORE BUILDING

Efficiency Measures

- High-efficiency HVAC package units with economizer controls
- DCV with CO2 sensors
- Increased insulation
- Improved roofing materials with high solar reflectance index
- Low-E glazing
- **Lighting exceeds utility advanced lighting requirements**
- Lighting night set-back and occupancy sensors
- **Commissioning**



Photos: Marie Dominique Verdier



Case Study

Deep Energy Savings in Existing Buildings

nbi new buildings institute

BETTERBRICKS Powerful Energy Ideas. Delivered by NEEA.

THE BEARDMORE BUILDING

Brian Runberg, owner, believes the building has "sparked new economic life into the community, giving it a renewed sense of pride and entrepreneurial spirit. Tenants saw the potential of what could happen in the building and came with business ideas."



Photos: Marie Dominique Verdier



Light Quantity:

OCT 1939-Nela Park

200 footcandles of “diffused light” – -twenty-five to fifty times as much illumination as many office people attempt to see by* -- aided this group when it met recently in the "round table room" of **General Electric** Institute at Nela Park, Cleveland.

-Making possible indoors this newest challenge to seeing conditions as found outdoors is the experimental fluorescent fixture shown here on the ceiling.

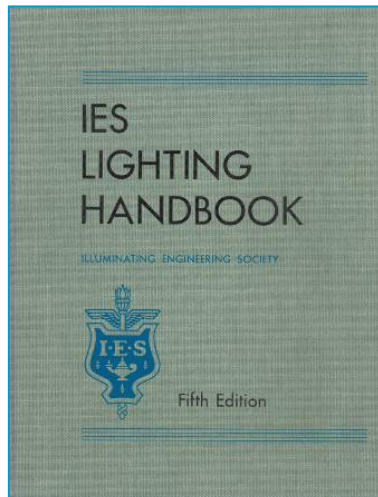
* 8 to 4 fc ?



How much light do we need?



Light level recommendations 5th Ed., circa-1972



LEVELS OF ILLUMINATION (INTERIOR) 9-87

Continued

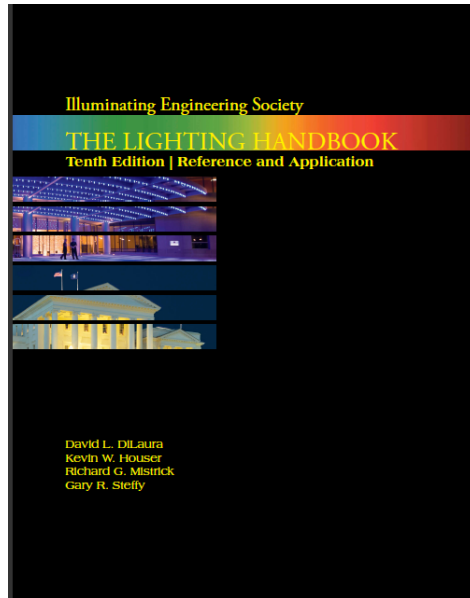
Area	Footcandles on Tasks*	Dekalux [‡] on Tasks*
Offices		
Drafting rooms		
Detailed drafting and designing, cartography	200†	220†
Rough layout drafting	150†	160†
Accounting offices		
Auditing, tabulating, bookkeeping, business machine operation, computer operation	150†	160†
General offices		
Reading poor reproductions, business machine operation, computer operation	150†	160†
Reading handwriting in hard pencil or on poor paper, reading fair reproductions, active filing, mail sorting	100†	110†
Reading handwriting in ink or medium pencil on good quality paper, intermittent filing	70†	75†
Private offices		
Reading poor reproductions, business machine operation	150†	160†
Reading handwriting in hard pencil or on poor paper, reading fair reproductions	100†	110†
Reading handwriting in ink or medium pencil on good quality paper	70†	75†
Reading high contrast or well-printed materials	30†	33†
Conferring and interviewing	30	33
Conference rooms		
Critical seeing tasks	100†	110†
Conferring	30	33
Note-taking during projection (variable)	30†	33†
Corridors	20*	22*

* Minimum on the task at any time for young adults with normal and better than 20/30 corrected vision. For general notes see beginning of tabulation. For other notes see end of tabulation.

‡ Dekalux is an SI unit equal to 1.076 footcandles. 1 dekalux = 10 lux.



Light level recommendations circa-2012-10th Ed.



Light level recommendations 10th Ed., circa-2012



Copyright ©2011 by the Illuminating Engineering Society of North America (IES). The purchase of this publication, by agreement, for single use only. No part of this publication may be reproduced in any form without prior written permission of the IES. For inquiries, please contact ies.org.

Applications and Tasks*	Notes	Recommended Maintained Illuminance Targets (foot-candle)						Uniformity Targets† Over Area of Coverage *† ratio L _{min} /L _{max} or L _{avg} / L _{max} (different uniformity target) Max:Avg Avg:Min Max:Min	Typical Area of Coverage‡ Task Preper Room or Task Area Designated Area
		Horizontal Eq. Targets Visual Area of Observation (years) when at least 25%		Vertical Eq. Targets Visual Area of Observation (years) when at least 25%		Category	Category		
ACCENTING	Accenting influences observers' overall brightness perceptions and provides visual relief. Accenting is also used for visual stimulation and emphasis. See 22 (LIGHTING FOR COMMON APPLICATIONS/ACCENTING) for default accenting criteria for consideration in any application.	>25	25-45	>45	>25	25-45	>45		
ADMINISTRATION	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Reception	See RECEPTION SPACES								
• Conferencing	See CONFERENCE								
• Reception/Waiting	See RECEPTION SPACES								
• Conferencing	See CONFERENCE/MEETINGS								
• Writing	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Computer	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Presentation	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Selfies	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Performance	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Computer	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Formal	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Informal	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Reading	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Office	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
• Training	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
BUILDING ENTRIES	See 22 (LIGHTING FOR COMMON APPLICATIONS)								
CONFERENCE									
• Meeting	Periodic, occasional, reading, and facial detail								
• Discussion	Facial, detail, and detail	F	150	300	400	400	400	400	400
• Presentation/Screen	Facial, detail, and detail	F	150	300	400	400	400	400	400
• Whiteboard	Facial, detail, and detail	F	150	300	400	400	400	400	400
• Audio/Visual	Facial, detail, and detail	F	150	300	400	400	400	400	400

Table 33.2 | Office Facilities Illuminance Recommendations continued next page



Light level recommendations 10th Ed., circa-2012 – Reading Detail



Table 32.2 | Office Facilities Illuminance Recommendations continued from previous page

Applications and Tasks*	Notes	Recommended Maintained Illuminance Targets (lux) ^{b,c,d}									
		Horizontal (E _h) Targets			Vertical (E _v) Targets						
		Visual Ages of Observers (years) where at least half are			Visual Ages of Observers (years) where at least half are						
		<25	25-65	>65		<25	25-65	>65			
		Category			Gauge	Category			Gauge		
OFFICES	See READING AND WRITING, establish tasks and normalize to illuminance of most important task or most common task; use controls to provide illuminance variability if tasks so demand.										
PARKING	See 26 LIGHTING FOR EXTERIORS										
PEDESTRIAN WAYS	See 26 LIGHTING FOR EXTERIORS										
READING AND WRITING											
• Computer	See READING AND WRITING/VDI Screen and Keyboard										
• Electronic Readers											
• LCD or LED Devices	E _v and E _h @height of device	P	150	300	600	Avg	N	75	150	300	Avg
• Facsimile	E _v and E _h @height of device	N	75	150	300	Avg	K	25	50	100	Avg
• Analog	E _v @2' 6" AFF; E _h @4' AFF	R	250	500	1000	Avg	M	50	100	200	Avg
• Digital	E _v @2' 6" AFF; E _h @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Handwritten Work	Based on fair-to-good penmanship/hand print on white or canary paper										
• Pencil											
• Graphite/HB	E _v @2' 6" AFF; E _h @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red	E _v @2' 6" AFF; E _h @4' AFF	R	250	500	1000	Avg	M	50	100	200	Avg
• Ballpoint/Rollerpoint/Felt-tip											
• Black	E _v @2' 6" AFF; E _h @4' AFF	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red, Green, Blue	E _v @2' 6" AFF; E _h @4' AFF	Q	200	400	800	Avg	L	37.5	75	150	Avg
• Laptop	See READING AND WRITING/VDI Screen and Keyboard										
• Microforms (Projected)		L	37.5	75	150	Avg	I	15	30	60	Avg
• Print Media	Digital-printing-press-generated, white paper										
• 6-pt Font											
• Matte paper and ink	E _v @2' 6" AFF; E _h @4' AFF	R	250	500	1000	Avg	L	37.5	75	150	Avg
• Specular paper and ink	E _v @2' 6" AFF; E _h @4' AFF	R	250	500	1000	Avg	L	37.5	75	150	Avg
• 8- and 10-pt Font											
• Matte paper and ink	E _v @2' 6" AFF; E _h @4' AFF	P	150	300	600	Avg	K	25	50	100	Avg
• Specular paper and ink	E _v @2' 6" AFF; E _h @4' AFF	P	150	300	600	Avg	K	25	50	100	Avg
• 12-pt Font											
• Matte paper and ink	E _v @2' 6" AFF; E _h @4' AFF	O	100	200	400	Avg	K	25	50	100	Avg
• Specular paper and ink	E _v @2' 6" AFF; E _h @4' AFF	O	100	200	400	Avg	K	25	50	100	Avg

Relative task size and contrast

This is 12 point type
This is 10 point type
This is 8 point type
This is 6 point type

This is 12 point type
This is 10 point type
This is 8 point type
This is 6 point type

This is 12 point type
This is 10 point type
This is 8 point type
This is 6 point type



What about daylight?



47



Goals

Interior Lighting

“The **primary lighting goals** for office lighting are to;

-optimize the open office spaces for **daylight integration** and to

-provide **appropriate lighting levels** in the private and open office spaces while

-**not** producing a **dull** environment.”

<http://www.ashrae.org/aedg>

© 2011 ASHRAE

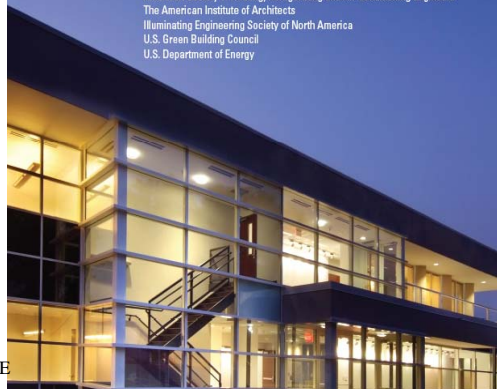
Posted originally, 4/28/11

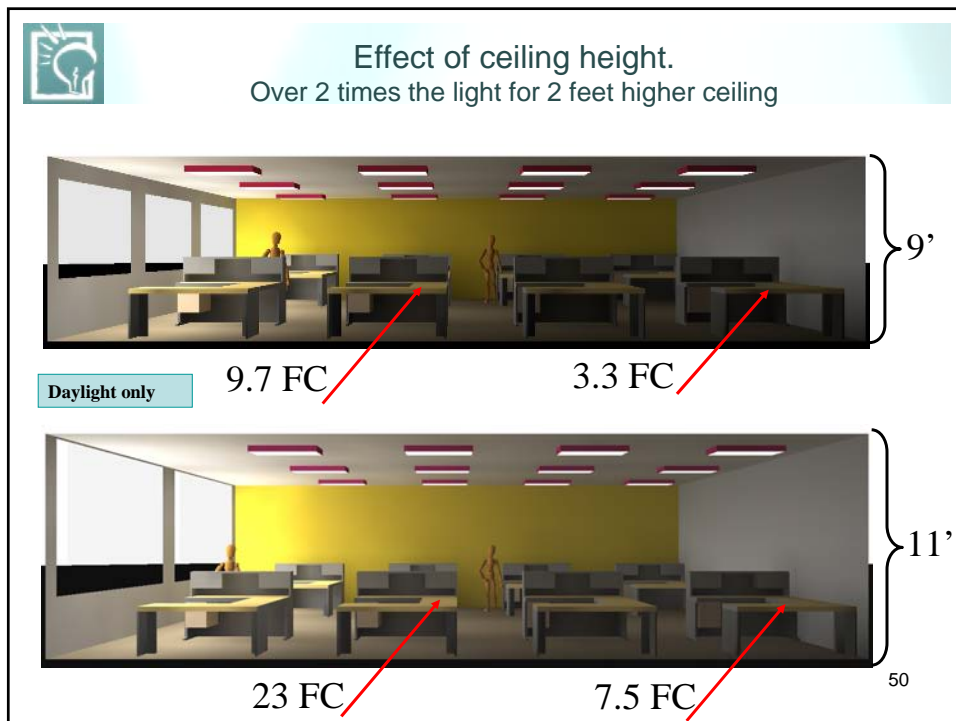
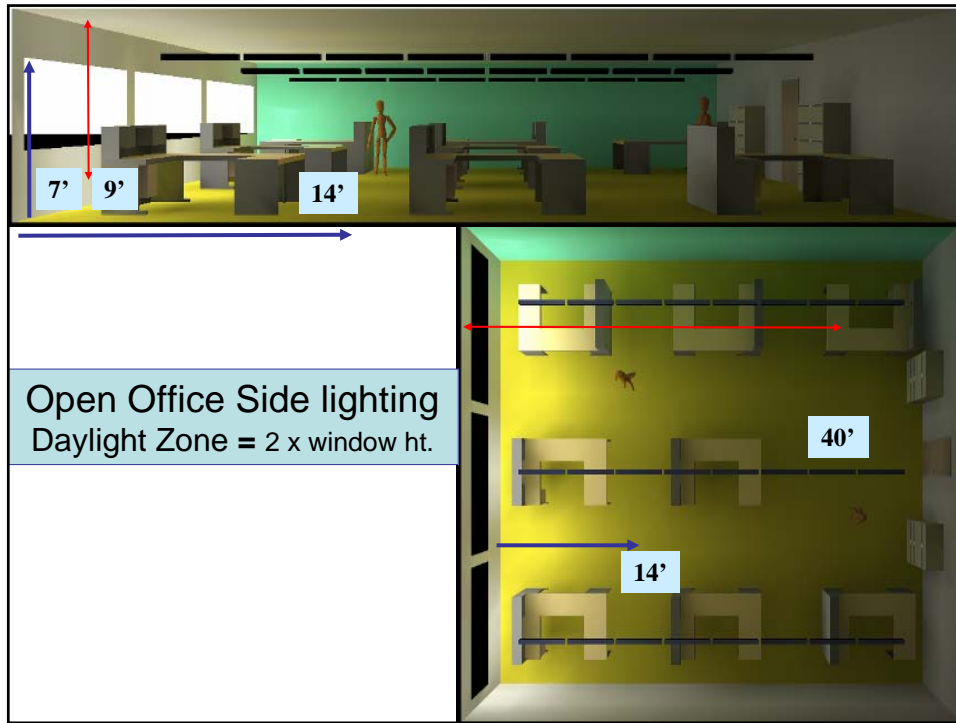


Advanced Energy Design Guide for Small to Medium Office Buildings

**Achieving 50% Energy Savings
Toward a Net Zero Energy Building**

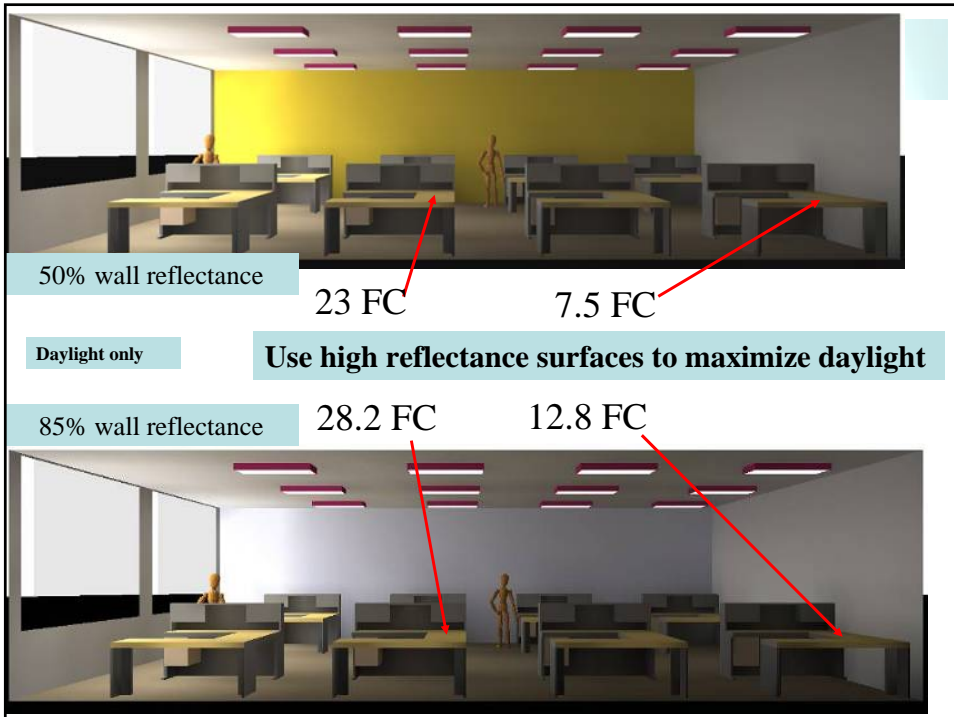
Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy







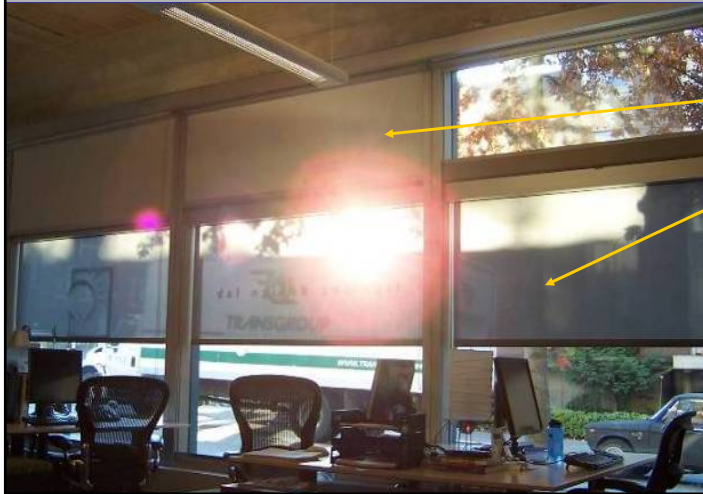
Changing window opening. It can be done...





Glare- (Direct, Reflected, & Contrast)

- “Electric or natural light sources that are too bright can produce discomfort and impair vision.” IESNA



100% Black out shade

95% Woven fabric shade

53



Orientation of Workstations to Vertical Glazing



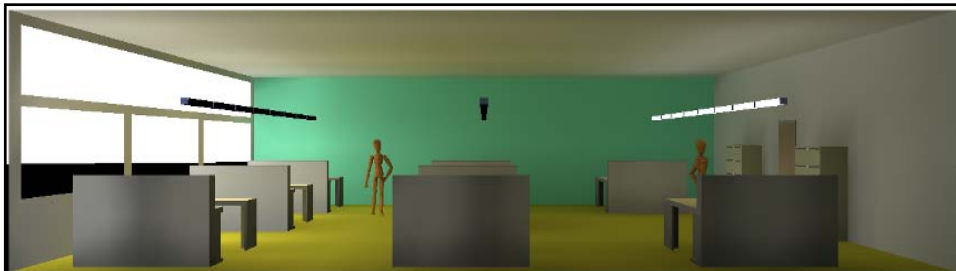
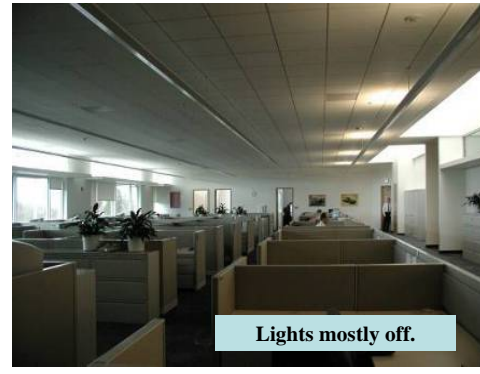
- Orient partitions and shelves of workstations to 90 degrees of windows (perpendicular).
- Orient computer monitors to 90 degrees also (+/- 30 deg)

54

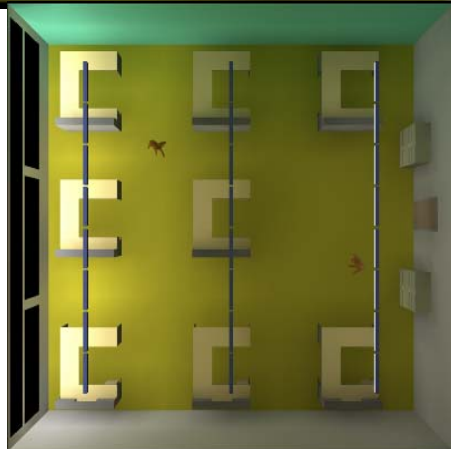


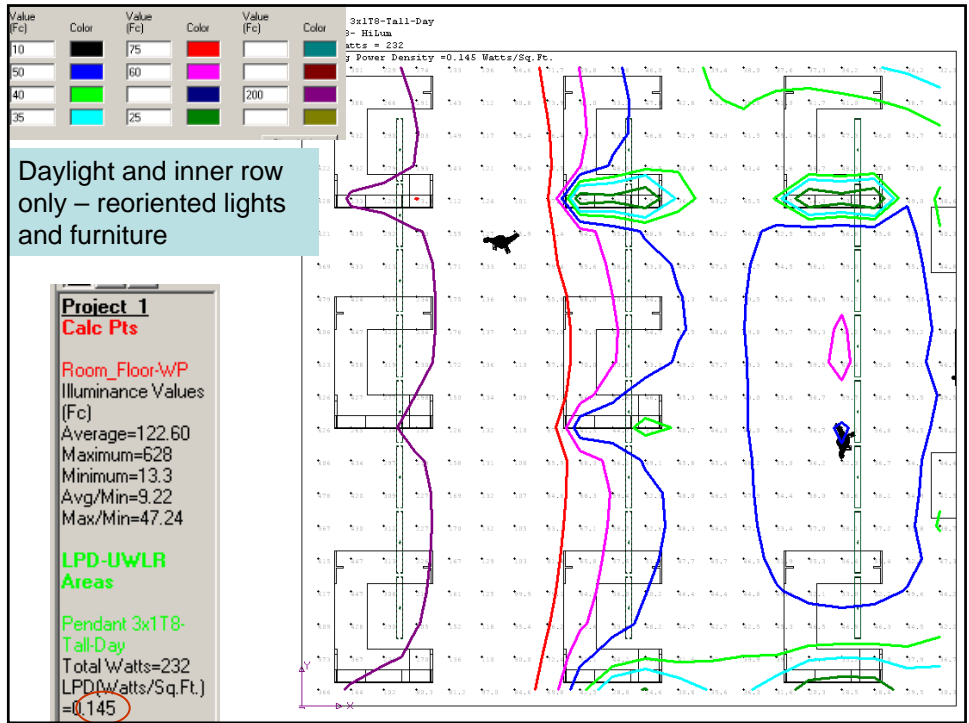
Balanced Light

Perimeter daylight is balanced by lighting in the “back” of the space. This could be accomplished with electric lights or even better, use skylights.




Daylight and inner row
only – reoriented lights
and furniture






The high performance window

59



Daylight in private perimeter office.



Easier to manage than open office.

Why?

60



Case Study

Deep Energy Savings in Existing Buildings



HOME ON THE RANGE

Site Details

- Owner: Northern Plains Resource Council
- Location: Billings, MT
- Building Type: Office
- Project Description: Major Renovation
- Size SF: 8,500
- Stories: 1
- Project Completion: 2006
- Year Built: 1940



Energy Performance

% Better than Baseline= 51%
 Baseline Average for U.S. Offices*
 Measured Energy Use (KBtu/SF/yr) 46
 Energy Star Score= 99

* CBECS – U.S. DOE Energy Information Agency's Commercial Building Energy Use Index 2003



Before



Case Study

Deep Energy Savings in Existing Buildings



HOME ON THE RANGE

Efficiency Measures

- High-efficiency boiler
- Radiant-floor hydronic system
- Variable frequency drives
- Increased insulation
- Low-e glazing
- Photovoltaics
- **T8 fixtures with dimmable ballasts and daylighting controls**
- **Light shelves**
- Occupancy sensors
- HVAC controls
- **Commissioning**





To Review:

How to optimize a system for maximum light w/
least power.

- Modern T8 lamps & ballast
- Efficient luminaire
- Optimize room reflectance.
- Optimize for daylight
- **Integrated; control / luminaire placement strategy**



63

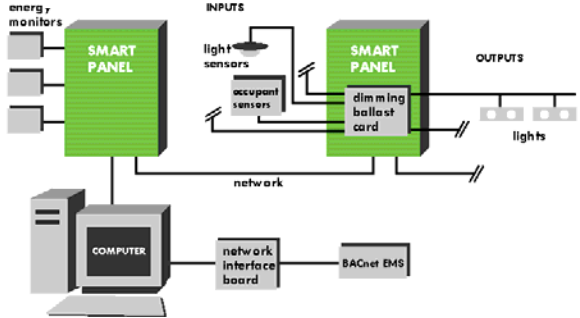
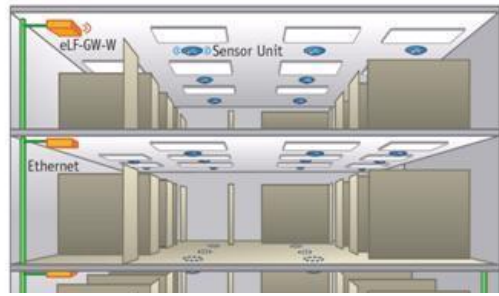


Advanced Lighting control systems...

NXT TECHNOLOGY OVERVIEW

The NXT

The NXT is the next generation, compact control system for the eLF-GW-W luminaire.





Three simple concepts combined

- Integrated; control / luminaire placement strategy

- 1-Occupancy/Vacancy
- 2-Bi-Level (2 zone)
- 3-Task/Ambient



65



Comparison of Control Options in Private Offices. Advanced Lighting Controls Testbed

- Typical Office Building
- 7 Month Study Period
- 5 Controls Scenarios
- April 2000

... the energy savings due to occupant sensing vs. dimming depended on the behavior of occupants.

In offices whose occupants tended to stay at their desks all day, dimming controls saved more energy, and vice versa.

Control Strategy	Energy Saved
Single Level Switching	0%
Bi-Level Switching	23%
Occupancy Sensors	20-26%
Dimming - Photo Sensors	27%
Occupancy and Photo Sensors	46%
Dimming -Task Tuning	23%

Judith D. Jennings, Francis M. Rubinstein, Dennis DiBartolomeo, Steven L. Blanc
<http://eetd.lbl.gov/btp/pub/LGpub.html>

66

Courtesy: Lawrence Berkley National Laboratory



Controls savings



Lighting Controls in Commercial Buildings

Alison Williams^{1*}, Barbara Atkinson PE¹, Karina Garbesi PhD¹, Erik Page PE², and Francis Rubinstein FIES¹

Data research from 240 savings estimates from 88 papers and case studies.

Building Type	Occupancy	Daylighting	Personal Tuning	Institutional Tuning	Multiple Types
Office	22% (n=23)	27% (n= 18)	35% (n=13)	36% (n= 11)	40% (n=24)
Warehouse	31% (n= 4)	28% (n= 1)	-	-	-
Lodging	45% (n= 2)	-	-	-	-
Education	18% (n= 5)	29% (n= 7)	6% (n= 2)	-	34% (n= 7)
Retail (other than mall)	-	29% (n= 3)	-	60% (n= 1)	-
Healthcare inpatient	-	-	-	-	35% (n= 1)
Public assembly	36% (n= 2)	36% (n= 1)	-	-	-
Healthcare outpatient	23% (n= 1)	-	-	-	-
Other	7% (n= 1)	18% (n= 1)	-	-	-

TABLE 8. Energy Savings by Building Type—Final Filter

“We found that simulations appear to overestimate savings... especially for daylight”

67



Occupancy Sensing vs Vacancy Sensing

A

With **vacancy sensing**, lights only turn on when user turns the **lights on manually**. Then, automatically turn lights off when spaces are unoccupied. Like a regular occupancy sensor.

This can save more energy, but...



68

Courtesy: Leviton



Problem with vacancy sensing

The space may feel ...“vacant”
So, all lights may get turned on anyway.



Which to use where?

- **Occupancy-**
- “Owned spaces”
 - Office
- Lobby or retail- “We’re here”
- Non daylit task areas



- **Vacancy-**
- Non-“Owned” task areas w/ daylight.
 - Storage
 - Copy room
 - Back stair/hall



Bi-Level Switching

B

Configure luminaire or space with 2 or more switched circuits.

•Characteristics:

- Simple
- Easy to Understand
- May be used with an Occupancy Sensor or Vacancy Sensor



•Considerations:

- All lamps frequently turned on
- Installed cost may be equivalent to dimming
- May change light distribution

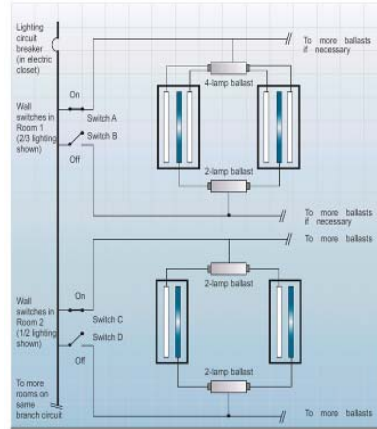
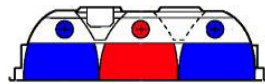
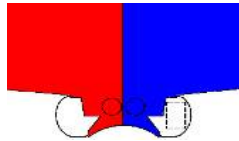


Figure 8-5 – Bi-level Switching in Typical Office Application



71

Courtesy: Advanced Lighting Guidelines, Lithonia, Focal Point



Bi-level with uniform light

There are bi-level ballast available for a one ballast application

www.sylvania.com

QUICKTRONIC® PROStart® T8 QUICKSTEP® Bi-Level Dimming

NEMA Premium

Normal Ballast Factor

High Efficiency Series

Lamp / Ballast Guide

Primary Systems
 32W 18 - ICT800P
 3-lamp QHS202/10/10/10V P36-3C

Also operates:
 FRO2, FRO3, FRO5, FRO24, F017 & FRO16

NOTE: NOT FOR USE WITH ENERGY SAVING TO LAMPS, operation in bi-level mode will cause lamp instability and lamps may not start.

FORSEMA QUICKTRONIC High Efficiency PROStart QUICKSTEP is a programmed rapid start electronic T8 ballast that will easily switch from 100% to 50% power with standard wall switches. The QUICKSTEP ballast will operate the variety of lamp and L-level restriction (L) lamps at high efficiency QUICKSTEP bi-level stop dim ballasts are specifically designed to meet California's Energy Efficiency Standards (Title 24) for multi-level lighting controls. (Section 1113) The connected lamp and ballast system offers a high efficiency system for T8 luminaires along with high performance features that are standard on SYLVANIA HIGH EFFICIENCY Series ballasts.

GE Lighting

ULTRAMAX T8
 High Efficiency 100 - 60% Step Dimming

GE UltraMax® T8 Bi-Level Dimming Ballasts

The 6E632MAX-H95-560 & 6E632MAX-90-560 ballasts are cost effective energy management solutions for big box retail, warehouses, and industrial facilities, providing the flexibility to reduce light levels in unoccupied spaces and cut energy usage during peak load

Perfect for Bi-Level Switching

- 50% to 100% bi-level dimming
- Great for fixed light output applications as well
- Unlimited hi-low cycle switching - limited to approximately five on/off cycles (total) per day
- Use with low voltage occupancy sensors, lighting panel relays or when using two ballasts for multiple (high/low) light levels in one area

Sufficient Lighting, Flexible Operation

- Reduces uneven light distribution and dark spaces caused when switching in rows, checkboard patterns, or using tandem wiring patterns
- High ballast factor (L 58) to low (L1) step dimming
- 100% light level of a 3 high ballast factor is approximately the same as a 3 lamp normal ballast factor
- 100% light level of a 3 high ballast factor is approximately the same as a 4 lamp normal ballast factor
- Wall-wired LED-T7/T8 Ready-to-Go
- Anti-dimension control for use with F3278/AVM, F3278 or F3278/7560 reduced wattage lamps
- 2, 3, 4 or 6 lamp offering

Meets or Exceeds Industry Standards

- High efficiency NEMA premium 6-lamp = extreme 95% efficiency at full load
- UL rating 55°C ambient approved
- UL type CC anti-arc rating

imagination at work

ULtramax is a registered trademark of the General Electric Company © 2013

72



Bi-level combined with occupancy or vacancy



+



Can be done separately or integrated into the same device



Lights come on when entering, but only half way

73

Courtesy: WattStopper



Bi-level and lighting uniformity (one zone).



If done **conventionally**, bi-level lighting results in the same luminaire appearance and light distribution, but just a lower light level... and less power consumption.

High light- OK for tasks, but more than needed for ambient.

74



Bi-level and lighting uniformity (one zone).



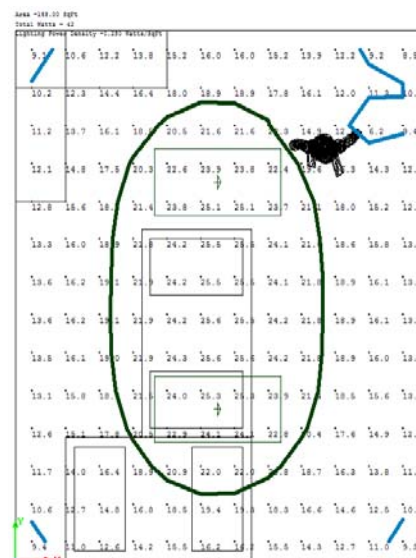
If done **conventionally**, bi-level lighting results in the same luminaire appearance and light distribution, but just a lower light level... and less power consumption.

Low light- not enough for task, but OK for ambient.

75



High performance luminaire + 28T8 with Bi-Level (one zone)



Statistics

Project 1
Calc Pts

Room_Workplane
Illuminance (Fc)
Average=34.97 Maximum=51.2
Minimum=12.5 Avg/Min=2.80
Max/Min=4.10

LPD-UWLR Areas

LPDArea
Area(SqFt)=168 Total Watts=84 LPD
(Watts/SqFt)=0.500

Value (Fc)	Color	Value (Fc)	Color
5	Blue	35	Orange
10	Light Blue	40	Yellow
20	Green	45	Red
30	Dark Green	50	Dark Red



Full output compared to 50% output

Statistics

Project 1
Calc Pts

Room_Workplane
Illuminance (Fc)
Average=17.43 Maximum=25.6
Minimum=6.2 Avg/Min=2.82
Max/Min=4.13

LPD-UWLR Areas

LPDArea
Area(SqFt)=168 Total Watts=42 LPD
(Watts/SqFt)=0.250



Where do we put the light?

General lighting only.

Requires that the ambient lighting provide the task levels of light. This **puts more light than normally needed in non-task areas.**



Task lighting only.

Means that some areas in the space get a very low light level. This can **lead to contrast problems.**

77



Task / Ambient Lighting Strategy

Advanced Lighting Guidelines
2001 Edition



- **Ambient lighting** is to within 1/3 to 2/3 of target illumination.*
- **Task lighting** is to within 2/3 to 4/3 of target illumination.

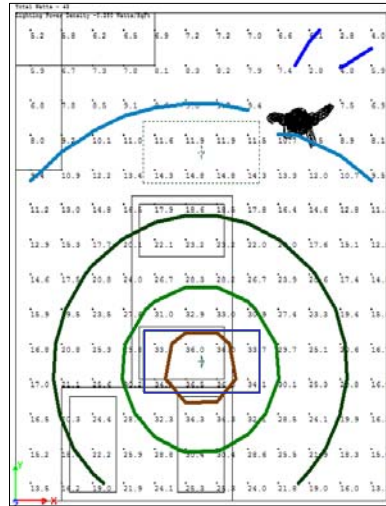
*Daylight can be a great source for ambient light



78



Two Zone Bi-Level Task Ambient



Statistics			
Project 1			
Calc Pts			
Room_Workplane			
Illuminance (Fc)			
Average=17.48	Maximum=25.6		
Minimum=2	Avg/Min=2.82		
Max/Min=4.13			
LPD-UWLR Areas			
LPDArea			
Area(SqFt)=168	Total/Watts=42	LPD	
(Watts/SqFt)=0.250			
Value (Fc)	Color	Value (Fc)	Color
75	Blue	76	Blue
110	Blue	40	Orange
120	Green	45	Red
130	Green	50	Red

Low light level with task - ambient

Statistics			
Project 1			
Calc Pts			
Room_Workplane			
Illuminance (Fc)			
Average=17.85	Maximum=36.5		
Minimum=2.8	Avg/Min=6.36		
Max/Min=13.04			
LPD-UWLR Areas			
LPDArea			
Area(SqFt)=168	Total/Watts=42	LPD	
(Watts/SqFt)=0.250			

Highest light level is over workstation

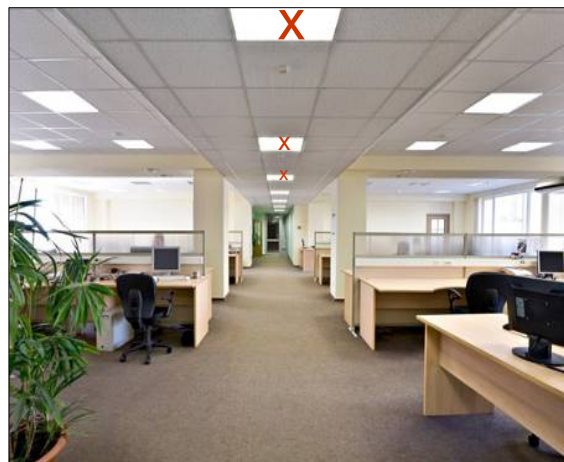


Task Ambient lighting strategy

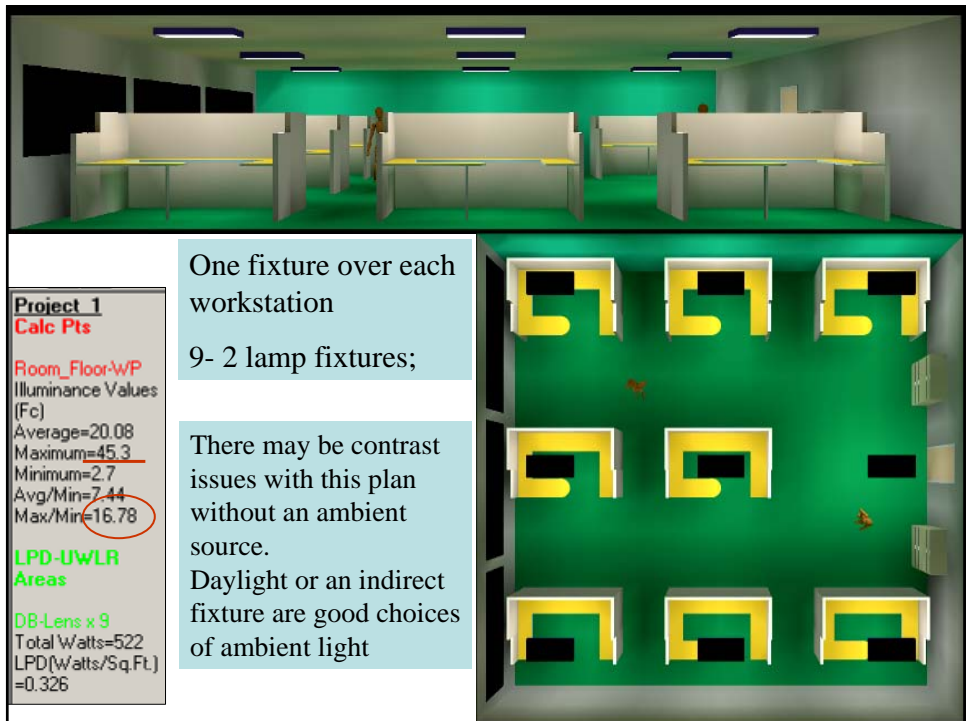
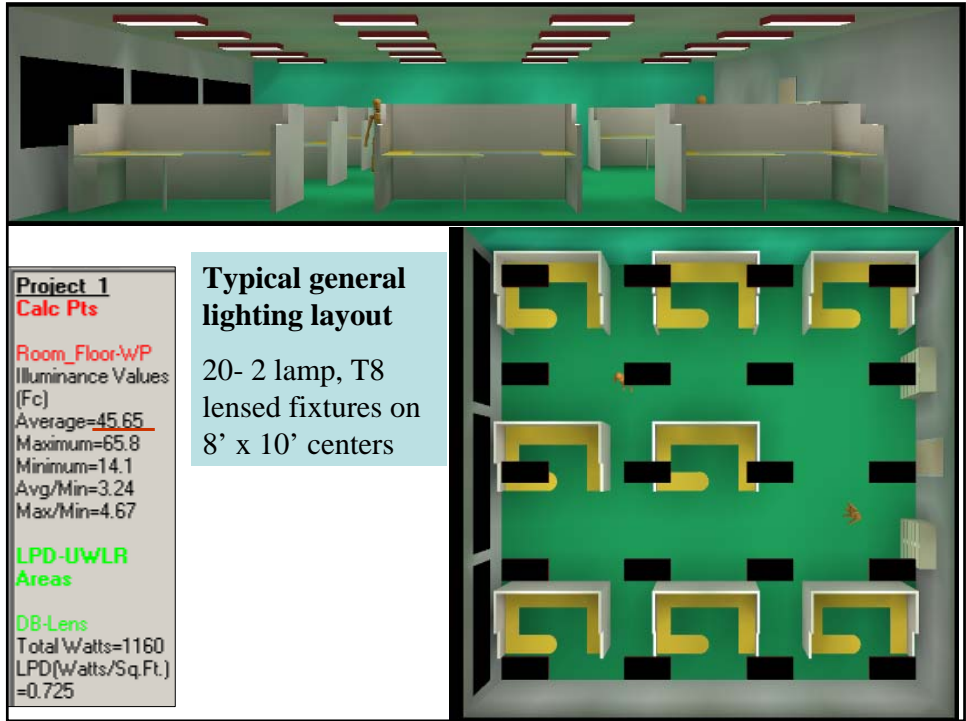
- Lights in the circulation areas can possibly be eliminated, resulting in lower Lighting Power Densities LPD


Just use lights over the task areas.

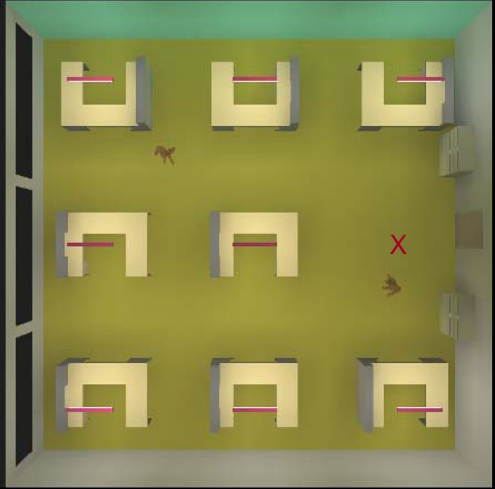
Ideally one per work station.



80





<p>Calc Pts</p> <p>Illuminance Values (FC)</p> <p>Average=22.22</p> <p>Maximum=43.5</p> <p>Minimum=6.8</p> <p>Avg/Min=3.27</p> <p>Max/Min=6.40</p> <p>LPD W/SqFt</p> <p>Total Watts=464</p> <p>LPD=.290</p>	<p>2-T8 lamps per work station = $8 \times 2 = 16$ lamps</p> <p>Note that the indirect/direct light and lighter surfaces helps control contrast, while still providing good task levels.</p>	
--	---	--



Case Study

Deep Energy Savings in Existing Buildings



nbi new buildings institute



BETTERBRICKS
Powerful Energy Ideas. Delivered by NEEA.

JOHNSON BRAUND DESIGN GROUP

Site Details

- Owner: JBDG Inc
- Location: Seattle, WA
- Building Type: Office
- Project Description: Equip. Upgrade
- Size SF: 8,000
- Stories: 2
- Project Completion: Ongoing
- Year Built: 1984



Energy Performance

% Better than Baseline= 69%

Baseline Average for U.S. Offices*

Measured Energy Use (KBtu/SF/yr) 29

Energy Star Score= 94

* CBECS – U.S. DOE Energy Information Agency's Commercial Building Energy Use Index 2003





Case Study

Deep Energy Savings in Existing Buildings



JOHNSON BRAUND DESIGN GROUP

Efficiency Measures

- High-efficiency HVAC heat pump
- Heat recovery
- Replaced entry doors
- Sealed and caulked existing windows
- **Lighting upgrade to T5 fixtures**
- Daylighting controls
- Occupancy sensors
- Electricity management monitoring system



Photo: Courtesy of Johnson Braund Design Group



Putting it all together

Baseline Room and Hi-Performance Luminaire

- **Small load= .5 W/Sq'**
 - High performance luminaire

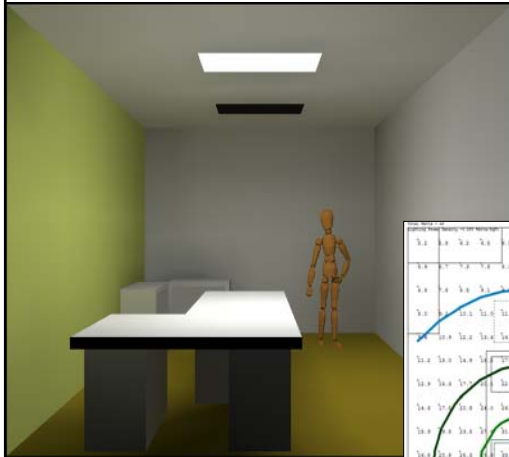


Statistics	
Project 1	
Calc Pts	
Room_Workplane	
Illuminance (Fc)	
Average=34.97	Maximum=51.2
Minimum=12.5	Avg/Min=2.80
Max/Min=4.10	
LPD-UWLR Areas	
LPDArea	
Area(SqFt)=168	Total Watts=84 LPD
(Watts/SqFt)=0.500	

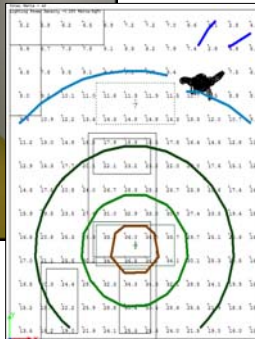


Putting it all together

Baseline Room Hi-Performance Luminaire w/ controls



- Small load= .5 W/Sq'
 - High performance luminaire
- **Occupancy**= .5 - (~25%) = .4 W/Sq'
 - Entry triggered for user feedback
- **Bi-level** at 50%= (~25%)
 - two zone
 - Only half power at entry
- **Task/ Ambient**



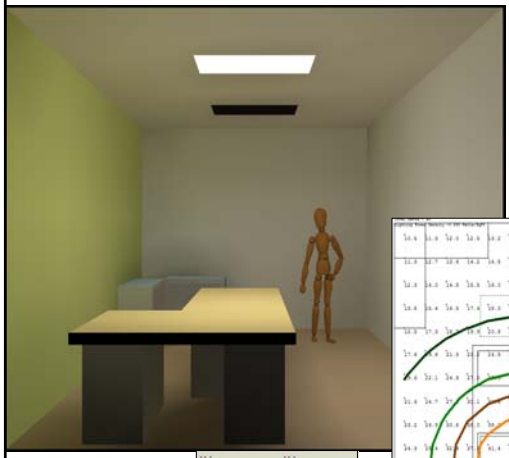
Statistics	
Project 1	
Calc Pts	
Room_Workplane	
Illuminance (Fc)	
Average=17.85	Maximum=36.5
Minimum=2.8	Avg/Min=6.38
Max/Min=13.04	
LPD-UWLR Areas	
LPDArea	
Area(SqFt)=168	Total Watts=42
LPD (Watts/SqFt)=0.250	

Value (Fc)	Color	Value (Fc)	Color
5	Blue	25	Brown
10	Light Blue	40	Orange
20	Green	45	Red
30	Dark Green	50	Dark Red

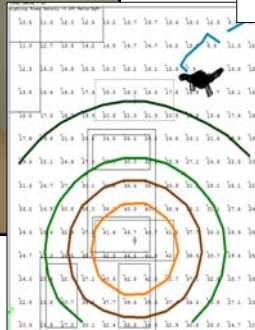


Putting it all together

Baseline Room Hi-Performance Luminaire w/ controls & surfaces



- Small load= .5 W/Sq'
 - High performance luminaire
- **Occupancy**= .5 - (~25%) = .4 W/Sq'
 - Entry triggered for user feedback
- **Bi-level** at 50%= (~25%)
 - Only half power at entry
- **Task/ Ambient**
- **High Reflectance surfaces**



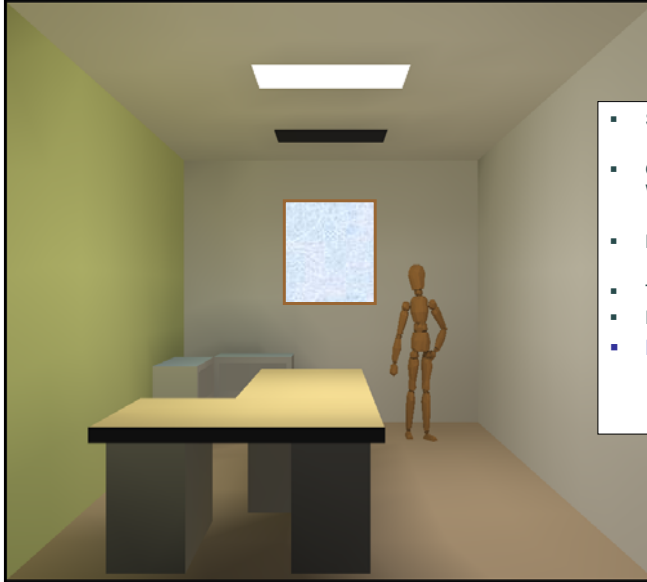
Statistics	
Project 1	
Calc Pts	
Room_Workplane	
Illuminance (Fc)	
Average=24.99	Maximum=44.6
Minimum=7.3	Avg/Min=3.16
Max/Min=5.65	
LPD-UWLR Areas	
LPDArea	
Area(SqFt)=168	Total Watts=42
LPD (Watts/SqFt)=0.250	

Value (Fc)	Color	Value (Fc)	Color
5	Blue	25	Brown
10	Light Blue	40	Orange
20	Green	45	Red
30	Dark Green	50	Dark Red



Putting it all together

Baseline Room Hi-Performance Luminaire/ Controls and Daylight



- Small load= .5 W/Sq'
 - High performance luminaire
- Occupancy= .5 - (~25%) = .4 W/Sq'
 - Entry triggered for user feedback
- Bi-level at 50%= (~25%)
 - Only half power at entry
- Task/ Ambient
- High Reflectance surfaces
- **Daylight for ambient fill-in**

89



Combined strategies (same office 2 views)



Light off
(task/ambient)



**Bi-level (2 zone)
Occupancy
Sensor**





Lastly...

Interior Lighting

“The primary lighting goals for office lighting are to;

-optimize the open office spaces for **daylight integration** and to

-provide **appropriate lighting** levels in the private and open office spaces while

-not producing a dull environment.”

AEDG-2011- 50%

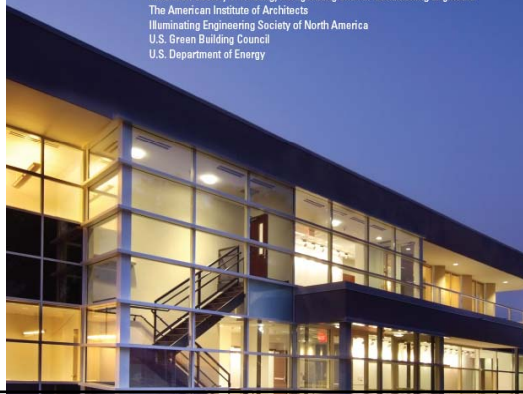
Posted originally, 4/28/11



Advanced Energy Design Guide for Small to Medium Office Buildings

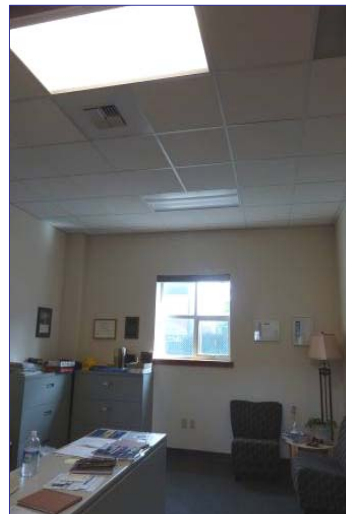
Achieving 50% Energy Savings Toward a Net Zero Energy Building

Developed by:
American Society of Heating, Refrigerating and Air-Conditioning Engineers
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy



Low power density + daylight

When you are at .25 watt/SqFt, there is room to add a little accent light.





Low power density + daylight + accent lighting

When you are at .25 watt/SqFt, there is room to add a little accent light.



Covered parking- Different than exterior lots.- How?





Parking –different lighting for different areas.



Three modern choices.

- LED
- Induction
- Linear Fluorescent



96



Parking technologies – Looking at the numbers

Type	Life	Efficacy <small>*Lamp efficacy</small>	Color	Cost
HID- PS/MH 175 (195)	15,000	85* (65)*	4,000K 65 CRI	\$ - \$\$
LED – A LED – B LED – C	50,000 – 100,000 Or longer?	45 66 78	4K/88 5K/68 4K/65	\$\$ - \$\$\$
Induction 100	100,000	~75*	4100K 80 CRI	\$\$
Fluorescent F32T8	40,000 – 60,000	~90*	4100K 85 CRI	\$

**Ease of controllability – ●=Easiest, ●=Medium, ●=Hardest

97

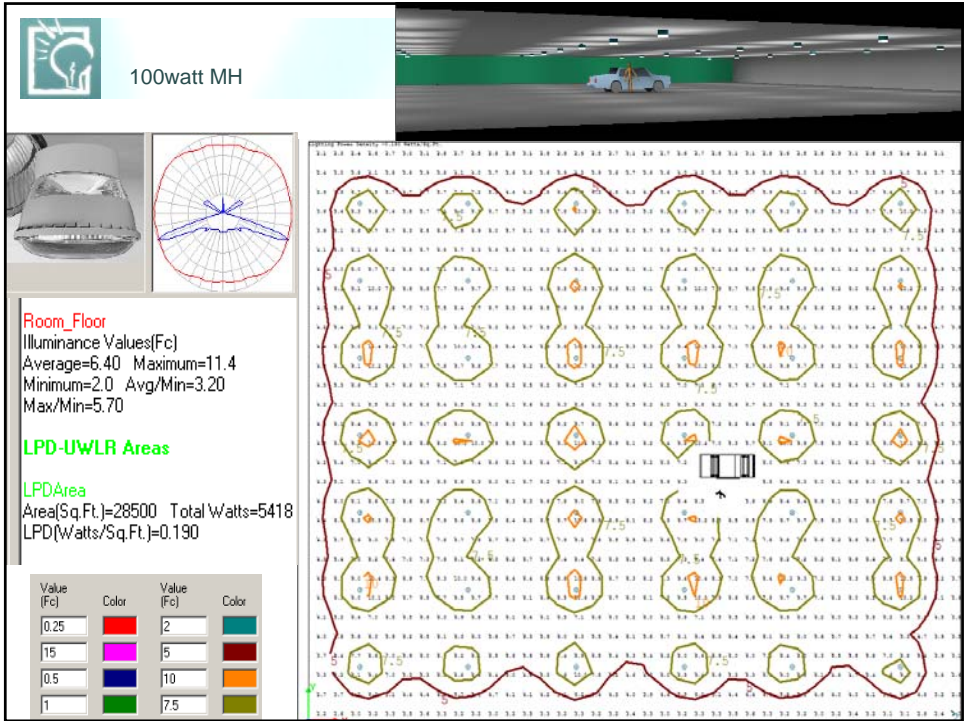


Optics



- Glare control
- Distribution
- Infrastructure investment
- Luminaire efficiency

98



Parking Performance

Summary table.

Parking garage in the simulation is 190' wide and 150' long, with a 8' ceiling. Reflectances are (60/40/20). All simulations use 42 fixtures in the same locations,

Product/Lamping	Watts per fixture	Watts per Sq Ft	Average FC** on floor	Max FC	Min FC	Max to Min ratio
100watt MH	129	.19 w/sq'	6.4	11.4	2	5.7
LED-A	54	.08 w/sq'	4.3	6.1	1.	6.1
LED-B	79	.12	5.2	12.9	.8	16.1
Generic 8' strip 2- 32 watt T8	58	.085 w/sq'	6.3	13.7	1.6	8.56

****Foot candles are initial lumens in all cases as LED files do not include mean lumens. Appropriate light loss factor can be applied.**

100



Parking- LED and fluorescent



101



Parking with fluorescent



102



Fluorescent does not necessarily mean utilitarian



103



Case Study: Seattle Parks at West Marginal Way

- Retrofit strategies and baseline data comparisons
- Compiled by Lighting Design Lab for SCL
 - Eric Strandberg

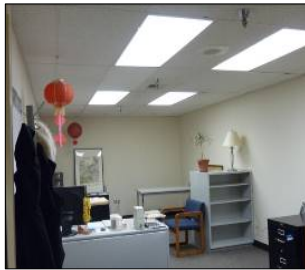




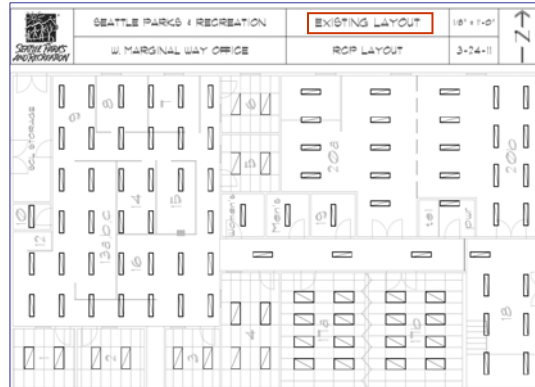
Existing conditions, typical



2 lamp suspended “wrap”



4 lamp recessed prismatic



105



Existing conditions*, T8 scenario data

(73) 2 lamp wraps at 58 watts per fixture =
4,234 watts (32 watt T8 w/ electronic
ballast NBF)

(30) 4 lamp prismatics at 115 watts per
fixture = 3,450 watts (32 watt T8 w/ 1
electronic IS NBF ballast)

Total wattage = 7684

Total square footage (approx.) = 6000

Lighting Power Density (LPD) = 1.3 w/sq'



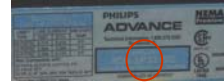
*Due to the varied equipment on site, normal ballast factor wattages will be used for T8 baseline.

Actual observations revealed an inconsistent mix of ballast types

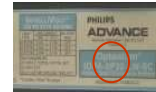
106



Ballast diversity on site



2-lamp & 3-lamp ballasts.
(no 3 lamp fixtures on site)



107



Basic strategy- w/ upgraded fixtures*

Due to the generally high lamp and luminaire, count a combination of delamping and luminaire removal will be recommended along with improved fixtures. NBF "NEMA" ballasts, with standard 835 T8 lamps.

(51) 2 lamp pendants* at 55 watts per fixture = 2805 watts
(32 watt T8 w/ electronic ballast NBF)

(26) 2 lamp high performance lensed* at 55 watts per fixture = 1430 watts (32 watt T8 w/ 1 electronic IS NBF ballast)

Total wattage = 4235

Total square footage (approx.) = 6000

Lighting Power Density (LPD) = .71 w/sq'

*see following spec sheets





Open Office

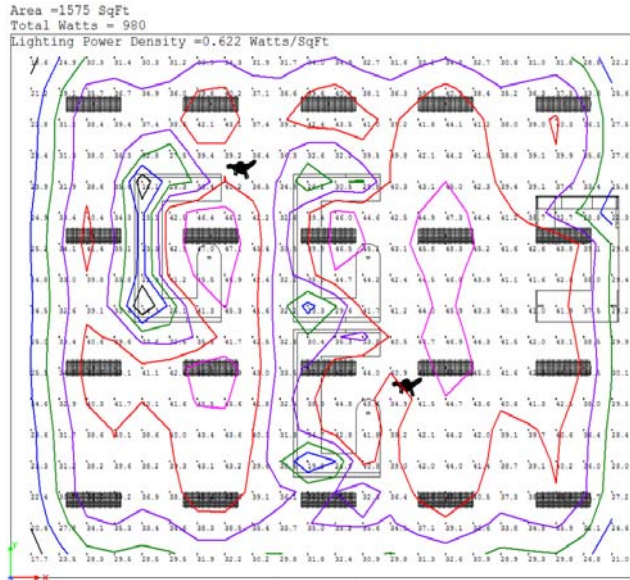
Statistics

Project 1
Calc Pts

Open Office_Workplane
Illuminance (Fc)
Average=36.48 Maximum=48.3
Minimum=14.3 Avg/Min=2.55
Max/Min=3.38

LPD-UWLR Areas
LPD Area
Area(SqFt)=1575 Total Watts=980
LPD(Watts/SqFt)=0.622

Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
20	Black	40	Red	60	Green
25	Blue	45	Magenta	65	Cyan
30	Green	50	Yellow		Purple
35	Purple	55	Orange		Olive



Conference Room and Small Office



Same luminaire type for each space, low ballast factor ballast in conference room





Conference room Finelite option

General

Model: HPR-2x4-2T8-DCCO

Description: FINELITE HPR-2x4-2T8-DCCO-LFB-Mean

Definition:

Lumens Per Lamp: 2000 Number Of Lamps: 2

Luminaire Lumens: 4757 Efficiency (%): 85

Luminaire Watts: 49

Ballast Loss Factor (LLF): 0.770 Spooly: []

Luminaire Box: LLHC: X: 2, Y: 1, Z: 0.01

URHC: X: 2, Y: 1, Z: 0

Photometric File:

Description: C:\Documents and Settings\VM User\Application Data\TEST\26417 (TEST) LIGHTING SCIENCES, INC. (SUSSENA) E:\SUSSENA\MANUFACT\FINELITE, INC. (LUMINCA) FINELITE HPR-2x4-2T8-DCCO (LUMINARE) 2x4 FLDROSEFFICIENT RECESSED LUMINAIRE (LAMP) TWO SYLVANIA 32 WATT T8 LAMPS (BALLAST) ONE SYLVANIA QHE-2C3218/UVV ISM-5C BALLAST (IESNA) LM-63-2002

FINELITE High Performance Recessed (HPR) 2x4

DESCRIPTION

Offers a highly effective recessed luminaire featuring excellent visual comfort and outstanding performance for offices, schools, restaurants, and retail applications. Advanced optical design makes HPR a perfect candidate for low-voltage applications and provides the solution compared to other recessed products.

ORDERING GUIDE

Sample Number: HPR-2-2x4-200-119-217-00-01-8-85-080

Finish: Select HPR

Luminaire Type: Single, 2-Fixture

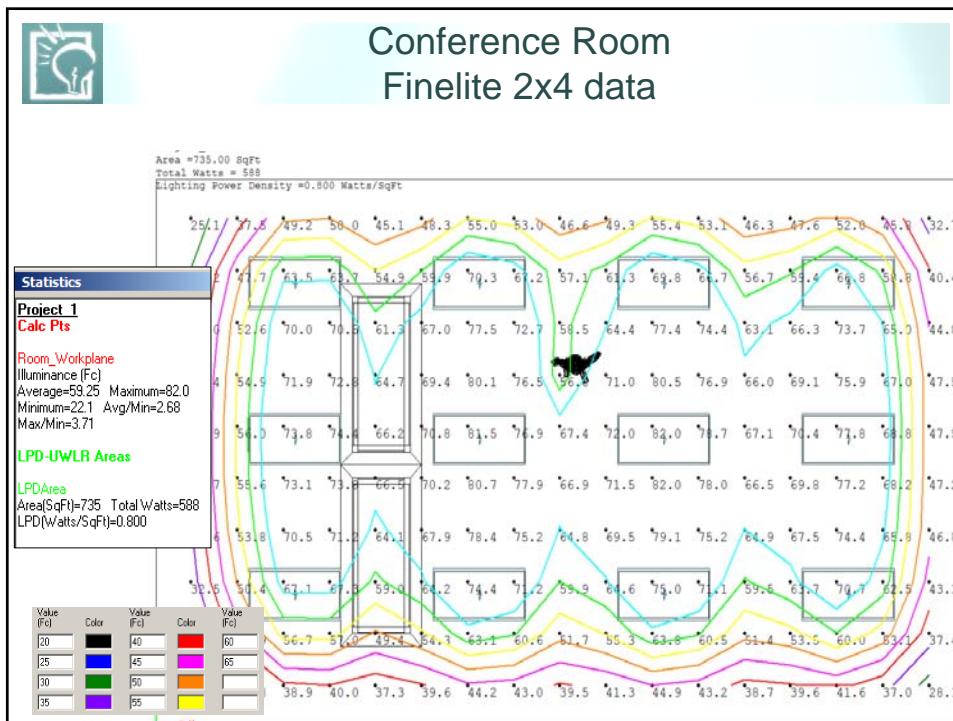
Color: Select (00) Silver, (02) Black, (03) White, (04) Brass

Lamp Type: 2 x T8 (1 ft. to 10 ft.)

Output: Select (00) 10W, (01) 15W, (02) 20W, (03) 25W, (04) 30W, (05) 35W, (06) 40W, (07) 45W, (08) 50W, (09) 55W, (10) 60W, (11) 65W, (12) 70W, (13) 75W, (14) 80W, (15) 85W, (16) 90W, (17) 95W, (18) 100W, (19) 105W, (20) 110W, (21) 115W, (22) 120W, (23) 125W, (24) 130W, (25) 135W, (26) 140W, (27) 145W, (28) 150W, (29) 155W, (30) 160W, (31) 165W, (32) 170W, (33) 175W, (34) 180W, (35) 185W, (36) 190W, (37) 195W, (38) 200W



Conference Room Finelite 2x4 data





Small Office – Day-Brite

General
 Label: SoftTrace25T6232-D-EB-mtNB
 Description: 25T6232-D-1Q-EB
 Definition: Luminaire Per Lamp: 2000, Number Of Lamps: 2, Efficiency (%): 89, Luminaire Lumens: 4771, Total LLF: 0.880, Luminous Flux: 4200, URMC: 2, X: 0.906, Y: 0.01, Z: 0.906

Arrangement
 SINGLE, 1200032 1W RECESSED, 1200032 1W RECESSED

Render Mode
 Luminous, Model Mode, Line Width/Color, Power

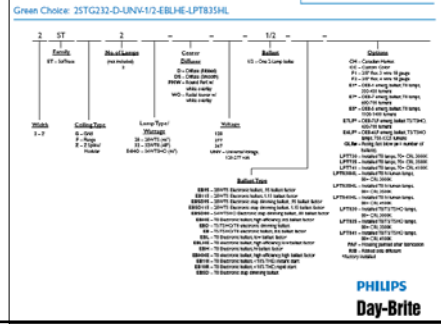
Photometric File
 Description: Classification: LCS: Max Information... Candela: IES
 Filename: C:\Documents and Settings\All Users\Application Data\TEST1\27004 (TEST) [LAW] PHILIPS DAY-BRITE PHOTOMETRIC LABORATORY (ISSUEDATE) 10/28/2007 (MANUFACT) PHILIPS DAY-BRITE (LUMINANCE) 25T6232-D-1Q-EB (LUMINAIRE) DAY-BRITE 2x4 SOFTTRACE W/DIFFUSE DIFFR LAMP(F) 25T6
 (BALLAST) 25T6VWA QTP2x2T8/UV ISN-SC
 (ESNA) LM 63 2002 (TEST_LEVEL)

- Application**
- Ideal for modern offices, schools and small enterprises.
 - Excellent optical efficiency and luminaire efficacy provide significant energy savings.
 - Many recessed lamp systems are available providing flexibility to allow the luminaire to specific applications.
 - Long opening lumen can be switched to less than 50% light power for energy savings to meet mood lighting needs with outstanding geometrical distribution.
 - G44 Flange or 2-pinhole Modular models available.
 - One-piece die-cast aluminum metal housing provides added rigidity, resists damage during shipment/handling.
 - Wireway cover is easily removable without tools for quick bulb or wiring access from below.
 - 1/8" grid clips are built into lamp sockets for quick and easy installation, no extra parts required.
 - Suitable for surface and recessing.
 - Duct, G.I. for dry wiring or conduct entry in hollow channels.
- Electrical**
- UL listed for damp locations. Certified certified approved.
 - Emergency ballasts available, UL listed for dry locations.
 - Systems are available offering electrical stress efficiency ratings up to 92% Lumen/Chair.
 - Total luminaire efficacy as high as 88 LPW/enclosure.
 - Center section is built with water panels, allowing for air and steam collection against suspended ballasts.
 - One-piece enclosure helps drive air as assembly for easy access to lamps and ballast from below without tools.
 - Targets provide vacuum retention of enclosure and allows non-slip grip points to hold during working.
 - Collapsible spring loaded latches allow easy opening and closing of the enclosure.
 - Choice of external enclosure finishes: off-white, acrylic, metal powdercoat steel with wet/dry or white metal finish with wet/dry.
 - Smooth side diffusers standard, ribbed optional.
 - Any corner section can be used with other side diffuser.

0169.3-AR
Architectural Fluorescent
SoftTrace
 2x4 2 Lamp T5, T5HQ, or T8

Specifiers Reference

Project: _____
 Type: _____
 Products: _____
 Comments: _____



Small Office – Day-Brite 2x4



Area = 143.00 SqFt
 Total Watts = 110
 Lighting Power Density = 0.769 Watts/SqFt

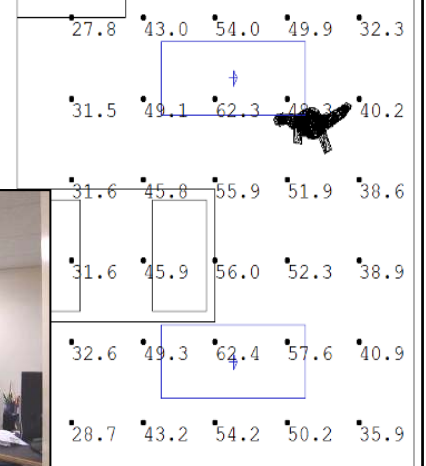
Statistics

Project 1
Calc Pts

Room_Workplane
 Illuminance (Fc)
 Average=44.73 Maximum=62.4
 Minimum=27.8 Avg/Min=1.61
 Max/Min=2.24

LPD-UWLR Areas

LPD Area_1
 Area(SqFt)=143 Total Watts=110
 LPD(Watts/SqFt)=0.769

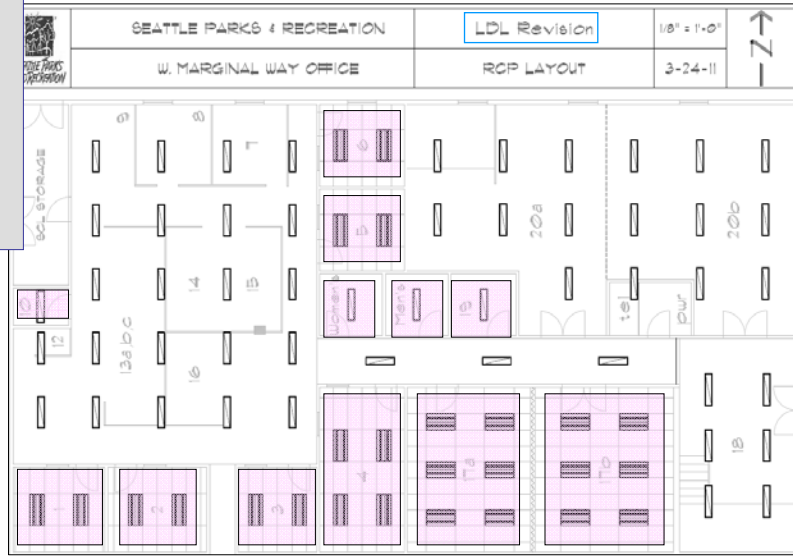




Occupancy sensor opportunities

25% to 40% savings in shaded areas.

30 fixtures at 55watts each = 1,650 – 30% = 1,155 watts. (495 watts saved)



Daylit spaces... and the Badger



Lobby – good daylight potential



Open Office- limited daylight potential



Small Office – good daylight potential

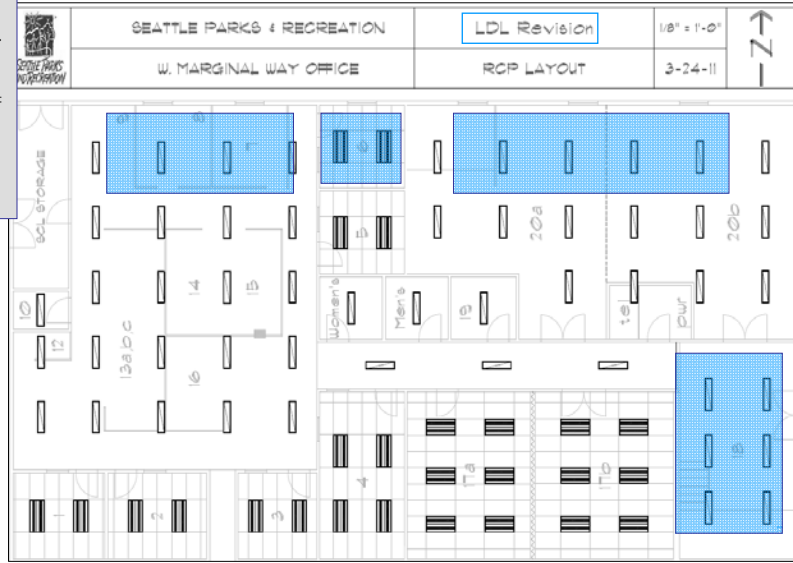
118



Daylight control opportunities

27% to 40% w/o occupancy.

15 fixtures at 55 watts each = 825 watts – 30% = 577 watts. (247 watts saved)



Combined control opportunities*

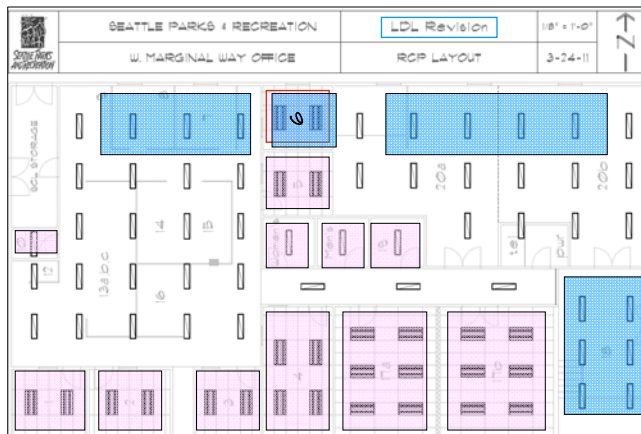
(51) 2 lamp pendants at 55 watts per fixture = 2805 watts (32 watt T8 w/ electronic ballast NBF)

(26) 2 lamp high performance lensed* at 55 watts per fixture = 1430 watts (32 watt T8 w/ 1 electronic IS NBF ballast)

Total wattage = 4,235 – 742** = 3,493

Total square footage (approx.) = 6,000

Lighting Power Density (LPD) = .58 w/sq



*Note that office #6 has both occupancy and daylight control zones.

**Combined control wattage savings

120



Who we are:

The Lighting Design Lab is a Northwest Utility funded lighting education facility promoting commercial and industrial energy conservation.



Lighting Design Lab services

- Regional Classes
- Demonstration Facility
- Lighting Consultation
- Product Evaluation
- Mock-Up Facility
- Website & Newsletter



www.lightingdesignlab.com

122



Our Sponsors

