106-Lighting Retrofits and Audits:
and Overview of LLLC Basics.

Presented by

Eric Strandberg LC

Senior Lighting Specialist

Spring 2022

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Before we begin...

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions every ~12 minutes
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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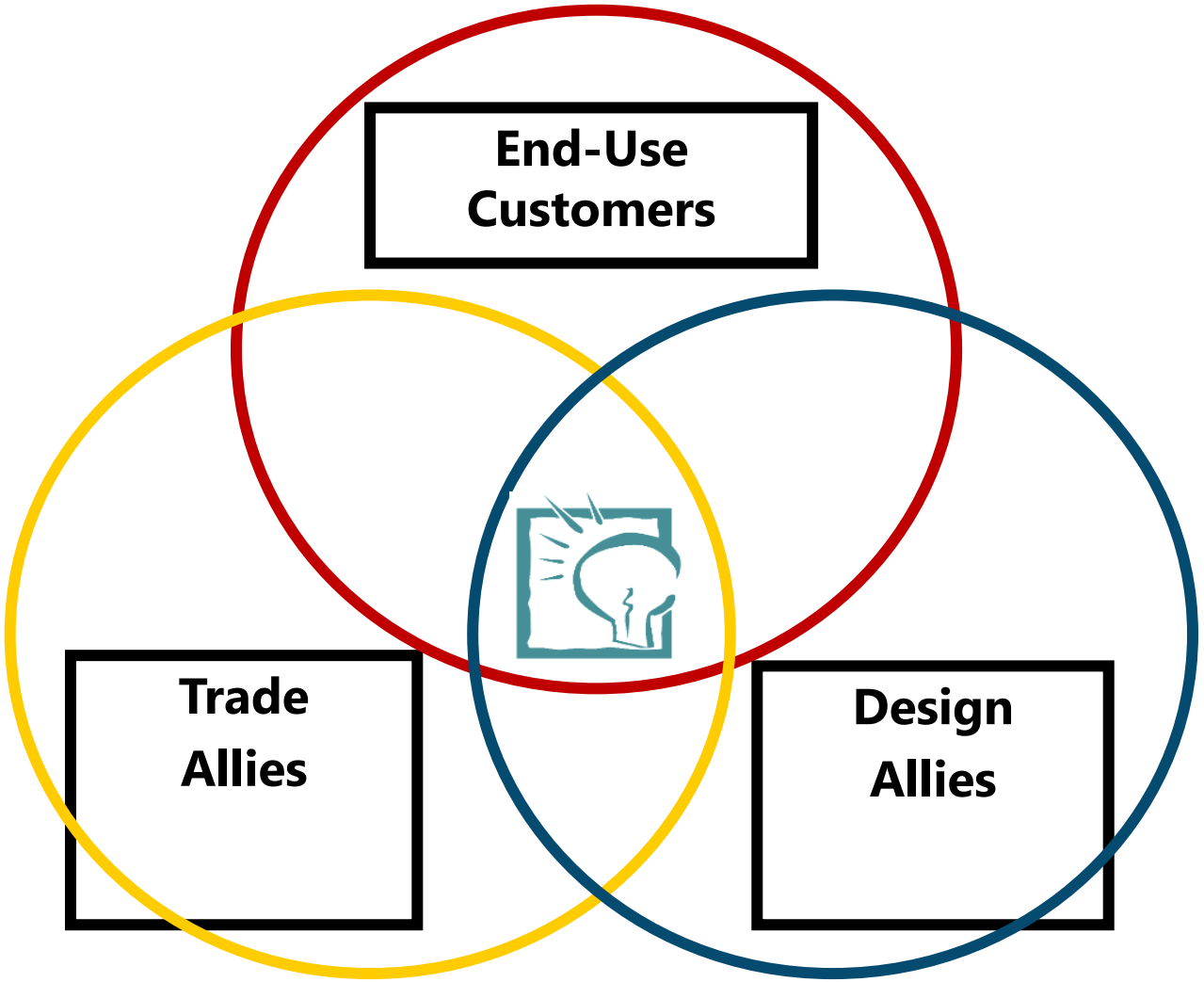

It takes a village…

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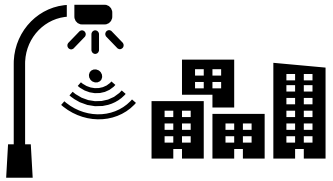
LDL's Four Core Service Areas

EDUCATION & TRAINING

TECHNOLOGY EVALUATION



TOOLS & RESOURCES

INFORMATION AGGREGATION

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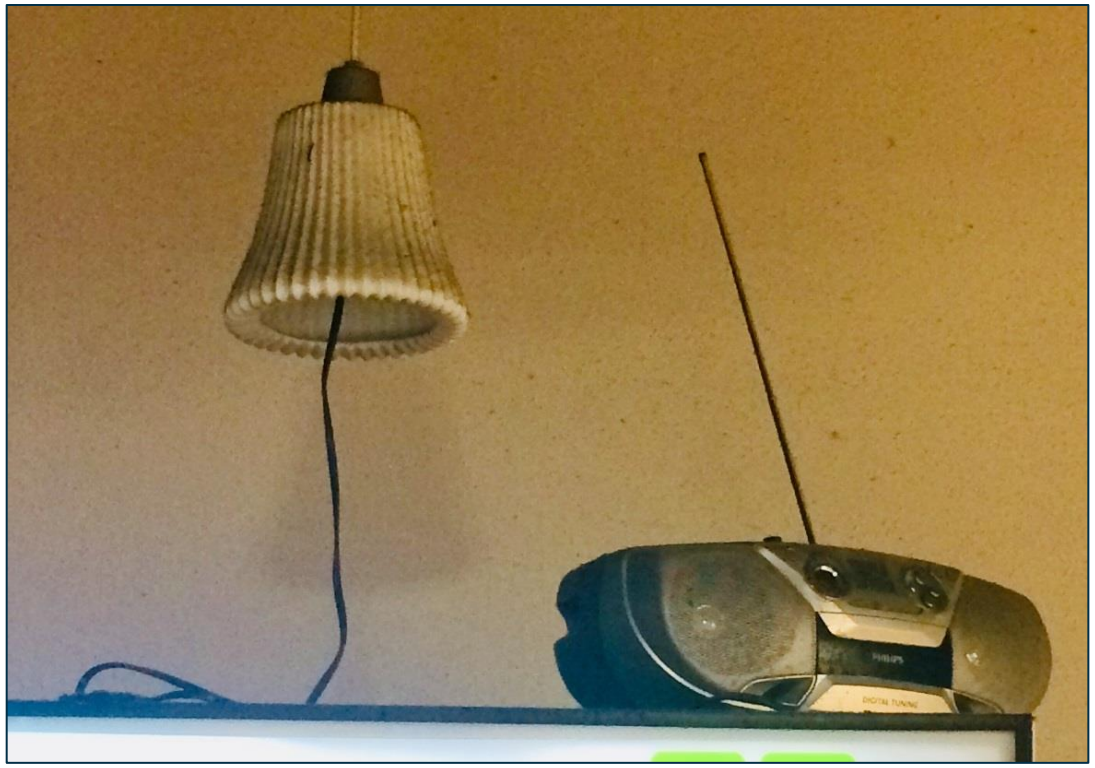
106-Lighting Retrofits and Audits:
and Overview of LLLC Basics.



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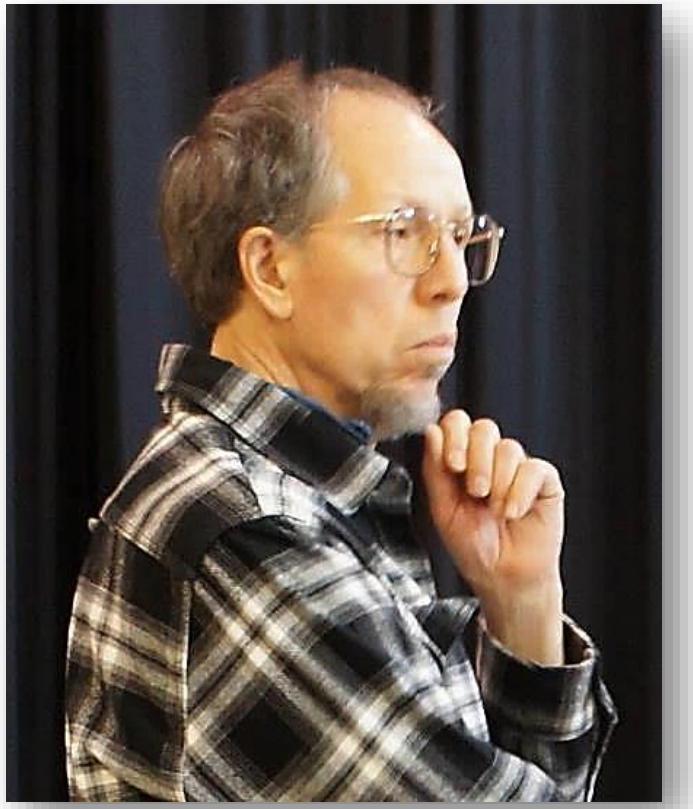

eric@lightingdesignlab.com

Since 1995 Eric Strandberg LC, has been one of the lighting specialists at the Lighting Design Lab promoting energy efficiency and quality lighting design. With a passion for “all things lighting”, he has over 30 years in the lighting industry. This work encompasses almost every aspect of lighting design and conservation including; developing and presenting classes, writing articles, technology evaluation and project consultation.

What are we doing today?

- Overview of the procedures and issues around doing a lighting audit.
- Look at some of the common retrofit options available and what to be aware of.
- Introduce the advantages of Luminaire Level Lighting Controls

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Pop Quiz- How many of you:

- Have done lots of audits and retrofits.
- Do lighting but want to know more about existing buildings.
- Are a contractor and want to know more about lighting.
- Are new to the field and want to know about every aspect.
- Thought this was a cooking class.

Determine project goals and motivations

- Dollar savings- Cut O&M costs
- Energy savings- Be green (LEED-EB)
- Productivity enhancement- Avoid disruption
- Improved lighting- Bad quantity/quality
- Timing- Aging system
- Code triggered- Building remodel
- **All of the above?**

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Is everyone on the same page?

- ***What is the priority?***
- Owner- Low long-term costs
- Tenant- “Green” status
- Engineer- Maximize EE
- Contractor- Lowest first cost
- Facility operator- Low maintenance
- Users- Quality lighting
- Architect- Appearance
- ***Hopefully everyone gets what they want.***

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Do a preliminary survey

- What are the easy targets
  - What is the percentage of lighting and energy impacted
- What are the challenging areas
  - What is the percentage of lighting and energy impacted
- Is the goal to change ***all*** of the lighting regardless.
- Is a detailed audit warranted.

Always ask: How do you like the existing lighting?

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Is this building a good candidate for a retrofit? -Clues to determining feasibility.

- **Cost-Effective:**
  - Facility has long hrs. of operation.
  - Lighting system is more than 20 years old.
  - Electric Utility has high demand and/or energy rates.
  - Utility actively practices DSM, offers rebates.
  - Facility has higher light levels than required.
  - Presence of non-dimmed incandescent lamps.
  - Other energy saving opportunities:
    - Unrealized daylighting
    - Controls deployment

Sidebar: How much is the client actually paying for lighting?

Do they know?

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Clues to determining feasibility

- **<u>NOT</u> Cost-Effective:**
  - Facility has short hrs. of operation
  - Facility exceeds existing efficiency requirements
    - e.g. ASHRAE 90.1, IECC
  - Facility pays little for energy and/or peak demand
  - Facility is not eligible for rebates or incentives
  - Facility has undergone recent retrofit.

Is it already a Green Building?

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Which is likely more cost effective?

- A community center gymnasium or a pro sports stadium
- A theater or a library
- A big box store or a warehouse
- An office building lobby or a hotel lobby

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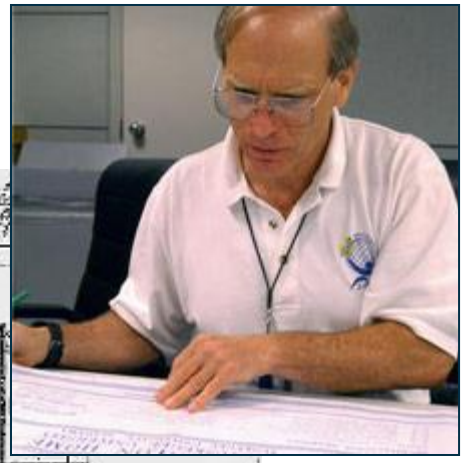
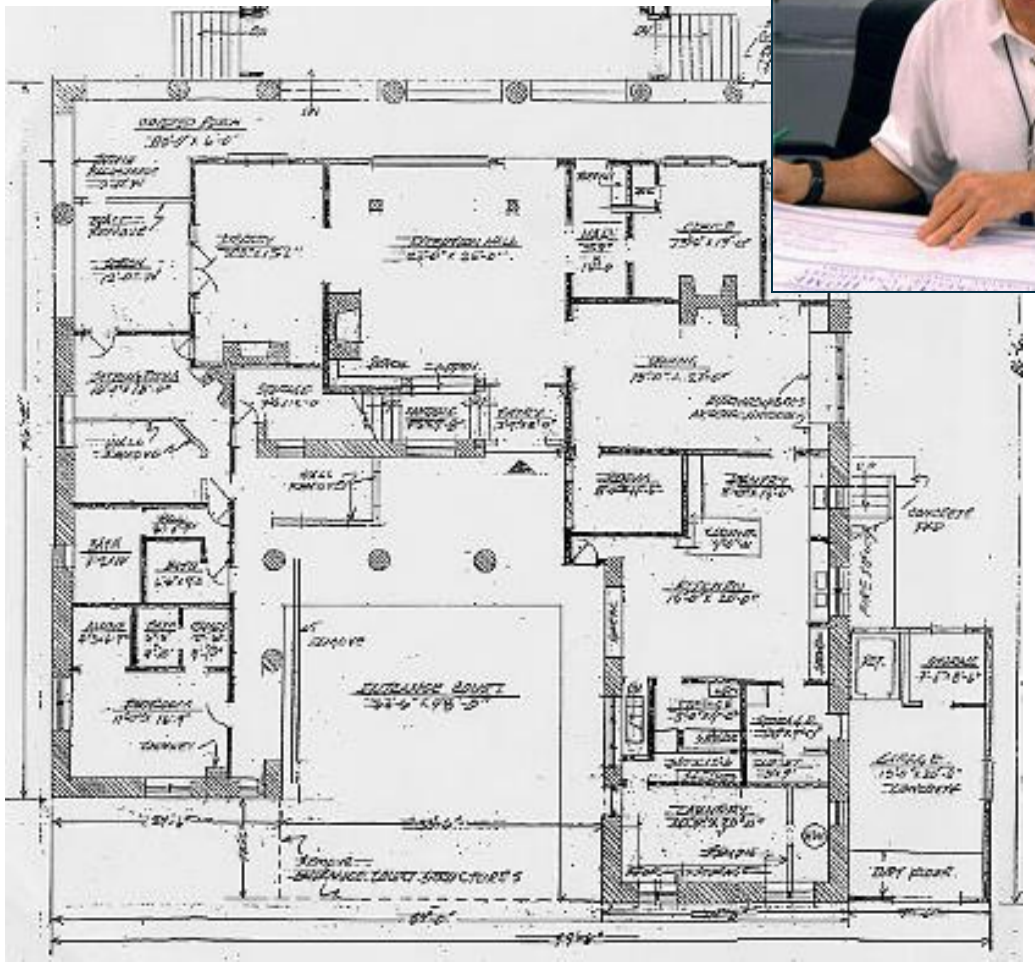
If warranted, a detailed audit may be in order

- **Do a plan survey**
- Identify similar spaces
- Review electrical circuiting
- Check current recommended light levels and lighting guides
  - Local codes
  - Building standards
  - IES recommendations





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Document the existing conditions

- **What you'll need:**
- Light meter
- Measuring tape- Laser*
- Notebook and/or tablet
- Tape recorder w/ transcription app
- Camera w/ zoom and wide angle
- Binoculars
- Personal Protection Equipment-
  - Ear plugs, hard hat, goggles, vest
- Counter
- Form(s)- (utility)

* Not always useful for exterior day

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Document lighting systems

- Illuminance levels – existing.
- Luminaires - types, placement, mounting*.
- Lamps - type, color, wattage.
- Ballasts - type, voltage.
- Daylighting conditions.
- Luminaires already retrofitted, modified, are they consistent w/ as builts?
- Lighting controls - occupancy sensors, timer switches, photocells, etc.
- Room reflectances.

*Same fixture different mounting?

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Additional Survey tips

- What is the *condition* of the existing lighting.
- Are there any controls in use.
  - Is lighting on during “off” hours.
  - Is lighting off during “on” hours.
- Building conditions
  - Ceiling type
  - Access to plenum
- Daylight opportunities
- Reflectance of interior surfaces.
- What is in the maintenance closet…

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Pop Quiz- Which of the following suggest that a retrofit is likely to be cost effective:

- The facility has long hours of operation.
- The measured light levels are higher than recommended practice.
- A community theatre stage has 50+ 500 watt lights.
- A hospital parking garage with 30 year old lights.
- The customer is going for LEED EB certification.

Document existing lighting- Light levels (LL)

- What is proposed
  - What is this based on
- What is Recommended
  - What is that based on
- Are the LL's consistent throughout the space
- Are users happy with the LL
  - What do you think

FOOTCANDLE LIGHT GUIDE

Footcandles are the most common unit of measure used by lighting professionals to calculate light levels in businesses and outdoor spaces. A footcandle is defined as the illuminance on a one square foot surface from a uniform source of light. The Illuminating Engineering Society (IES) recommends the following footcandle levels to ensure adequate illumination and safety for occupants. Below is a guideline for common areas to assist in achieving appropriate light levels with the greatest energy-efficiency.

Building Area & Task	Average Maintained Footcandles (Horizontal) (FC)	Range of Maintained Footcandles (Horizontal) (FC)	Average Maintained Footcandles (Vertical) (FC)	Range of Maintained Footcandles (Vertical) (FC)	Comments
WAREHOUSING & STORAGE					
Bulky Items—Large Labels	10		5		
Small Items—Small Labels	30		15		
Cold Storage	20	10 - 30	10	5 - 15	
Open Warehouse	20	10 - 30			
Warehouse w/Aisles	20	10 - 30	10	5 - 15	
COMMERCIAL OFFICE					
Open Office	40	30 - 50			@30" Above Finished Floor (AFF)
Private Office	40	30 - 50			@30" AFF
Conference Room	30				Matte surface reflectance for the table 40% recommended
Restroom	18	7.5 - 30			
Lunch & Break Room	15	5 - 20			

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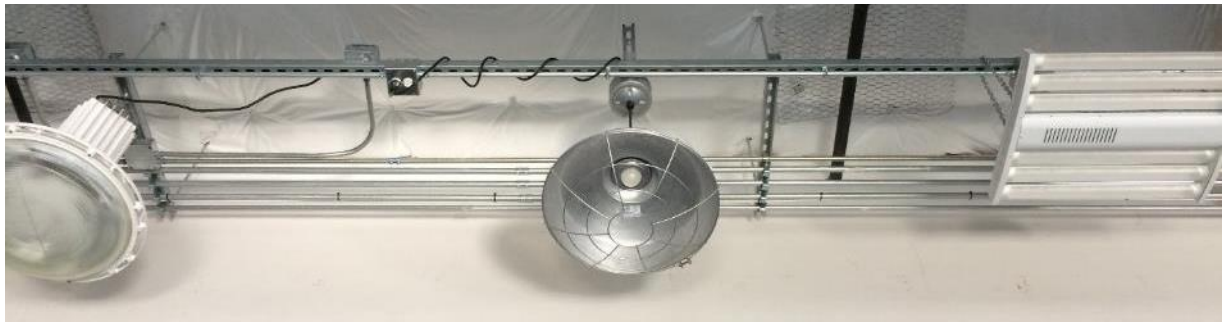
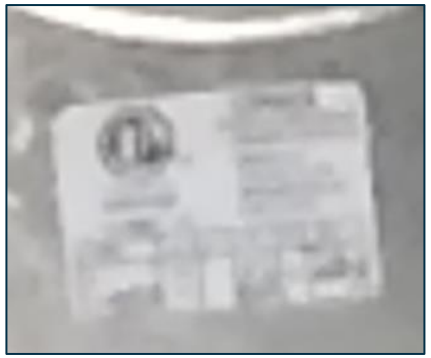
Document existing lighting- Luminaires

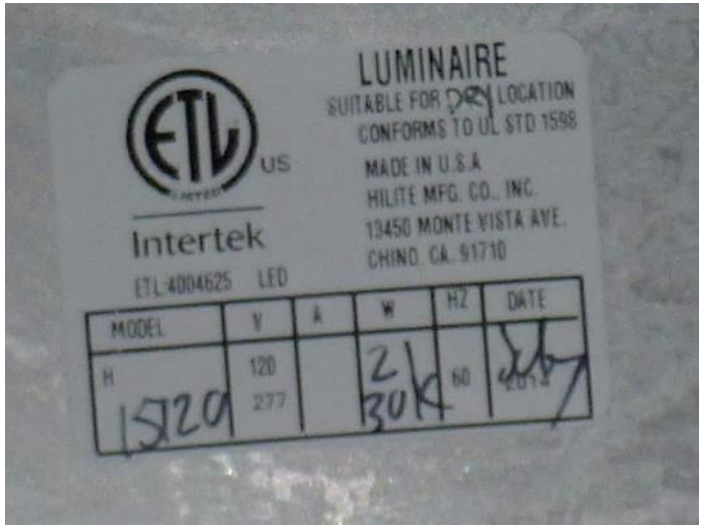
- A decent zoom can save a lot of time tracking down as-builts or ladders.





Phone pictures not useful for detail

Better camera zoomed (top)
Detail enlarged (below)



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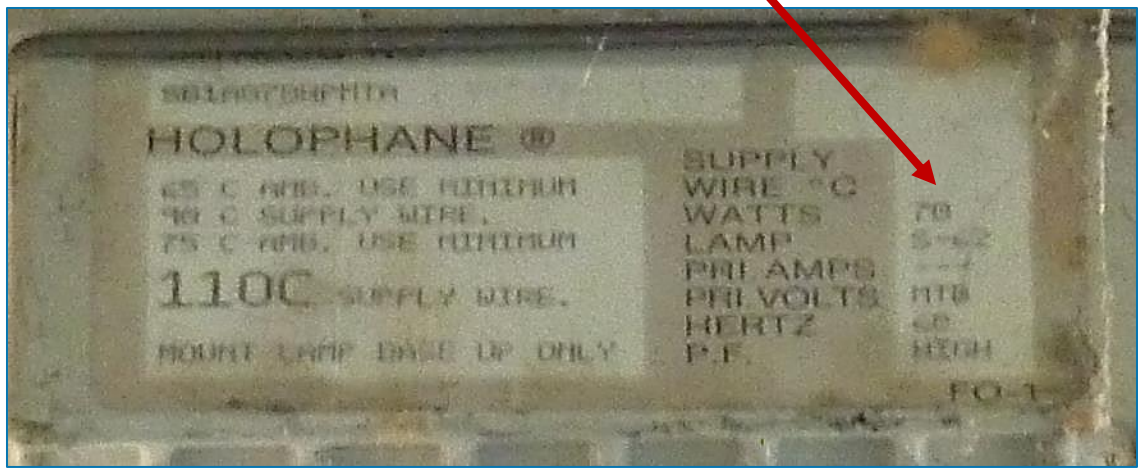


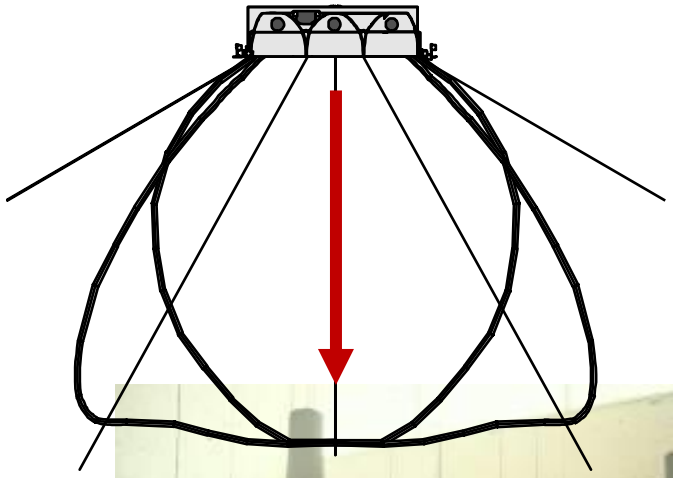
The client was “pretty sure” they had 100-watt lamps.

This difference will be a factor in project viability.

Document existing lighting- Luminaires- Distribution

Direct Luminaires

The direct luminaire is a light fixture in which 90 to 100% of the light is directed down to the task surface.



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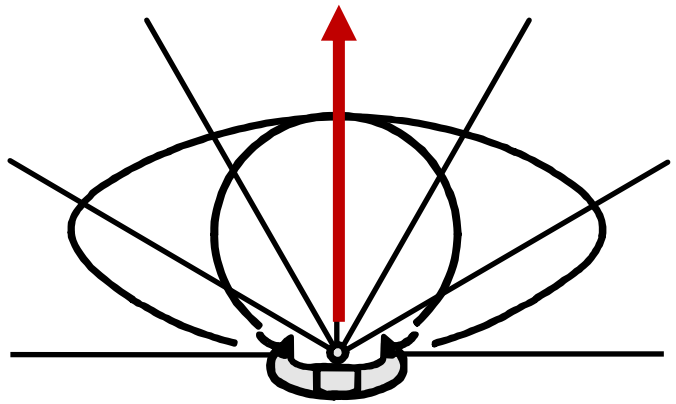
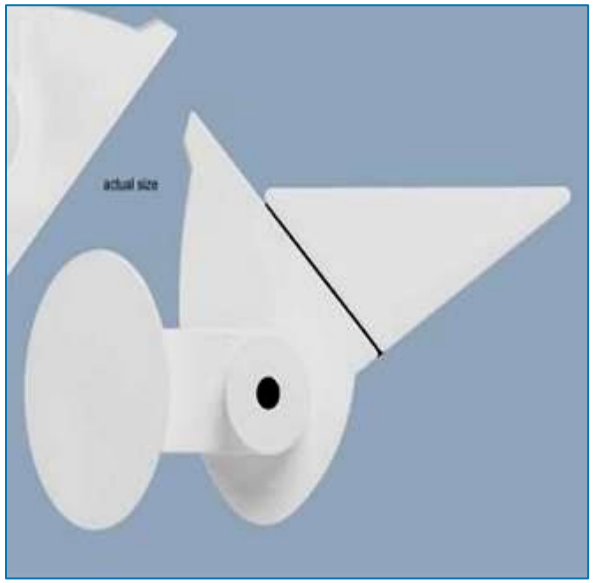
Document existing lighting- Luminaires- Distribution

Indirect Luminaires

The Indirect luminaire or "uplight" is a light fixture in which 90 to 100% of the light is directed upward away from the task surface.





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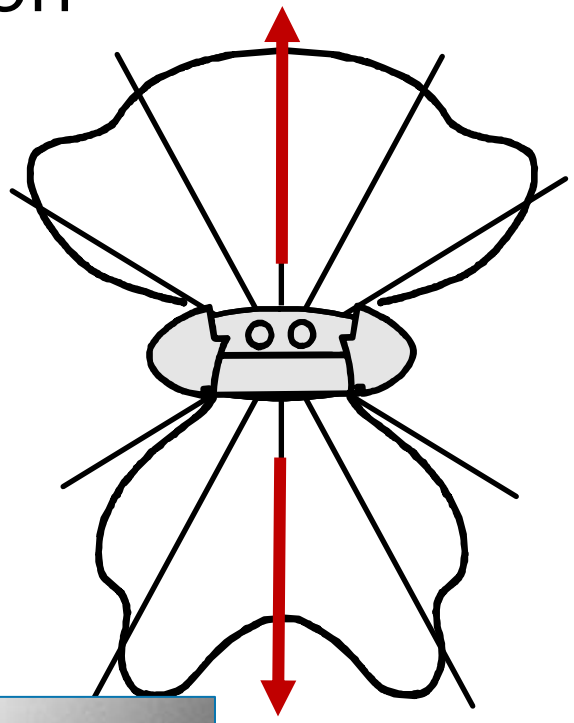
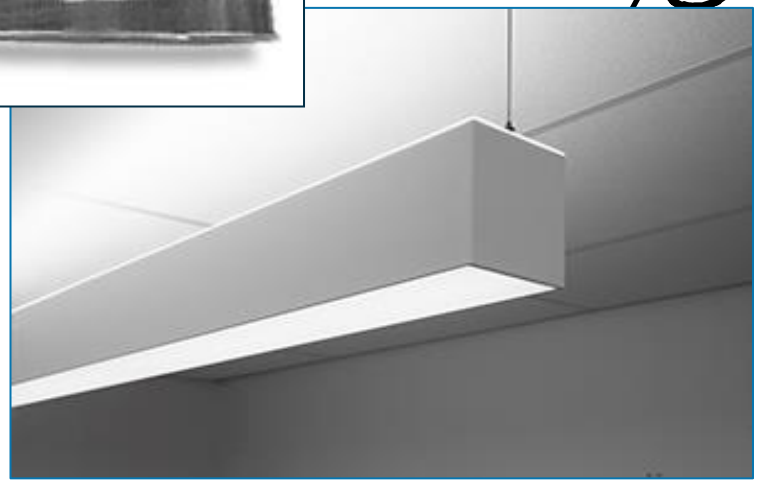
Document existing lighting- Luminaires- Distribution

Direct-Indirect / Indirect-Direct

This type of luminaire is a light fixture in which a high % of light goes up, and a high % goes down.





Document existing lighting- Luminaires

- What type
- What condition are they in
- What is the mounting
- What is the light distribution
- **What is being proposed**

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Audit of fixtures- Overall condition of components

- Sockets
- Fasteners
- Wiring
- Lens
- Ballast age

Is there superficial dirt, or is it damage (rust, breakage, ruined gaskets, etc.)

Document existing lighting- Ballasts

- What type
- Condition
- Consistency
- Location
- **Disposal issues**

A typical pre-1979 PCB-containing fluorescent light ballast (FLB)

A typical Non-PCB containing fluorescent light ballast. The ballast has a "No PCBs" marking on the top of the ballast and the text "electronic ballast". Only magnetic fluorescent light ballasts contained PCBs.

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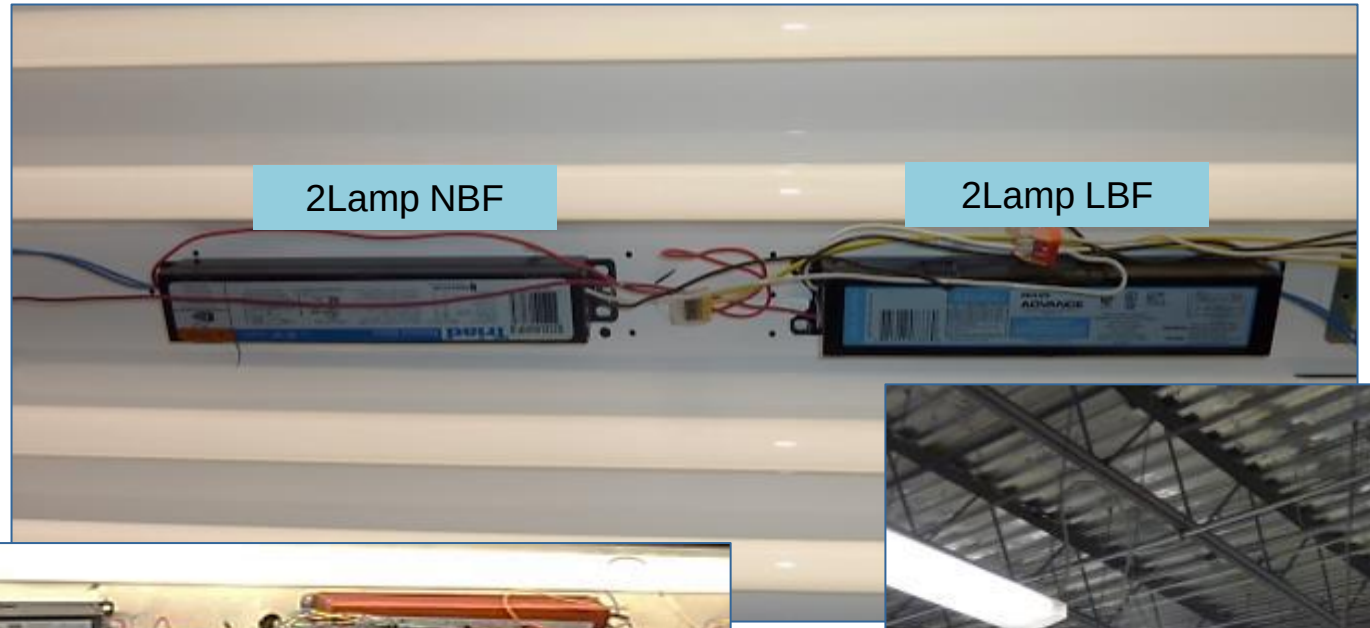
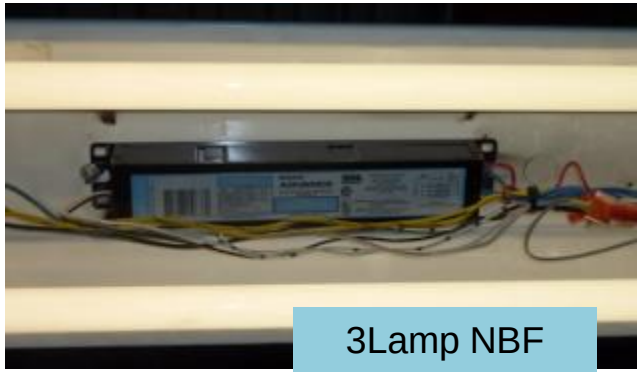
Document existing lighting system- Ballasts
Sometimes you just have to open a lot of fixtures.

All in one part of one building!





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Document existing lighting system- Controls

What kinds of controls?

- On/Off switches
- Manual dimmers
- Occupancy sensors
- Daylight sensors
- Time clocks
- **No** local controls**!**

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Document existing lighting system- Daylight

- Look for opportunities for an easy win.

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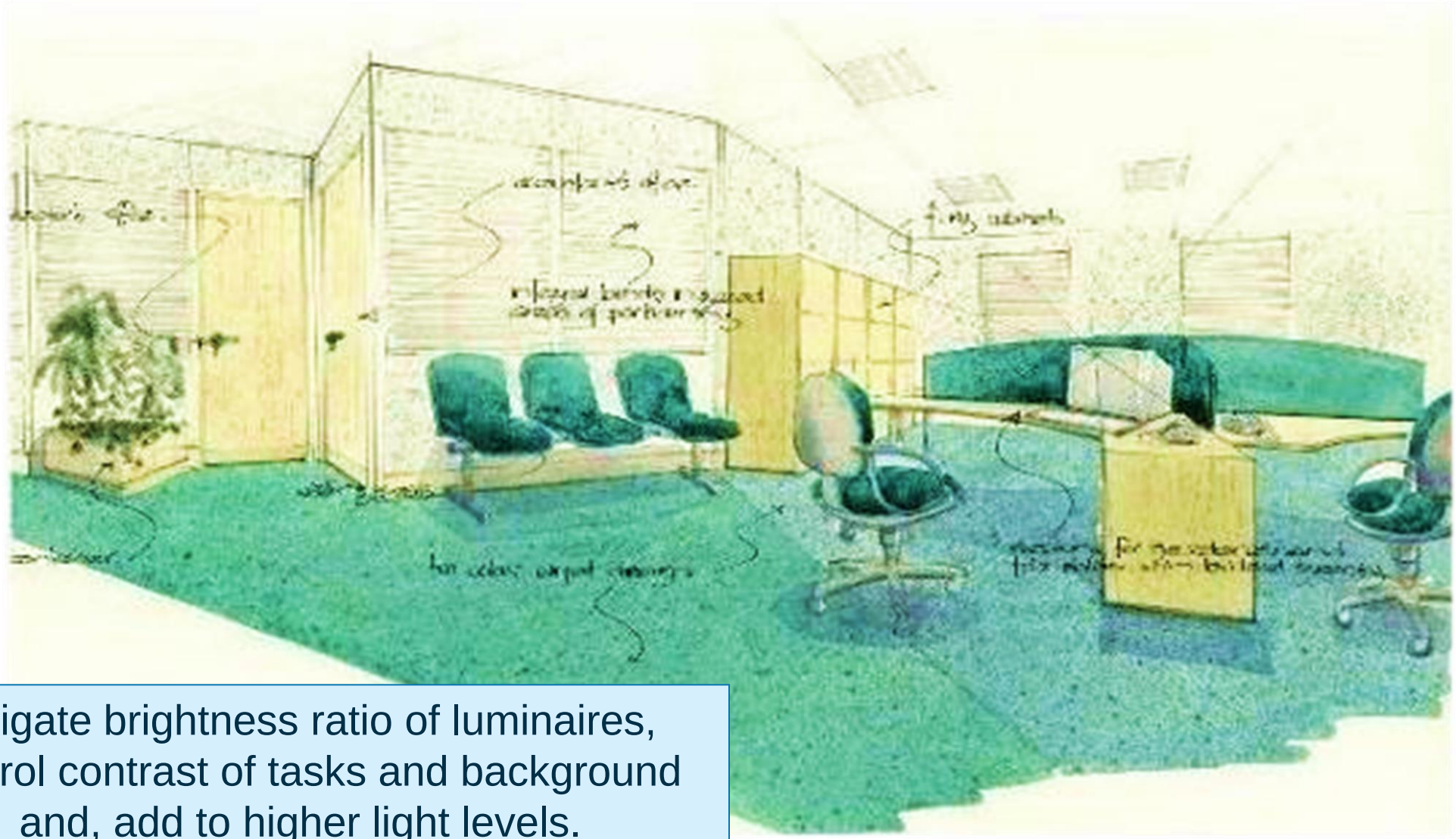
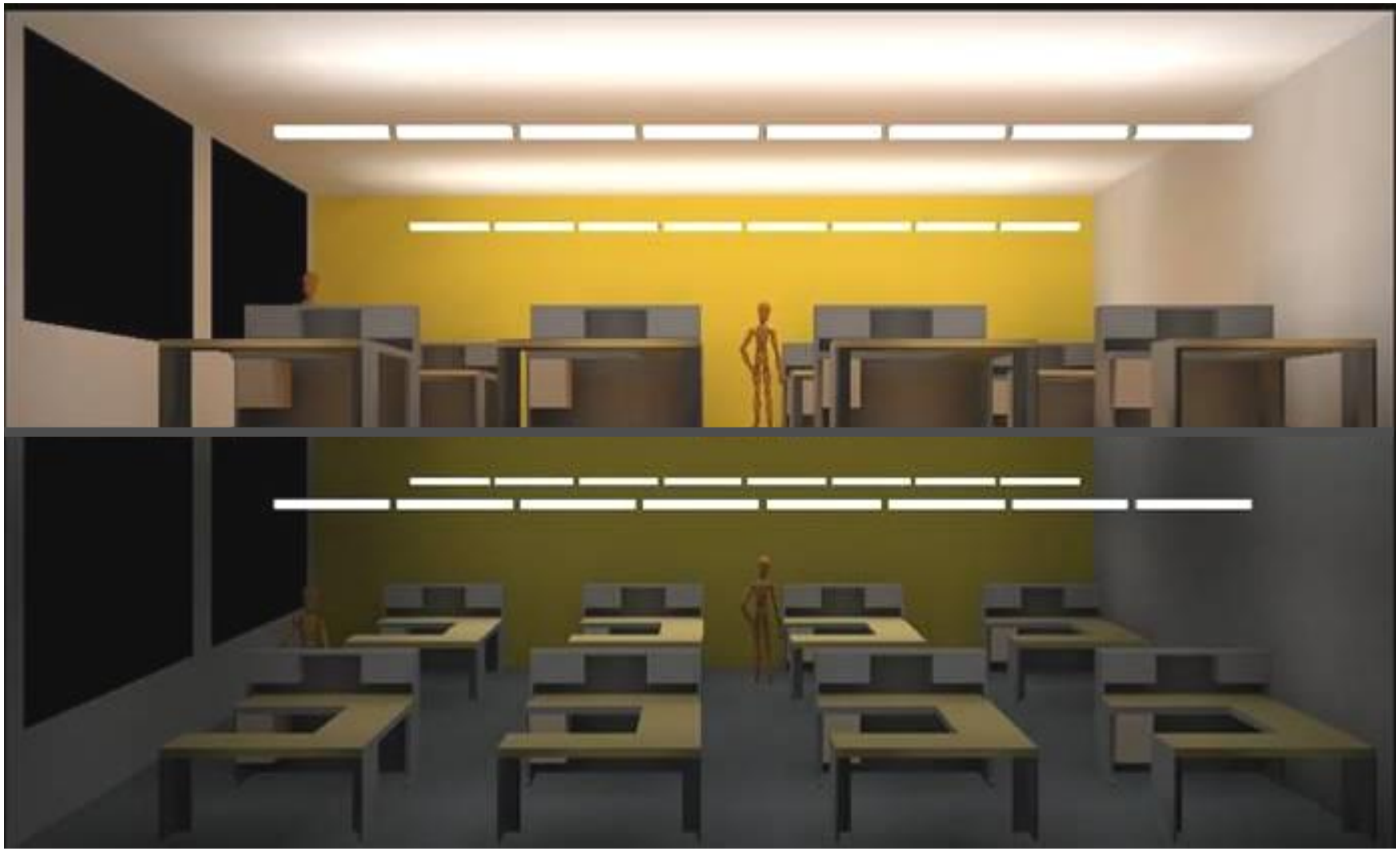
Document existing lighting system- Room surfaces



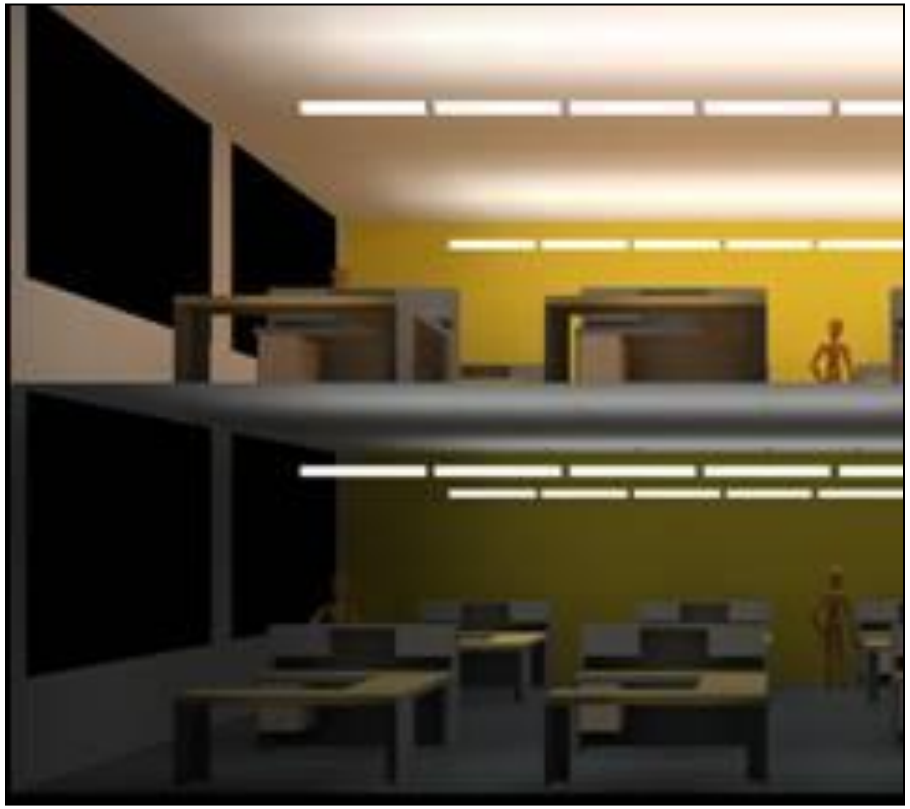
Mitigate brightness ratio of luminaires, control contrast of tasks and background and, add to higher light levels.

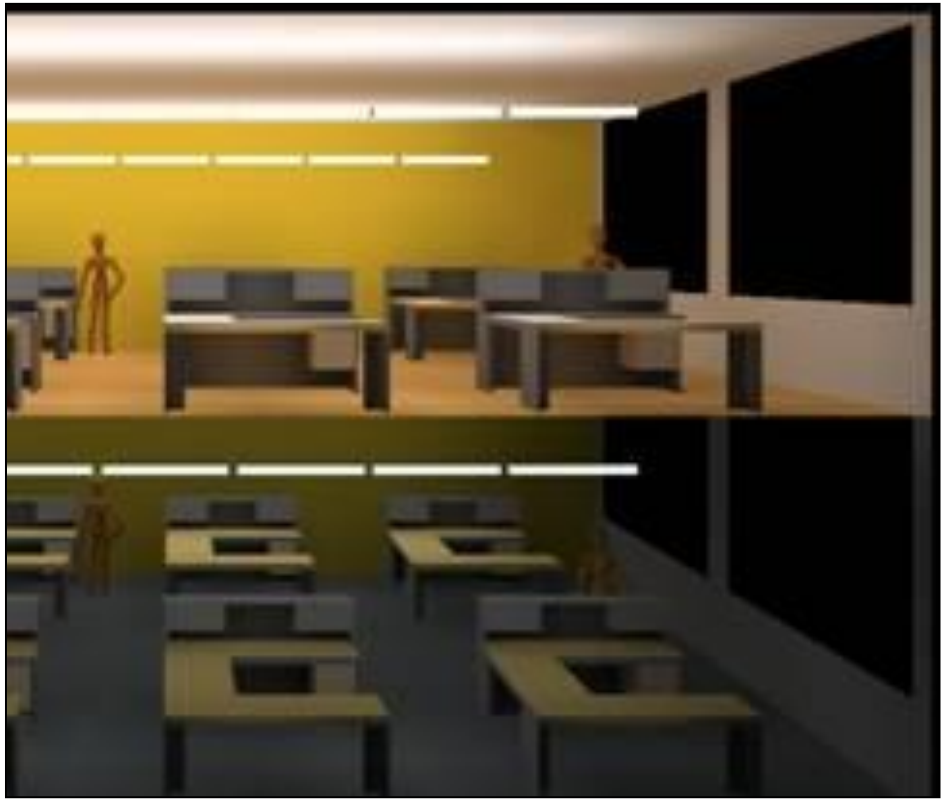
An important part of a lighting design should be existing or proposed surface conditions



Same lighting on each floor, but with a different surface reflectance

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

This isn't just "Interior Design" stuff!

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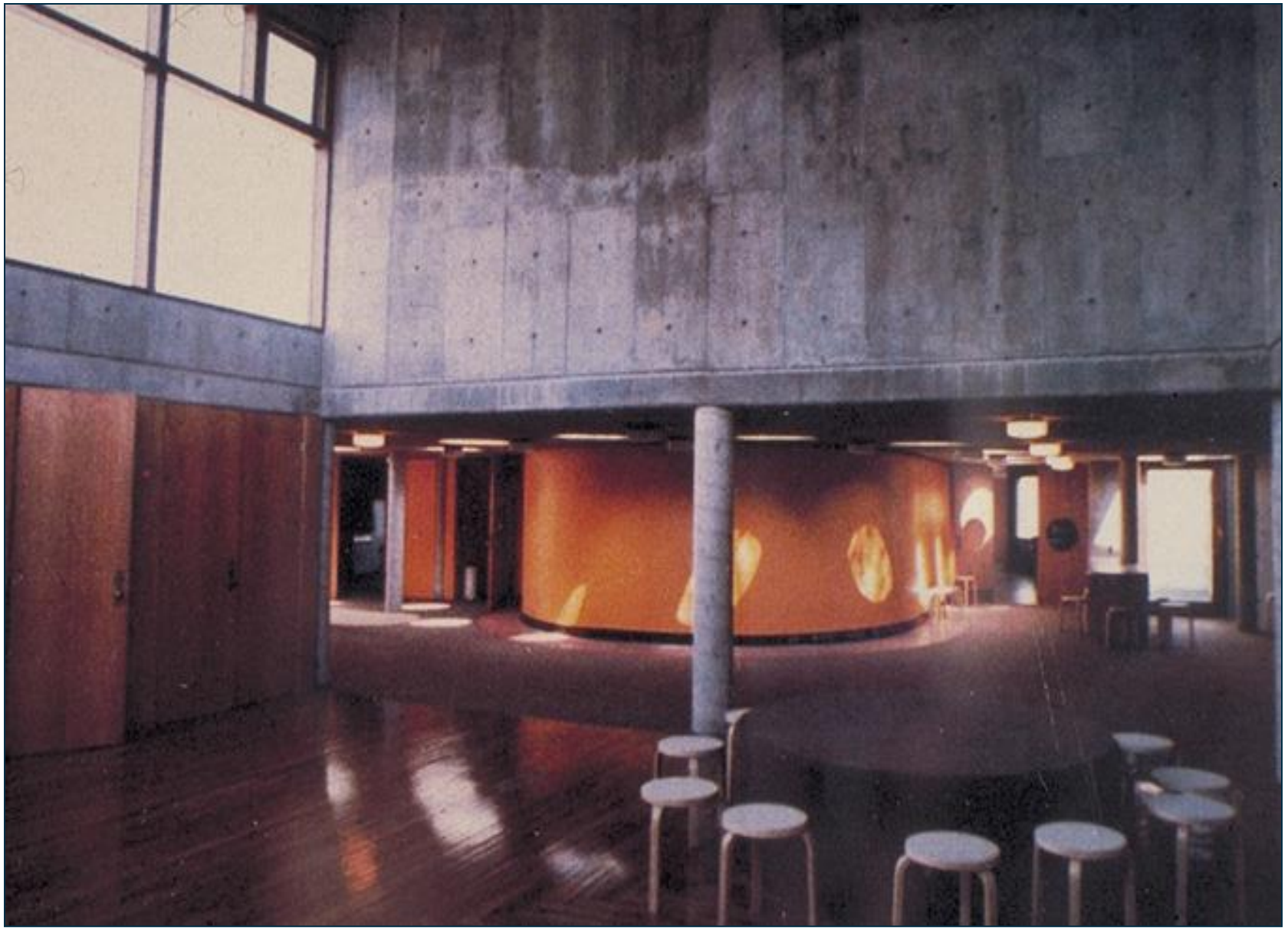

Note the dark surfaces

Light surfaces compound benefits

- Better visual performance

- More light for less energy
- Lower contrast ratios

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Light surfaces compound benefits

For any kind of space

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Estimating room reflectance - how to do it.

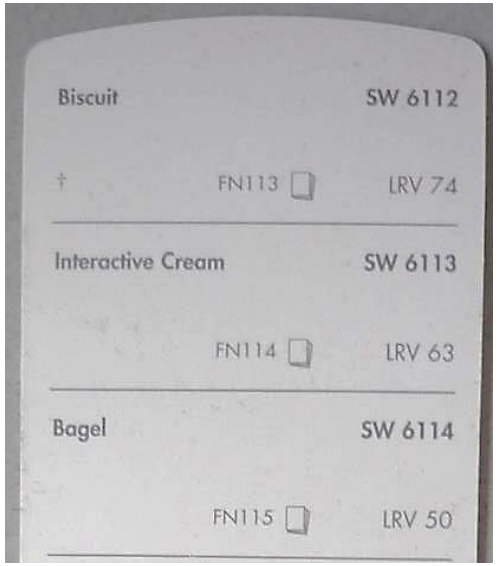
- Take light level reading **on** the wall.
- Hold meter about a foot out from the wall and meter **toward** the wall.
- The % difference is the amount of light absorbed.
- Example: 80 fc incident, **on** wall

  20 fc reflected **off** wall

  - (20-80=60)/80=.75

.75 x 100**= 75% absorbed**

Or you can look it up if you know which paint.



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When is the best time to audit exterior lighting

During the night?

During the day?

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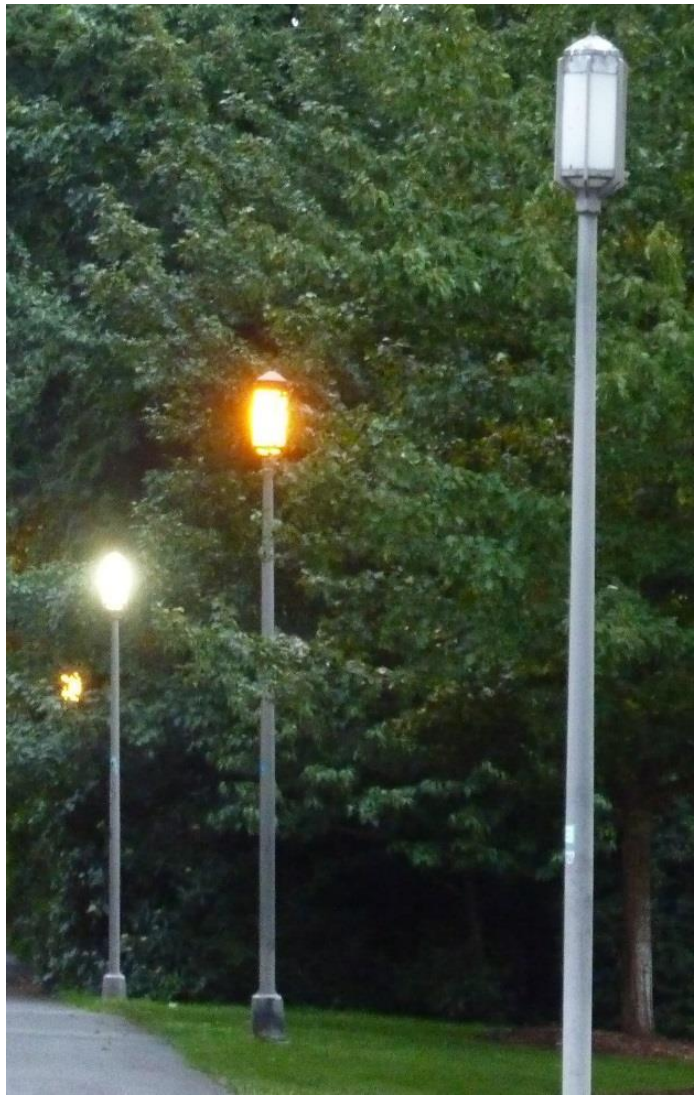
When is the best time to audit exterior lighting

During the night?



During the day?

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When is the best time to audit exterior lighting

During the night?

During the day?

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More advanced site analysis tools

- Luminance meter
- Data loggers
- Spectrometer
- Flicker checker
- Thermal imager
- UV meter
- GoPro?

If people are complaining about the lighting, Why?

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Light Quantity:

How much light do we need?

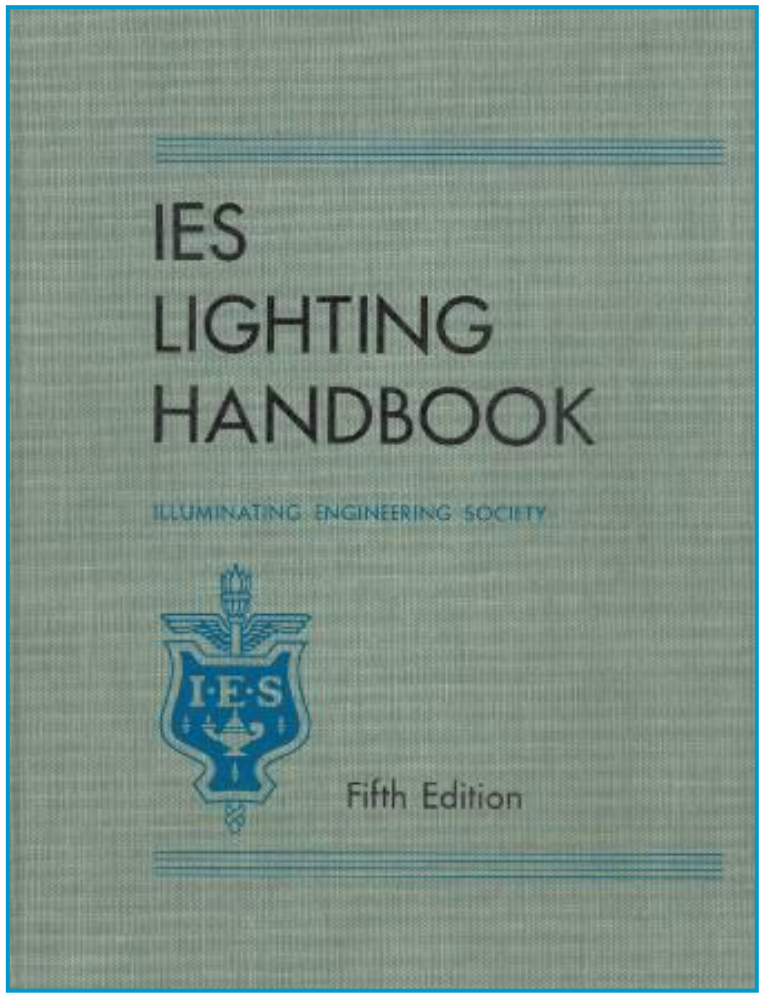
OCT 1939-Nela Park

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 ?

Light level recommendations
5th Ed., circa-1972



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		

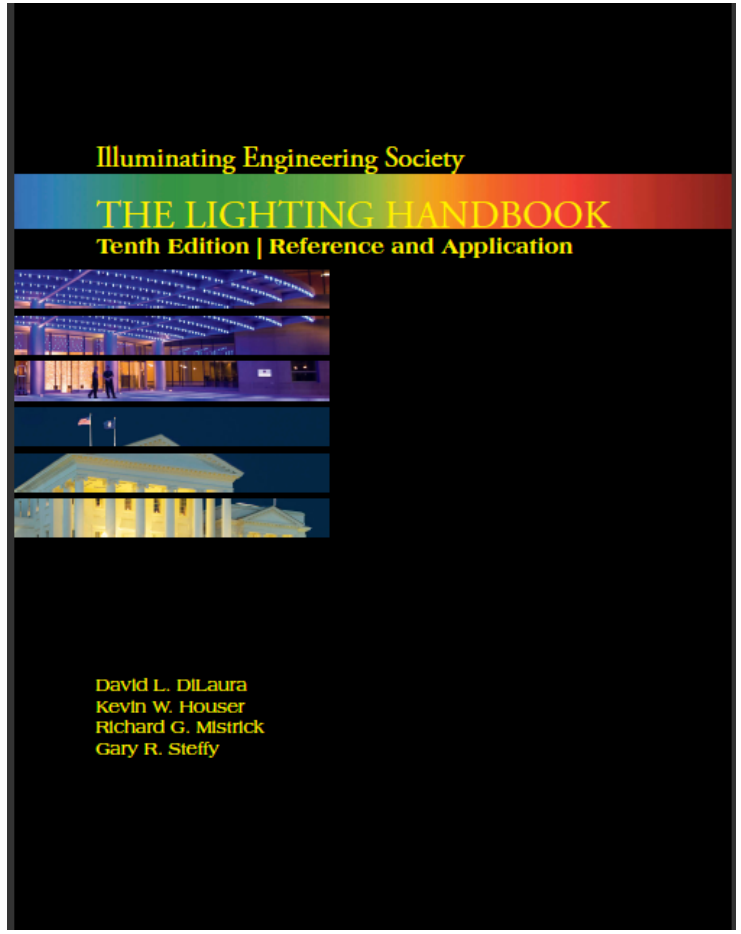
* Minimum on the task at any time for young adults with normal and better than 20/30 corrected vision. For general notes see beginning of tabulation. For other notes see end of tabulation.

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

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

Table 32.2 | Office Facilities Illuminance Recommendations continued from previous page

Applications and Tasks[a]	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				
		Category	<25	25-65	>65	Gauge	Category	<25	25-65	>65	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/VDT Screen and Keyboard										
• Electronic Readers											
• Electronic Ink Devices	E_h and E_v @height of device	P	150	300	600	Avg	N	75	150	300	Avg
• LCD or LED Devices	E_h and E_v @height of device	N	75	150	300	Avg	K	25	50	100	Avg
• Facsimile											
• Analog	E_h @2' 6" AFF; E_v @4' AFF[j]	R	250	500	1000	Avg	M	50	100	200	Avg
• Digital	E_h @2' 6" AFF; E_v @4' AFF[j]	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_h @2' 6" AFF; E_v @4' AFF[j]	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red	E_h @2' 6" AFF; E_v @4' AFF[j]	R	250	500	1000	Avg	M	50	100	200	Avg
• Ballpoint/Rollerpoint/Felt-tip											
• Black	E_h @2' 6" AFF; E_v @4' AFF[j]	P	150	300	600	Avg	L	37.5	75	150	Avg
• Red, Green, Blue	E_h @2' 6" AFF; E_v @4' AFF[j]	Q	200	400	800	Avg	L	37.5	75	150	Avg
• Laptop	See READING AND WRITING/VDT 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_h @2' 6" AFF; E_v @4' AFF[j]	R	250	500	1000	Avg	L	37.5	75	150	Avg
• Specular paper and ink	E_h @2' 6" AFF; E_v @4' AFF[j]	R	250	500	1000	Avg	L	37.5	75	150	Avg
• 8- and 10-pt Font											
• Matte paper and ink	E_h @2' 6" AFF; E_v @4' AFF[j]	P	150	300	600	Avg	K	25	50	100	Avg
• Specular paper and ink	E_h @2' 6" AFF; E_v @4' AFF[j]	P	150	300	600	Avg	K	25	50	100	Avg
• 12-pt Font											
• Matte paper and ink	E_h @2' 6" AFF; E_v @4' AFF[j]	O	100	200	400	Avg	K	25	50	100	Avg
• Specular paper and ink	E_h @2' 6" AFF; E_v @4' AFF[j]	O	100	200	400	Avg	K	25	50	100	Avg
• VDT Screen and Keyboard											



How much light will I get?
What is the efficacy?

LED Damp Rated High Bay

JCBL

9000, 12000, 15000, 18000,
24000, or 30000 lumens

LITHONIA LIGHTING®

JCBL LED Damp Rated High Bay

OPERATIONAL DATA

Lumen package	Input Watts	Ambient rating	Optic Reflector	Delivered lumens 3000K CCT, 70CRI	Delivered lumens 3500K CCT, 70CRI	Delivered lumens 4000K CCT, 70CRI	Delivered lumens 5000K CCT, 70CRI	Delivered lumens 3000K CCT, 80CRI	Delivered lumens 3500K CCT, 80CRI	Delivered lumens 4000K CCT, 80CRI	Delivered lumens 5000K CCT, 80CRI	Delivered lumens 3000K CCT, 90CRI	Delivered lumens 3500K CCT, 90CRI	Delivered lumens 4000K CCT, 90CRI	Delivered lumens 5000K CCT, 90CRI
30000LM	236	(-40°F-40°C) 122°F (50°C)	DALR	25277	25933	26708	26708	23847	24562	25039	25516	19554	20270	20985	20985
			DALRN	24084	24766	25448	25448	22721	23403	23857	24312	18631	19313	19995	19995
			SALR	25512	26234	26957	26957	24068	24790	25272	25753	19736	20458	21180	21180
			ACFR	27763	28549	29334	29334	26192	26977	27501	28025	21477	22263	23049	23049
			ACFRN	27483	28261	29038	29038	25927	26705	27224	27742	21260	22038	22816	22816
			ACCR	27853	28642	29430	29430	26277	27065	27591	28116	21547	22335	23124	23124
			ACCRN	26928	27691	28453	28453	25404	26166	26674	27183	20831	21594	22356	22356
			PLCR	25509	26231	26953	26953	24065	24787	25269	25750	19734	20456	21178	21178
			PLCRN	24684	25383	26081	26081	23287	23985	24451	24917	19095	19794	20492	20492
24000LM	188	(-40°F-40°C) 122°F (50°C)	DALR	20468	21047	21626	21262	19309	19888	20275	20661	15833	16413	16992	16992
			DALRN	19502	20053	20605	20605	18398	18950	19318	19686	15086	15638	16190	16190
			SALR	20658	21243	21827	21827	19489	20073	20463	20853	15981	16565	17150	17150
			ACFR	22480	23116	23753	23753	21208	21844	22268	22692	17390	18027	18663	18663
			ACFRN	22253	22883	23513	23513	20994	21624	22043	22463	17215	17845	18474	18474
			ACCR	22553	23192	23830	23830	21277	21915	22341	22766	17447	18065	18724	18724
			ACCRN	21804	22422	23039	23039	20570	21187	21599	22010	16868	17485	18102	18102
			PLCR	20655	21240	21825	21825	19486	20071	20461	20850	15979	16563	17148	17148
			PLCRN	19987	20553	21118	21118	18856	19421	19798	20176	15462	16027	16593	16593
18000LM	140	(-40°F-40°C) 135°F (55°C)	DALR	15606	16048	16490	16490	14723	15165	15459	15753	12073	12514	12956	12956
			DALRN	14870	15290	15711	15711	14028	14449	14729	15010	11503	11924	12345	12345
			SALR	15751	16197	16643	166453	14860	15306	15603	15900	12185	12631	13077	13077
			ACFR	17141	17626	18111	18111	16171	16656	16979	17303	13260	13745	14230	14230
			ACFRN	16968	17448	17928	17928	16007	16488	16808	17128	13126	13606	14086	14086
			ACCR	17197	17683	18170	18170	16223	16710	17034	17359	13303	13790	14276	14276
			ACCRN	16626	17096	17567	17567	15684	16155	16469	16782	12861	13332	13802	13802
			PLCR	15749	16195	16641	16641	14858	15304	15601	15898	12184	12629	13075	13075
			PLCRN	15240	15671	16102	16102	14377	14808	15096	15384	11789	12221	12652	12652
15000LM	117	(-40°F-40°C) 135°F (55°C)	DALR	13296	13672	14048	14048	12543	12919	13170	13421	10285	10662	11038	11038
			DALRN	12668	13027	13385	13385	11951	12310	12549	12788	9800	10158	10517	10517
			SALR	13419	13799	14179	14179	12660	13040	13293	13546	10381	10761	11141	11141
			ACFR	14603	15016	15430	15430	13777	14190	14465	14741	11297	11710	12123	12123
			ACFRN	14456	14865	15274	15274	13638	14047	14319	14592	11183	11592	12001	12001
			ACCR	14651	15065	15480	15480	13821	14236	14513	14789	11334	11748	12163	12163
			ACCRN	14164	14565	14966	14966	13362	13763	14031	14298	10957	11358	11759	11759
			PLCR	13418	13798	14177	14077	12658	13038	13291	13544	10380	10760	11139	11139
			PLCRN	12984	13351	13719	13719	12249	12616	12861	13106	10044	10411	10779	10779
12000LM	90	(-40°F-40°C) 135°F (55°C)	DALR	10221	10510	10799	10799	9642	9932	10124	10317	7907	8196	8485	8485
			DALRN	9738	10014	10290	10290	9187	9463	9647	9830	7534	7809	8085	8085
			SALR	10316	10608	10900	10900	9732	10024	10219	10413	7980	8272	8564	8564
			ACFR	11226	11544	11861	11861	10591	10908	11120	11332	8684	9002	9320	9320
			ACFRN	11113	11427	11742	11742	10484	10798	11008	11217	8597	8911	9226	9226
			ACCR	11263	11581	11900	11900	10625	10944	11156	11369	8713	9031	9350	9350
			ACCRN	10889	11197	11505	11505	10272	10580	10786	10991	8423	8731	9040	9040
			PLCR	10315	10607	10899	10899	9731	10023	10217	10412	7979	8271	8563	8563
			PLCRN	9981	10263	10546	10546	9416	9698	9887	10075	7721	8004	8286	8286
9000LM	67	(-40°F-40°C) 135°F (55°C)	DALR	8007	8233	8460	8460	7553	7780	7931	8082	6194	6420	6647	6647
			DALRN	7629	7845	8061	8061	7197	7413	7557	7701	5901	6117	6333	6333
			SALR	8081	8310	8539	8539	7624	7852	8005	8157	6251	6480	6709	6709
			ACFR	8794	9043	9292	9292	8296	8545	8711	8877	6803	7052	7301	7301
			ACFRN	8705	8952	9198	9198	8212	8459	8623	8787	6734	6981	7227	7227
			ACCR	8823	9072	9322	9322	8323	8573	8739	8906	6825	7075	7324	7324
			ACCRN	8530	8771	9012	9012	8047	8288	8449	8610	6598	6840	7081	7081
			PLCR	8080	8309	8538	8538	7623	7851	8004	8156	6251	6479	6708	6708
			PLCRN	7819	8040	8261	8261	7376	7597	7745	7892	6048	6270	6491	6491

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So many options so many variables

ORDERING INFORMATION Lead times will vary depending on options selected. Consult with your sales representative. **Example:** JCBL 24000LM SALR MVOLT GZ10 40K 70CRI SC6

JCBL					GZ10		
Series	**Lumens**	**Reflector**[1]	**Lens**[1,2]	**Voltage**	**Driver**	**Color temperature**	**Color rendering index**
JCBL	9000LM 9,000 lumens 12000LM 12,000 lumens 15000LM 15,000 lumens 18000LM 18,000 lumens 24000LM 24,000 lumens 30000LM 30,000 lumens	DALR Diffuse aluminum DALRN Diffuse aluminum narrow SALR Specular aluminum ACFR Frosted acrylic ACCR Clear acrylic PLCR Clear polycarbonate	(blank) Open bottom For use with aluminum reflectors ALDRP Drop prismatic ALCON Conical ALFGL Flat prismatic For use with acrylic and polycarbonate reflectors ACRDRP Drop prismatic ACRCON Conical ACRFGL Flat prismatic	MVOLT 120-277V HVOLT 347-480V 120 120V 208 208V 240 240V 277 277V 347 347V 480 480V	GZ10 0-10V dimming	30K 3000 K 35K 3500 K 40K 4000 K 50K 5000 K	70CRI 70 CRI 80CRI 80 CRI 90CRI 90 CRI

OPERATIONAL DATA

Lumen package	Input Watts	Ambient rating	Open Reflector	Delivered lumens 3000K CCT, 70CRI	Delivered lumens 3500K CCT, 70CRI	Delivered lumens 4000K CCT, 70CRI	Delivered lumens 5000K CCT, 70CRI	Delivered lumens 3000K CCT, 80CRI	Delivered lumens 3500K CCT, 80CRI	Delivered lumens 4000K CCT, 80CRI	Delivered lumens 5000K CCT, 80CRI	Delivered lumens 3000K CCT, 90CRI	Delivered lumens 3500K CCT, 90CRI	Delivered lumens 4000K CCT, 90CRI	Delivered lumens 5000K CCT, 90CRI	Comparable light source
30000LM	236	(-40°F-40°C) 122°F (50°C)	DALR	25277	25933	26708	26708	23847	24562	25039	25516	19554	20270	20985	20985	8-lamp T5HO, 400W HID
			DALRN	24084	24766	25448	25448	22721	23403	23857	24312	18631	19313	19995	19995	
			SALR	25512	26234	26957	26957	24068	24790	25272	25753	19736	20458	21180	21180	
			ACFR	27763	28549	29334	29334	26192	26977	27501	28025	21477	22263	23049	23049	
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Wattage

Lumens

Reflector

Optics

Lens

CCT

CRI

	4K, 70CRI	3K, 90CRI
30,000 nominal lumens. 236 watts.	125 l/w	80 l/w

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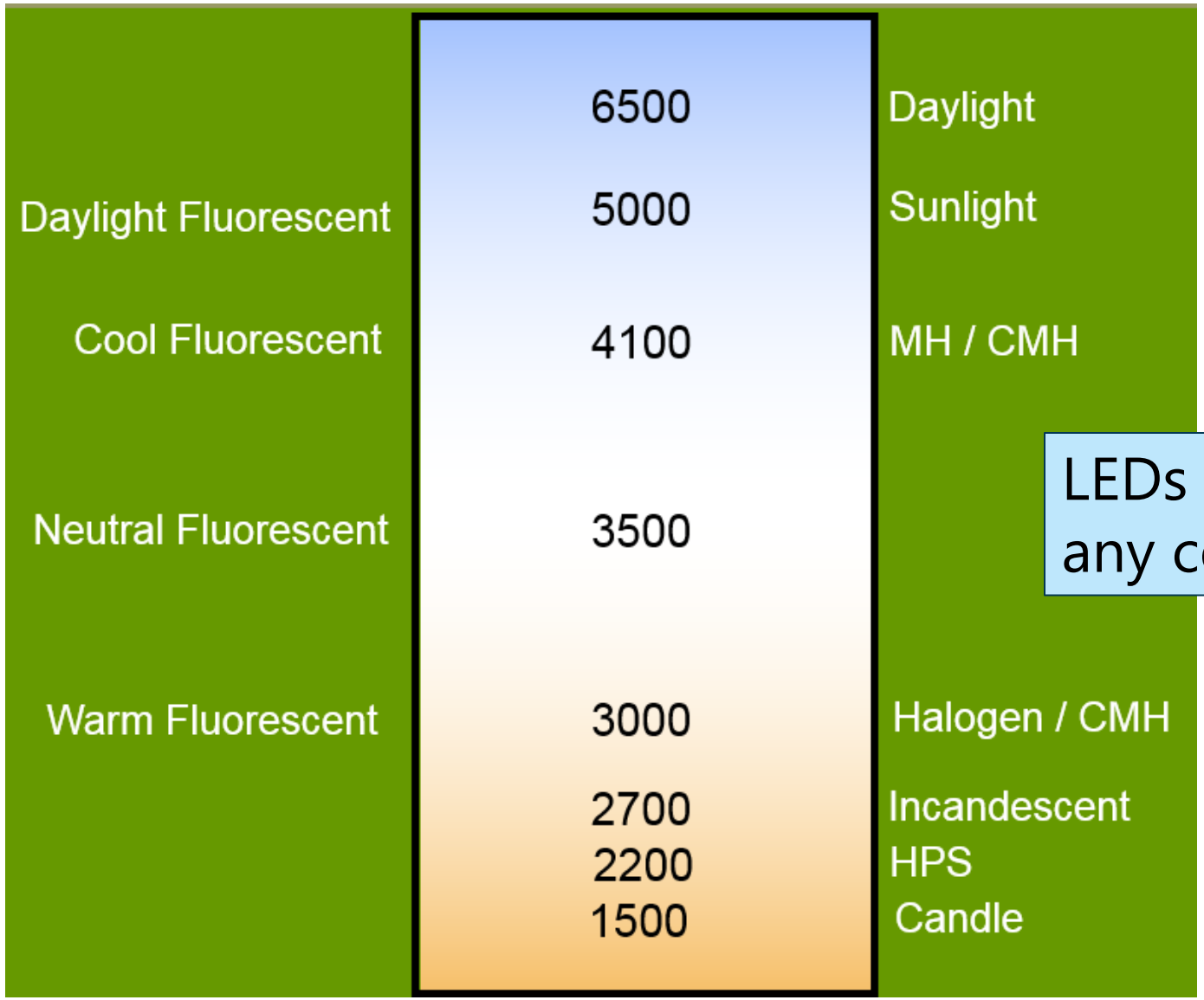
Question on CRI and CCT?
How many of you:

- Know all about CRI and CCT.
- Have been doing lighting a while but could use a refresher.
- Heard about them but always get confused.
- Are new to lighting and would like to find out about CRI and CCT.

Color qualities of light

Electric light sources vary widely in their spectral content and should be carefully selected for their color characteristics.

Describing the color of light – Correlated Color Temperature- CCT



Kelvin scale (i.e. 4100 Kelvins)

LEDs can be almost any color temperature

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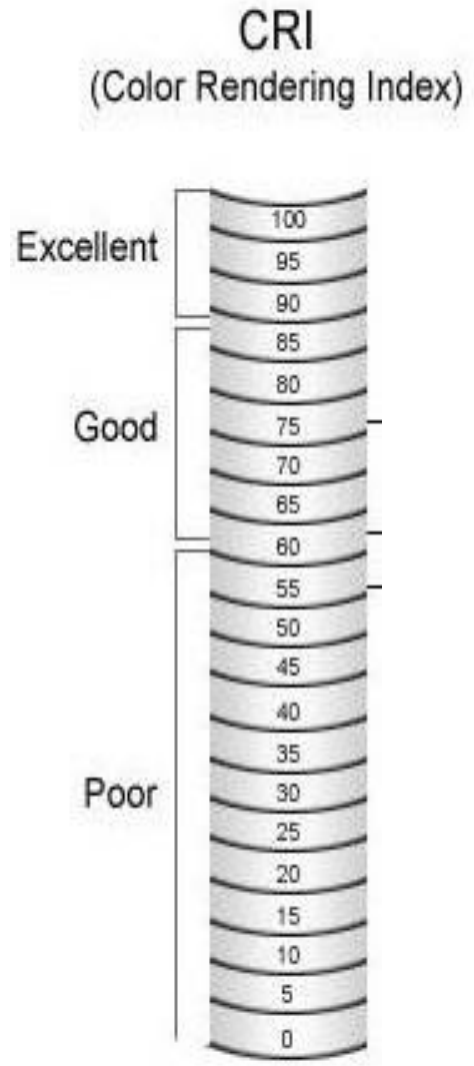
Color Rendering

Two 4,000K sources

CRI~=85

Scale goes from ~ 0 to 100.
Generally, higher is better

CRI~=65



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Design Issues-Color appearance and color contrast

High Pressure Sodium CRI- 22

Mercury Vapor CRI-15

LED- CRI- 80

High CRI & blue-white light can be had w/ MH, Plasma, LED, CFL, and Induction

lighting design lab

So many options so many variables

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OPERATIONAL DATA

Lumen package	Input Watts	Ambient rating	Open Reflector	Delivered lumens 3000K CCT, 70CRI	Delivered lumens 3500K CCT, 70CRI	Delivered lumens 4000K CCT, 70CRI	Delivered lumens 5000K CCT, 70CRI	Delivered lumens 3000K CCT, 80CRI	Delivered lumens 3500K CCT, 80CRI	Delivered lumens 4000K CCT, 80CRI	Delivered lumens 5000K CCT, 80CRI	Delivered lumens 3000K CCT, 90CRI	Delivered lumens 3500K CCT, 90CRI	Delivered lumens 4000K CCT, 90CRI	Delivered lumens 5000K CCT, 90CRI	Comparable light source
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			SALR	25512	26234	26957	26957	24068	24790	25272	25753	19736	20458	21180	21180	
			ACFR	27763	28549	29334	29334	26192	26977	27501	28025	21477	22263	23049	23049	
			ACFRN	27483	28261	29038	29038	25927	26705	27224	27742	21260	22038	22816	22816	
			ACCR	27853	28642	29430	29430	26277	27065	27591	28116	21547	22335	23124	23124	
			ACCRN	26928	27691	28453	28453	25404	26166	26674	27183	20831	21594	22356	22356	
			PLCR	25509	26231	26953	26953	24065	24787	25269	25750	19734	20456	21178	21178	
			PLCRN	24684	25383	26081	26081	23287	23985	24451	24917	19095	19794	20492	20492	

Wattage

Lumens

Reflector

Optics

Lens

CCT

CRI

	4K, 70CRI	3K, 90CRI
30,000 nominal lumens. 236 watts.	125 l/w	80 l/w

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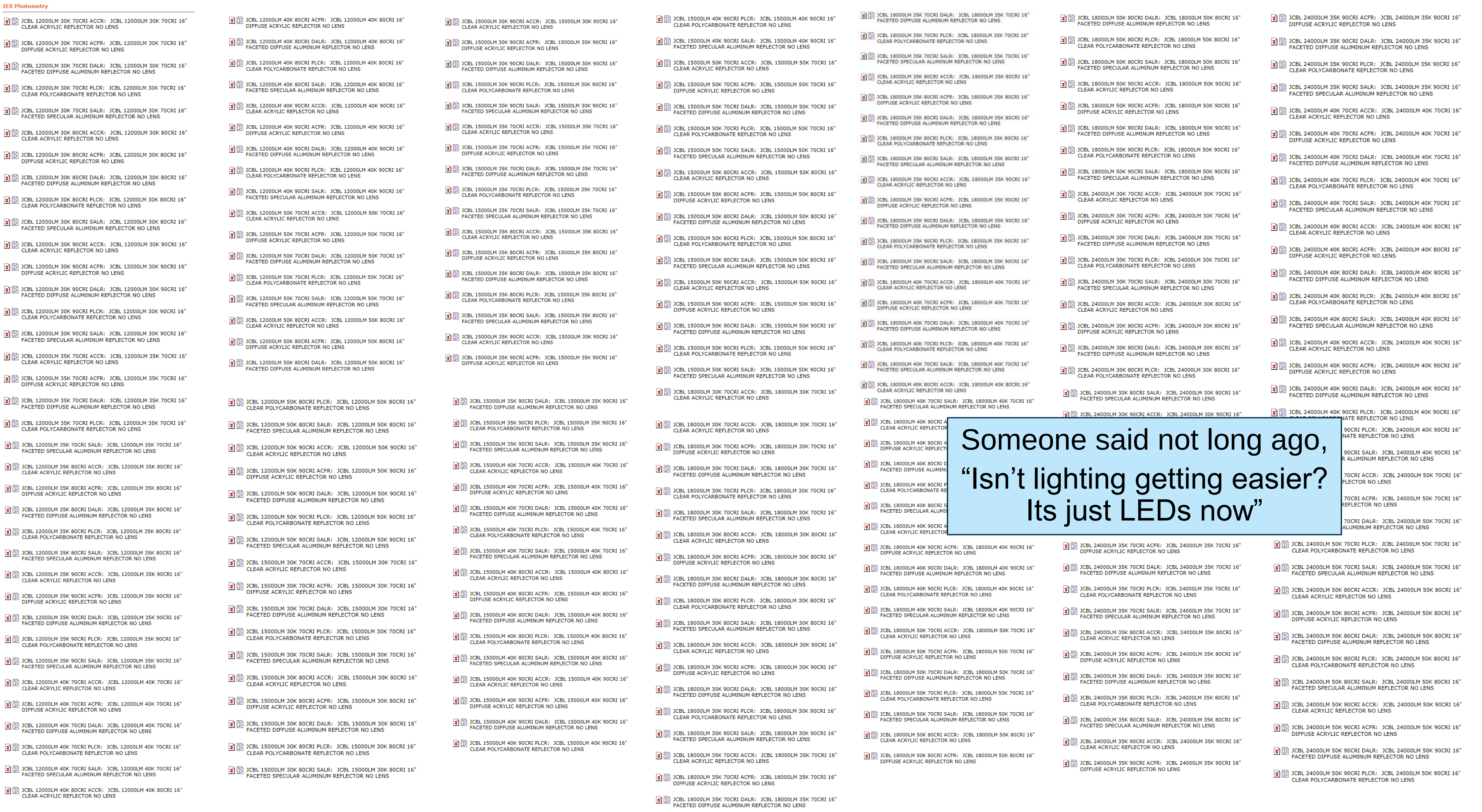
Photometric reports for just **one fixture**- …



Someone said not long ago,
“Isn’t lighting getting easier?
Its just LEDs now”

Pop Quiz- What are the benefits of light interior surfaces?:

- Potential to save energy.
- Improve visual comfort.
- Lower contrast ratios.
- Potential higher light levels.
- …Isn't this just Interior Design? *(Not my area!)*

Common retrofit applications

Fluorescent troffers

Recessed cans

Decorative surface

High-bay

Parking

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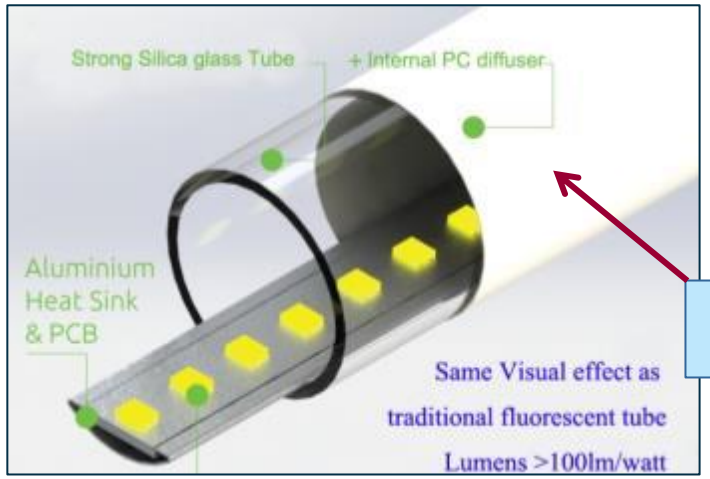
LED Tubes (TLEDs) - different formats

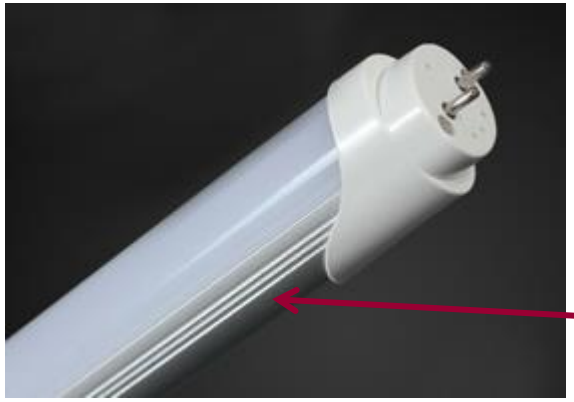
No diffuser

Narrow ends

Wide ends



Glass tube



Metal heat sink

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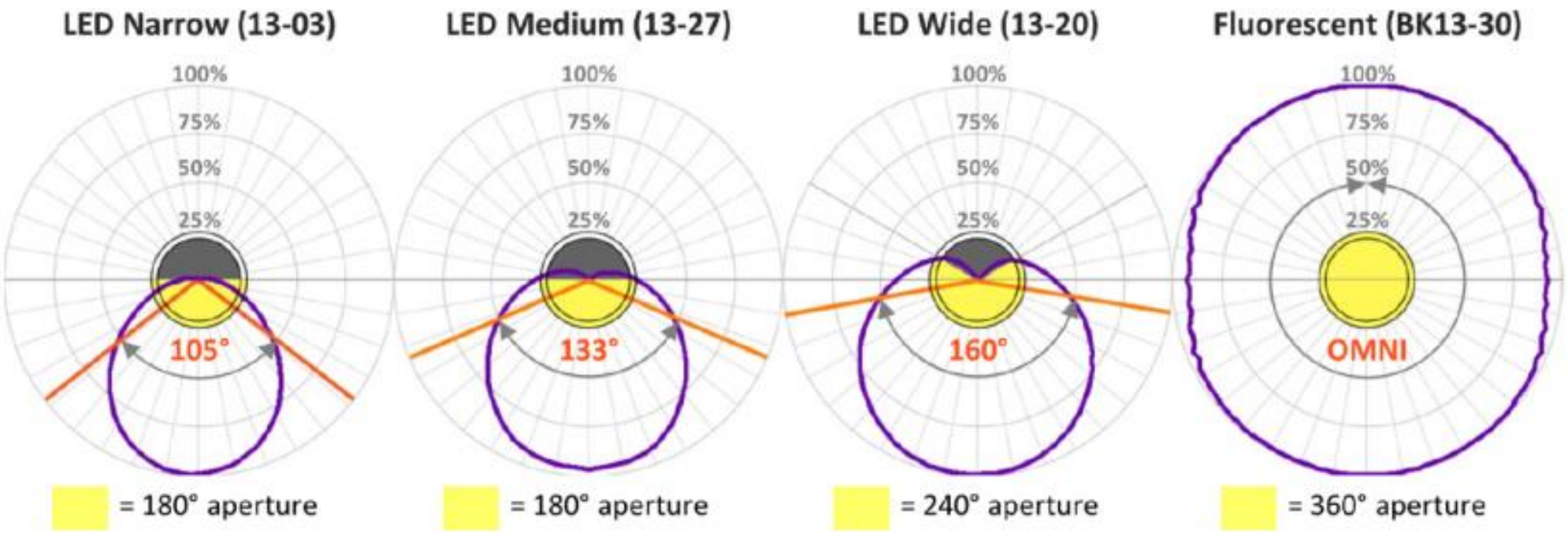
Tube cross section distribution



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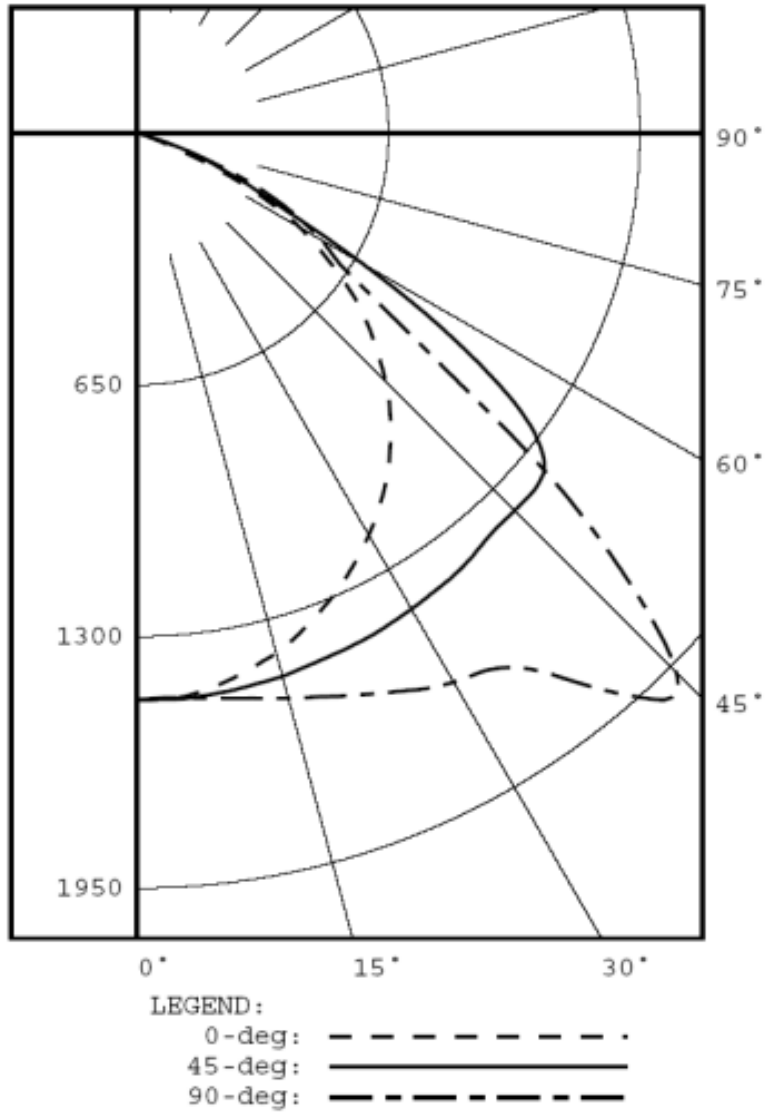
Directionality of TLEDs



Sometimes the directionality of TLEDs can be an **advantage**.

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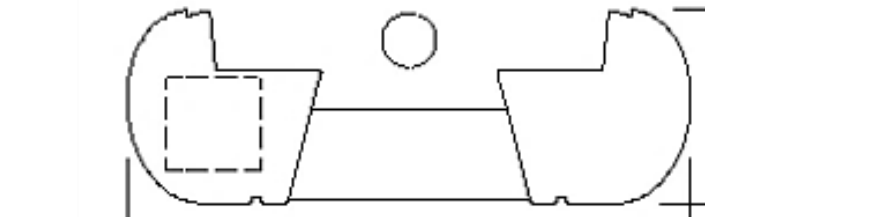
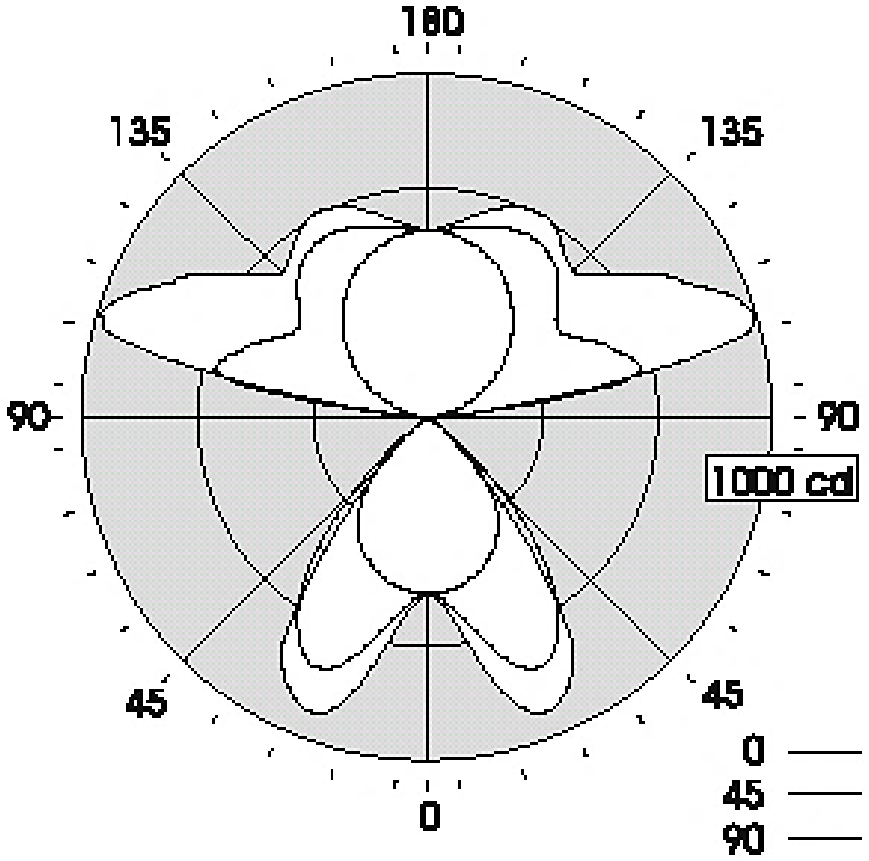
Directionality of TLEDs





Sometimes the directionality of TLEDs can be a **disadvantage**.

TLED- wiring

Tubes- at least 3 variations

No rewiring- Ballast Compatible (BC TLED) product operates through existing ballast (has an integral driver) –**UL Type A**

Rewiring- (TLED) disconnect ballast, and rewire sockets for line voltage (product has an integral driver) –**UL Type B**

Rewiring- remote driver product operates off of a driver external to the tube and may use the sockets.* -**UL Type C**

*When does a “tube” become a “kit”?

Ballast Compatible-TLED –Read the fine print

Compatible with >90% of electronic T8 ballasts, including instant start, programmed start, rapid start and dimmable fluorescent ballasts

Efficacy: 85-105 LPW at system level

Lamp Delivered Light Output: 1700-2100 lumens per LED lamp*

System Power: 20 watts**

Lamp Watts: 18.5**

Application Information

Application Notes

1. Due to numerous ballast designs and topologies, this lamp should be tested on existing ballasts before mass quantities are installed.
2. Not intended for use with older dedicated voltage (120V or 277V) instant start ballasts. These ballasts have electronic components that degrade over time and may become unsuitable for the new LED T8 lamp.

Rewire TLEDs

Eliminates the concerns of ballast compatibility …But

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"…most include an integral driver and are powered directly by mains voltage(120V or even 277V).

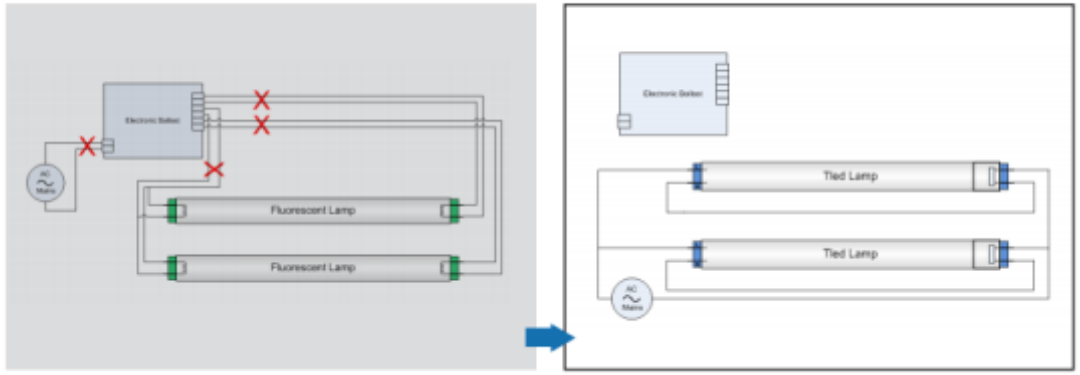
In addition, LED lamps may require power to be connected at one end or both ends—sometimes with an additional wire between opposite pins.

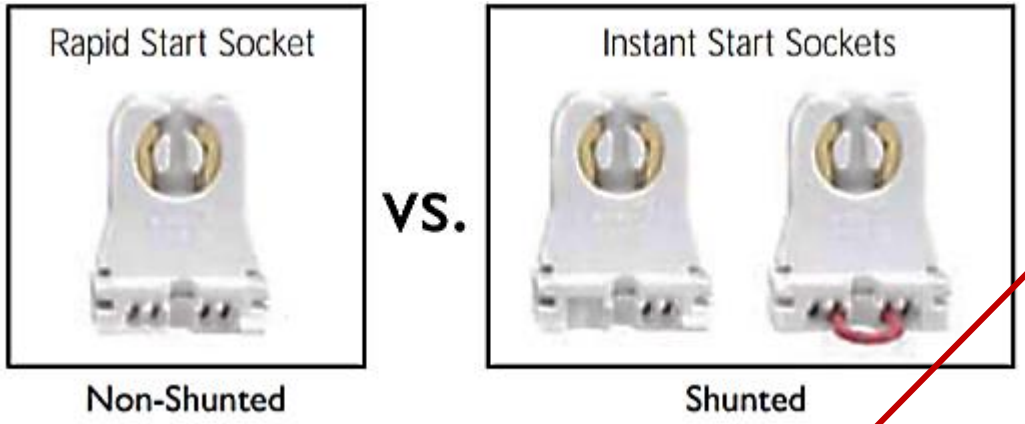
Improper wiring can result in product failure and/or dangerous conditions, such as sparking, smoking, or tripping circuit breakers.

Further, each lamp type may require either shunted or unshunted lamp holders…"

Rewiring and sockets

- Retrofit Luminaire with Two Lamps and one ballast





"Do not use this retrofit kit in luminaires employing shunted bi-pin lamp holders."

"Shunted lamp holders are found only in luminaires w/ instant-start ballasts."

WARNING: To avoid potential fire or shock hazard, do not use this retrofit kit in luminaires employing shunted bi-pin lampholders. Note: Shunted lamp holders are found only in fluorescent luminaires with Instant-Start ballasts. Instant-start ballasts can be identified by the words "Instant Start" or "I.S." marked on the ballast. This designation may be in the form of a statement pertaining to the ballast itself, or may be combined with the marking for the lamps with which the ballast is intended to be used, for example F40T12/IS. For more information, contact the LED luminaire retrofit kit manufacturer.

Remote driver tubes. *Still using the sockets*

The SYLVANIA ULTRA HE LED T8 retrofit kits are an energy saving and longer-life alternative to replace traditional fluorescent T12 or T8 lamps. Compared to traditional fluorescent lamps, ULTRA HE LEDT8 lamps offer higher efficacy and equivalent light output.

Lamp requires dedicated external driver and non-shunted G13 medium bi-pin lamp holders which are included in the retrofit kit.

"Each LED tube is operated by a GE Lightech™ driver. See reverse for LED tubes and Lightech driver product details."

Usually a manufacturer supplied proprietary driver

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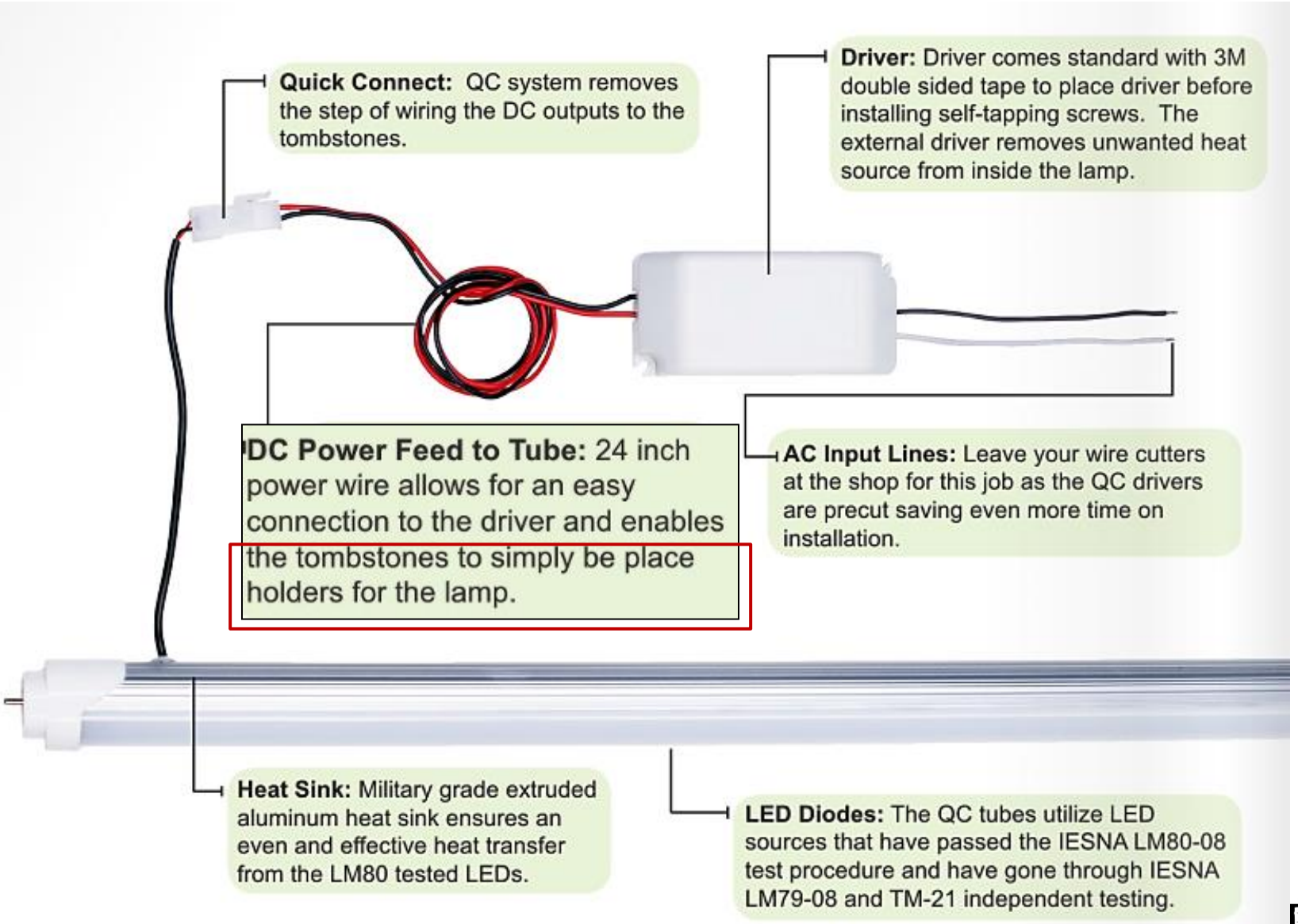
Remote driver tubes Using sockets, but *no power to them*



ESI VISION

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Kits - Basic

Kits

Variations of kits, all have rewired fixtures, and remote drivers

Basic Kit - Replacing just the electrical assembly

Uses existing luminaire optics

UR Series

CREE LED LIGHTING

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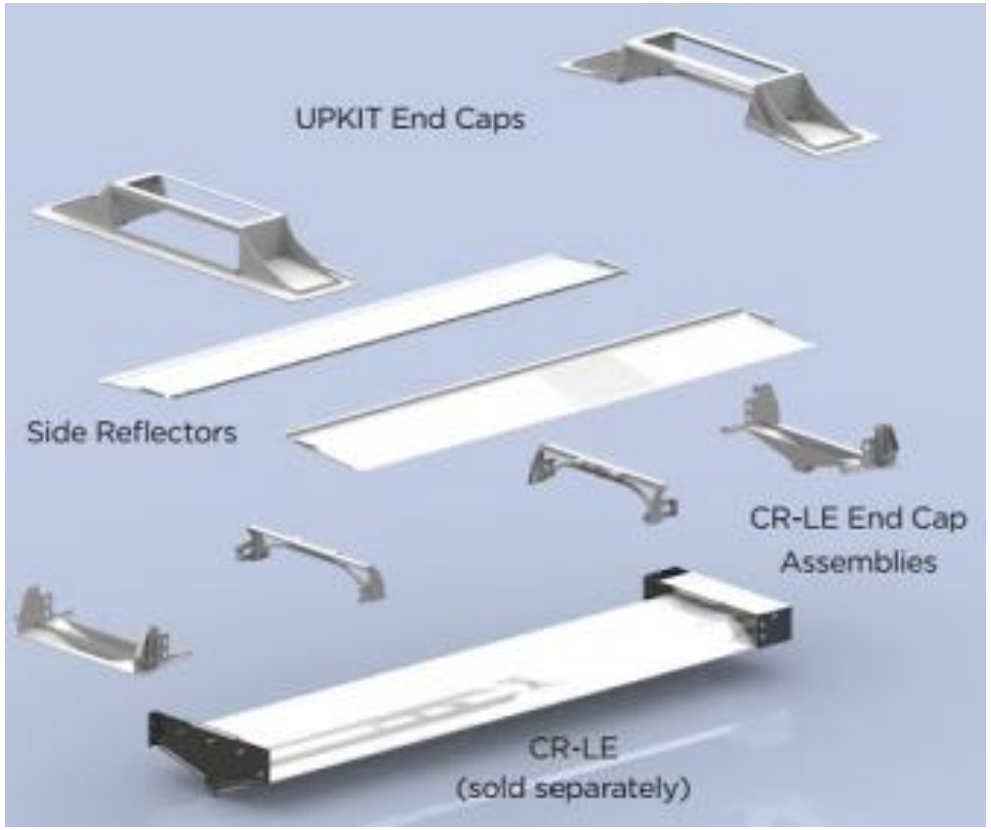
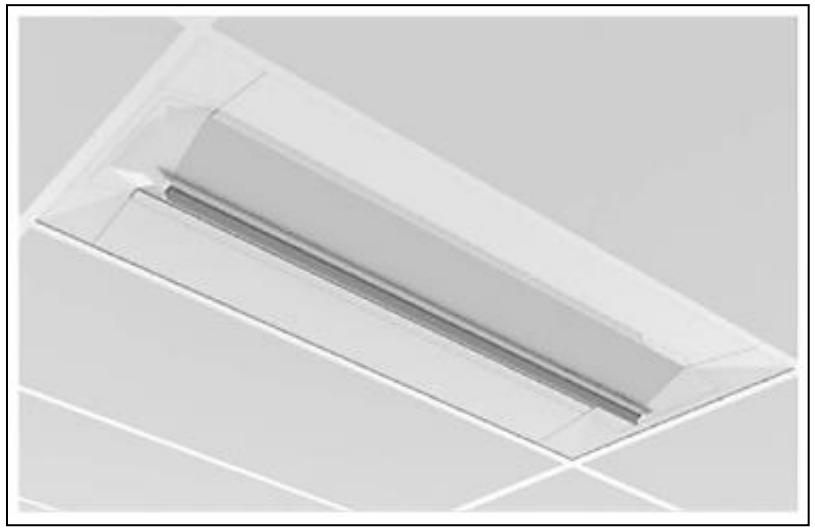
Kits - Complete have new optics

Complete Kit – New electrical assembly and new optical assembly



New optics



lighting design lab

What about a different kind of lighting?

Direct lighting system with recessed luminaires

Indirect lighting system with pendant luminaires

A new fixture gives the opportunity for a fresh modern look.

What are some other advantages to a new fixture?

What is the LED equivalent in **delivered** lumens?

CFL fixture: 83 watt w/ 4-1800 lumen lamps= 7,200

LED-A: 24 watt w/ 2558 lumens

LED-B: 22 watt w/ 1898 lumens

lighting design lab

CFL fixture efficiency – 37%

After the luminaire efficiency is applied to the 7200 lamp lumens then the luminaire lumens= 2660

General
Label: CM1732-4QF26 Tag:
Description: CM1732 Defaults...
Pole or Pendant Mounted
Dynamic: Attach to Z= 0
Static: Length =

Definition
Lumens Per Lamp: 1800 Number Of Lamps: 4
Luminaire Lumens: 2660 Efficiency (%): 37
Luminaire Watts: 83 S/P Ratio: 1
Total LLF: 1.000 Specify...

Luminous Box:	X	Y	Z
LLHC	-0.705	-0.705	-0.25
URHC	0.705	0.705	0.25

Arrangement: SINGLE
Arm Length: 0

Symbols
CIRCLE DOWN LS — Render Mode
Housing
Luminous
CIRCLE DOWN LS — Model Mode
Line Width/Color: Pixel

Photometric File
Description | Classification | LCS

Filename: C:\Users\strande\Desktop\Documents\class presentations\CFL
[TEST] 08017
[TESTLAB] LUMINAIRE TESTING LABORATORY, INC.
[ISSUEDATE] 04-12-2004
[MANUFAC] VISA LIGHTING
[LUMCAT] CM1732
[LUMINAIRE] FORMED ALUMINUM HOUSING, FORMED WHITE ENAM
[LAMPCAT] GE F26DBX/SPX35/4P
[LAMP] FOUR HORIZONTAL 26 WATT DOUBLE TUBE COMPACT FLUC
[BALLAST] TWO AC ELECTRONICS TP2/26RS UV

IESNA:LM-63-2002

Candela LCS
More...

lighting design lab

LED A lists “source lumens”

We don’t know what the luminaire efficiency is.

LED PERFORMANCE - 3500K STANDARD
120-277V - 3500K, 82 CRI - L80 rating - 60,000 hrs - L70 rating (projected) - 100,000 hrs
Amperage rated @ 110V input
Operating ambient temperature: -20°C / -4°F - 40°C / 104°F

Standard 3500K source lumens noted. Consult Brownlee.com for performance of all CCTs.
B6LED - 6W nominal, .05 A input - 698 lm - 114 lm/W
B12LED - 12W nominal, .10 A input - 1422 lm - 120 lm/W
C9LED - 9W nominal, .10 A input - 1072 lm - 122 lm/W
C17LED - 17W nominal, .15 A input - 1829 lm - 111 lm/W
C24LED - 24W nominal, .20 A input - 2558 lm - 107 lm/W
C37LED - 37W nominal, .30 A input - 3837 lm - 104 lm/W
C49LED - 49W nominal, .40 A input - 5116 lm - 107 lm/W

LED B lists “delivered lumens”

Performance	
Input Wattage	21.8
Input Voltage Range (V)	120
Delivered Lumens (lm)	1898
Efficacy (lm/W)	87.0
Color Rendering Index (CRI)	80
Color Temperature (CCT)	3000
Equivalent Wattage	100W Inc.
Beam Angle	0
Power Factor	0.00
MAX THD (%)	0
Min. Ambient Temp (°F)	0
Max. Ambient Temp (°F)	104

Luminaire lumens or Delivered lumens are derived from absolute photometry

Luminaire lumens

Model Number: ML2LA17SABNIP827

LED lighting facts®
A Program of the U.S. DOE

Maxlite

Light Output (Lumens)	1100
Watts	17.6
Lumens per Watt (Efficacy)	62.5
Color Accuracy	
Color Rendering Index (CRI)	80

Light Color
Correlated Color Temperature (CCT) **2700 (Warm White)**

Warm White | Bright White | Daylight

2700K 3000K 4500K 6500K

All results are according to IESNA LM-79-2008: *Approved Method for the Electrical and Photometric Testing of Solid-State Lighting.* The U.S. Department of Energy (DOE) verifies product test data and results.

Visit www.lightingfacts.com for the *Label Reference Guide.*

Registration Number: WJP2-JKQK4M (6/15/2015)
Model Number: ML2LA17SABNIP827
Type: Luminaire - Other

design lab

Know your light source.- LED- Integral Lamp
Not just Lumens or Lumens per watt

~ 75+ Lumens per watt*

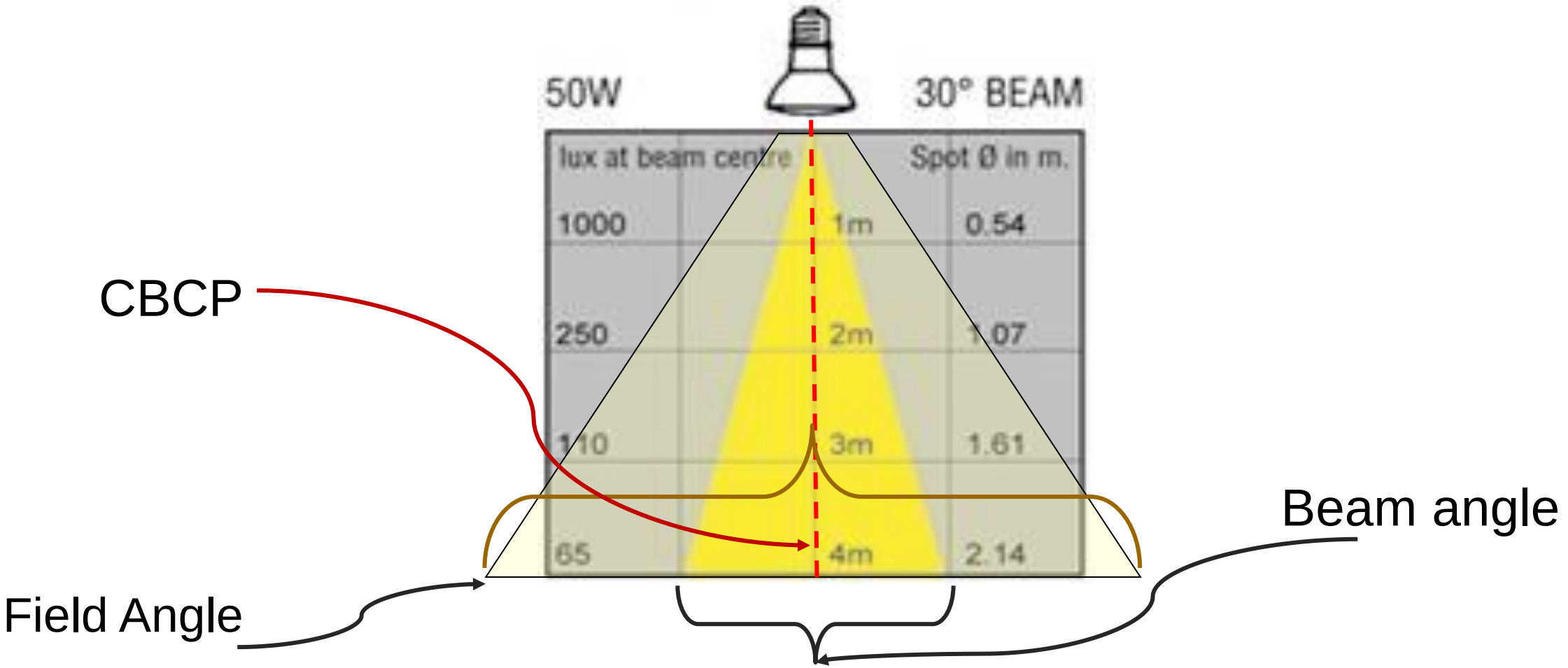
~ 95+ Lumens per watt

*CBCP and Beam Angle can be the most relevant quantities

lighting design lab

Beam Angle- The angle at which the light drops 50% from the CBCP

Field Angle- The angle at which the light drops to 10% (not used much)

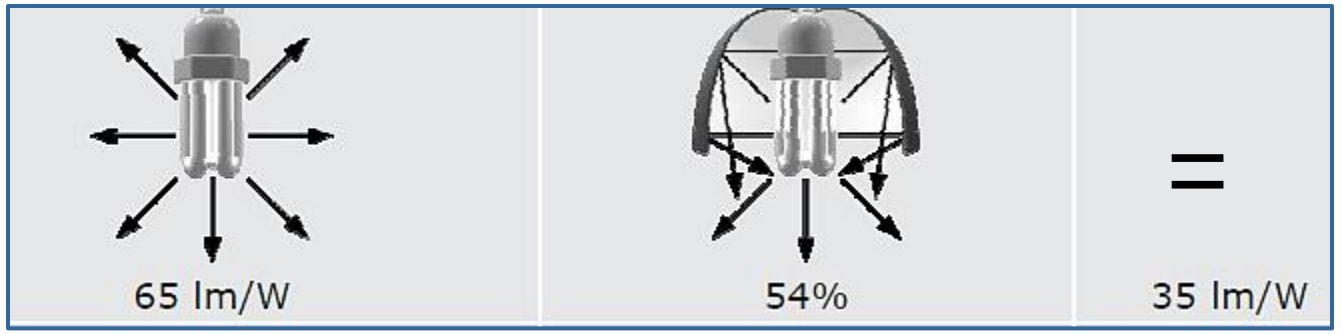


lighting design lab

Omni-directional lamps in recessed cans.

Some recessed cans are designed for omni-directional lamps. In this case it is the trim that shapes the light and contributes greatly to the optical properties and luminaire efficiency

It may not have been such a good idea anyway…



CFL recessed cans may lose 40% of light or more due to inefficiency.

lighting design lab

CFL to LED Retrofit

Potentially a "great fit"

Taking an omnidirectional lamp out of a usually marginal optical system and putting in a directional lamp

Replacing a 12K hr lamp w/a 50K lamp

26 watt ~= 13 (14.5) watt

But…

lighting design lab

But… CFL to LED replacement- Check compatibility

"**LED** replacement for CFL plug-in. LED plug-in lamps allow you to replace inefficient CFL 4 pin G24q/GX24 without tools or costly upgrades. **Simply plug the replacement lamp into the existing ballast.**"

lighting design lab

Last Updated
9/1/2015

GE LED Plug-In (4-pin) Ballast Compatibility List

IMPORTANT NOTICE. This list is based in part on information provided by the ballast supplier, and testing was done on a stable AC power supply under laboratory, which may not be representative of your particular end-use conditions. While each ballast type listed has undergone testing, some have undergone revisions that may change operating parameters and impact lamp performance. Applications and conditions of use are many and varied and beyond GE's control, so purchasers and users should make their own determinations as to the suitability of a lamp-ballast combination for their own particular application and use. Compatibility may also extend to ballasts beyond this list, so performing an on-site test before installation is recommended.

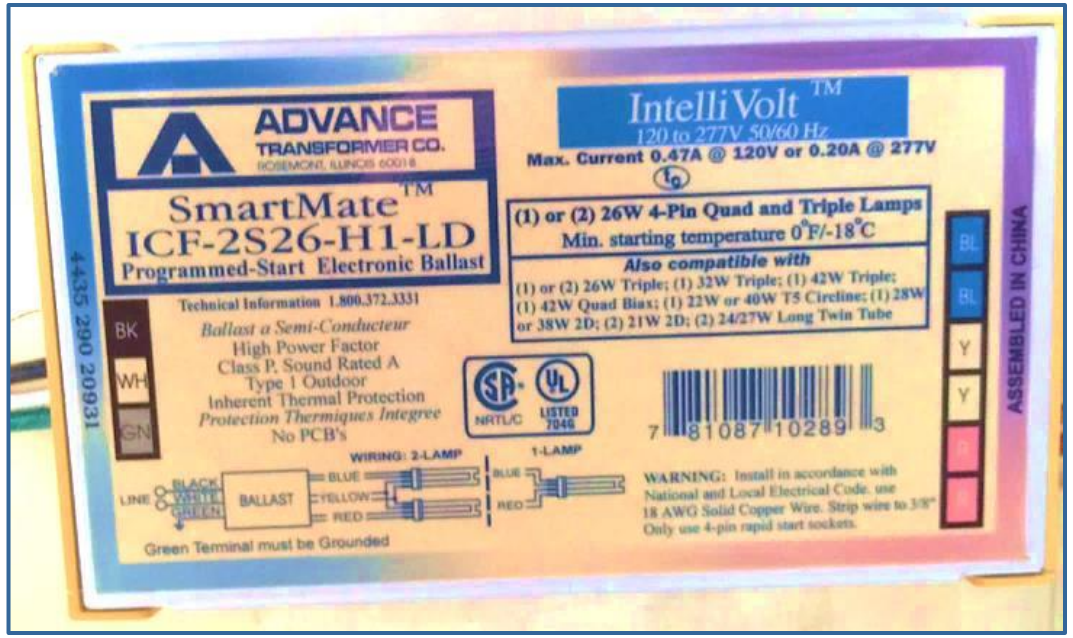
Ballast		One Lamp		Two Lamp	
		120V	277V	120V	277V
Advance	ICF-2S26-M1-BS				
Advance	ICF-2S26-H1-LD*				
Advance	ICF-2S13-H1-LD*				
Advance	ICF-2S18-H1-LD*				
Advance	ICF-2S18-M1-BS*				
Advance	IZT-2S26-M5-LD*				
Advance	ICF-2S26-M1-BS-QS*				
GE Proline	GEC226-MVPS-BES				
GE Proline	GEC226-MVPS-3W				
GE Proline	GEC226-MVPS-SE				
GE	GEC218-MVPS-3W				
GE	GEC218-MVPS-BES				
GE	GEC213-MVPS-3W				
Hatch	HC213PS/UV/D				
Hatch	HC226PS/UV/D				
Howard	EP2/18CF/MV/2				
Howard	EP2/26CF/MV/2				
LumaPro	4KGJ7				
LumaPro	16X954				
LumaPro	16X959				
LumaPro	4KGJ8				
Robertson	PSM226CQMVDWCE				
Sylvania	QTP 2x26CF/UNV S PEM				
Sylvania	QTP 2X26CF/UNV DM				
Sylvania	QTP 1/2x18CF UNV DM*				
Triad	C2642UNVSE				
Triad	C2642UNVME				
Triad	C218UNVME				

Compatible Not compatible

*compatibility may vary per revision

Information is subject to change without notice

Its supposed to work…



lighting design lab

Humm…

IMPORTANT NOTICE. This list is based in part on information provided by the ballast supplier, and testing was done on a stable AC power supply under laboratory, which may not be representative of your particular end-use conditions. While each ballast type listed has undergone testing, some have undergone revisions that may change operating parameters and impact lamp performance. Applications and conditions of use are many and varied and beyond GE's control, so purchasers and users should make their own determinations as to the suitability of a lamp-ballast combination for their own particular application and use. Compatibility may also extend to ballasts beyond this list, so performing an on-site test before installation is recommended.

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Advance	ICF-2S26-H1-LD*				
Advance	ICF-2S13-H1-LD*				
Advance	ICF-2S18-H1-LD*				
Advance	ICF-2S18-M1-BS*				
Advance	IZT-2S26-M5-LD*				
Advance	ICF-2S26-M1-BS-QS*				

The ESL Vision LED PL Series is the perfect replacement for high maintenance compact fluorescent lamps. ESL Vision's PL series features 110 lumen per watt, 85 CRI, and a wide range of bases to work in an array of applications.

Applications:

- Horizontal Base Recessed Cans
- Wall Sconces
- Ceiling Mounted Standard Base (E26) Fixtures

Features:

- Up to a 75% Energy Savings
- Compatible with Most Fluorescent Ballasts*
- Rotatable Bases
- Up to 110 Lumens per Watt
- 85+ CRI
- Mercury Free
- 5 Year Warranty
- Maintenance Free

7 Watt Side View | 7 Watt Front View | 9 Watt Front View | 11 Watt Front View

*For maintenance and energy savings reasons ESL Vision recommends bypassing all ballasts for permanent operation

*For maintenance and energy savings reasons ESL Vision recommends bypassing all ballasts for permanent operation

There is always some fine print.

lighting design lab

What about a retrofit “kit”? What has changed?*

*Note the lens

lighting design lab

CFL replacement products.
Wire in, recessed light source.

Improved optics, LED advantages

lighting design lab

The HID Opportunity- 2% of the sockets, 26% of the lighting energy in US

Mogul based HID lamps are used in a mere 2% of lamp sockets in the US, but in 2010 HID lamps used 26% of the lighting energy in the United States and are second only to linear fluorescent lamps for lighting consumption. *

***Mogul based LED replacement lamp study**
Conducted by the Lighting Research Center, Rensselaer Polytechnic Institute
Prepared for Bonneville Power Administration and Washington State University Energy Program

lighting design lab

Optics- built around a point source

Point source = Metal halide

Glare control
- High degree possible
- High degree ***needed***

Distribution
- High precision possible

Infrastructure investment

Luminaire efficiency
- Influences system lumens and delivered light

lighting design lab

Brightness and size

This is not strictly the case with LEDs.
But there is a relationship, so higher lumen needs, usually result in a larger size.

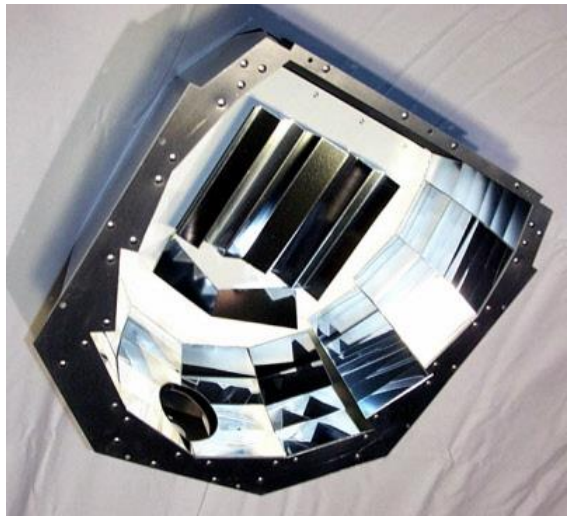
~760 lumens
7 watt

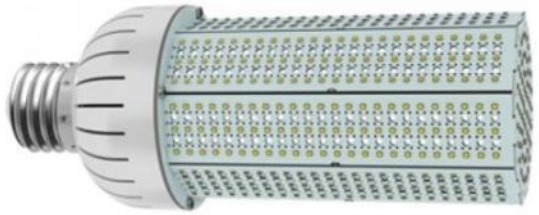
10X

~7800 lumens
75 watts

lighting design lab

Different HID optical systems





lighting design lab

Reflector and lens type

Translucent

Solid

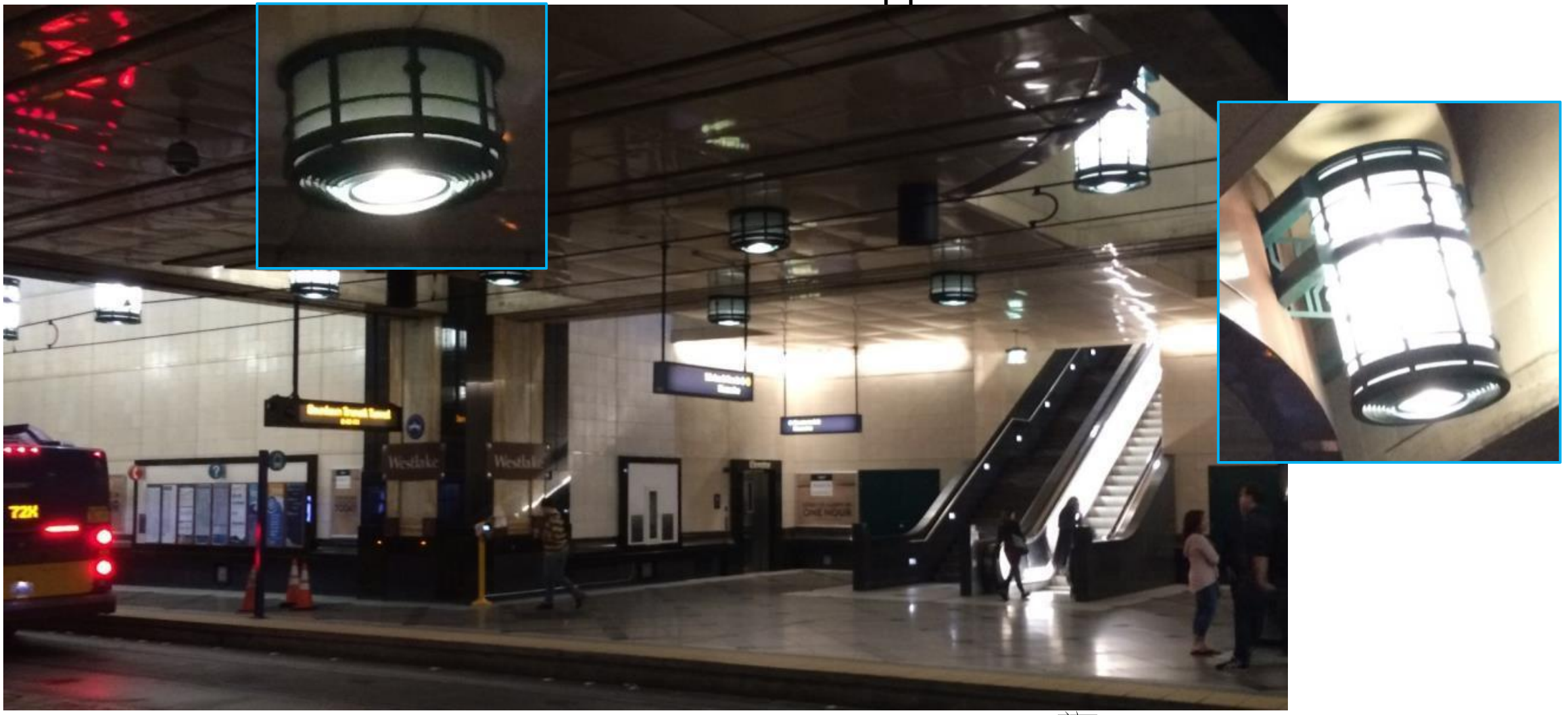
lighting design lab

Directional lamp vs omni directional.

In some cases it may not matter.

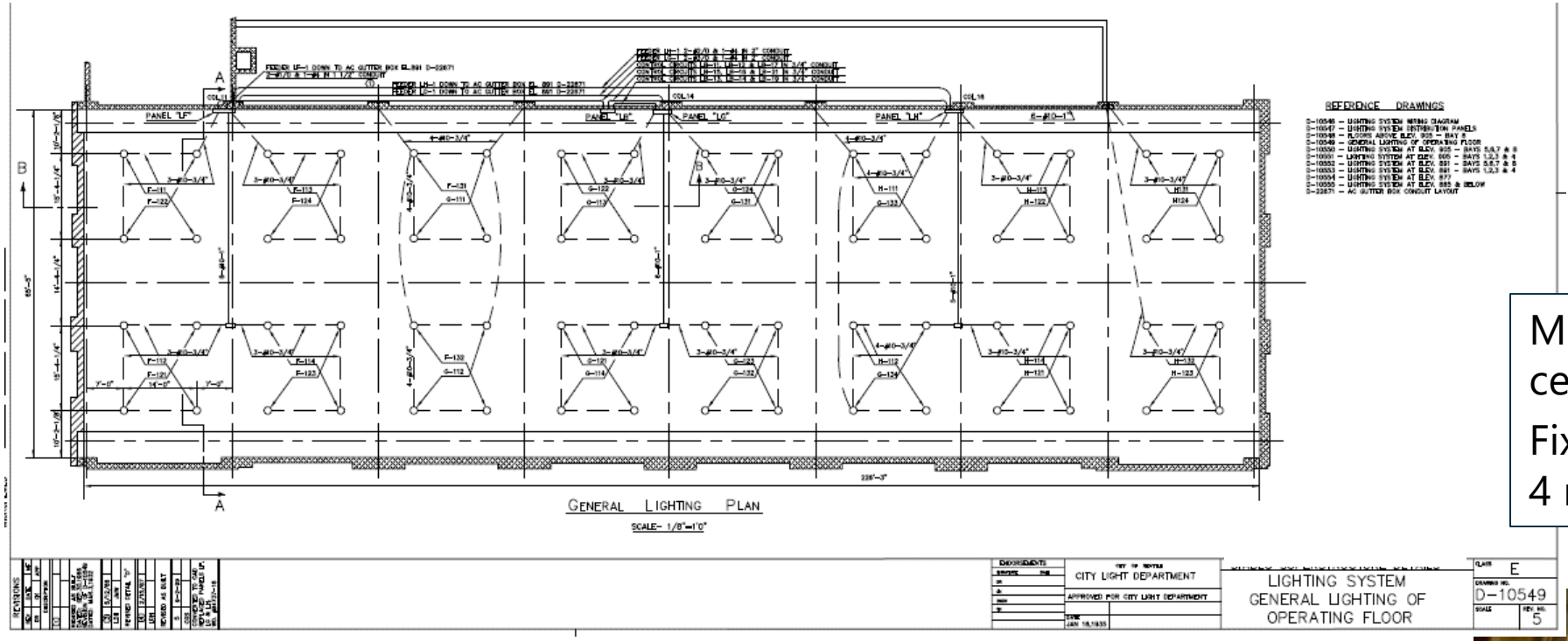
Directional retrofit for an omnidirectional decorative fixture

Sometimes appearance does matter.



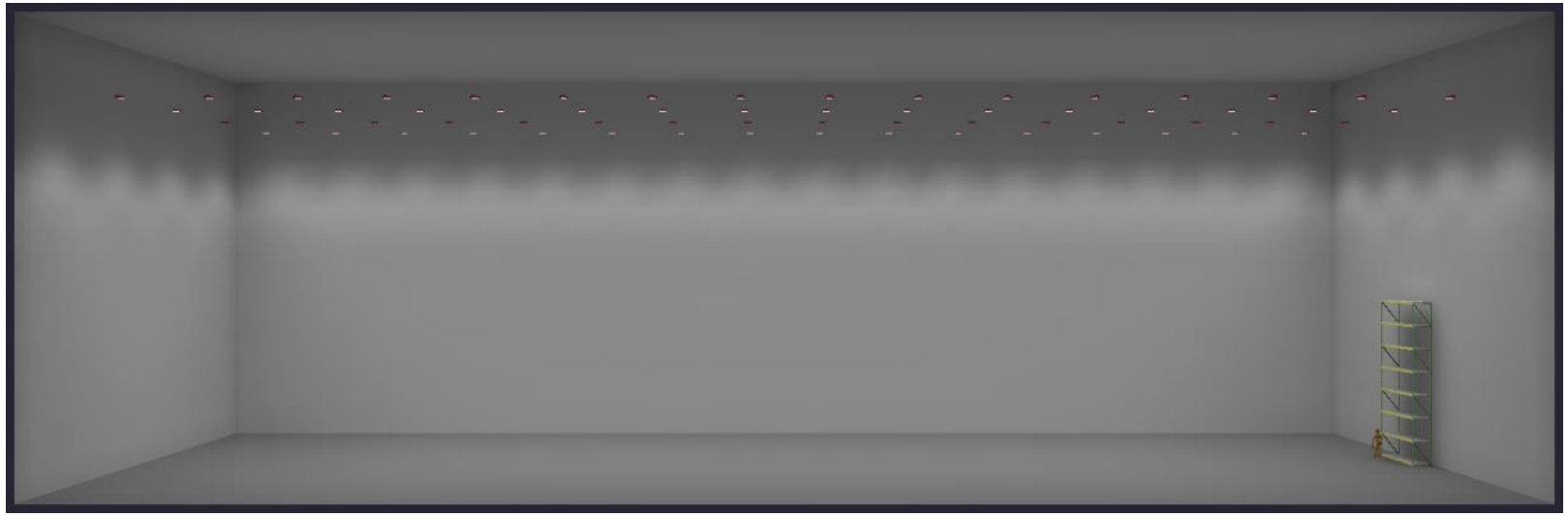
lighting design lab

Industrial retrofit case study



Model is 226’ x 65’ with 72’ ceiling (est. from plans)

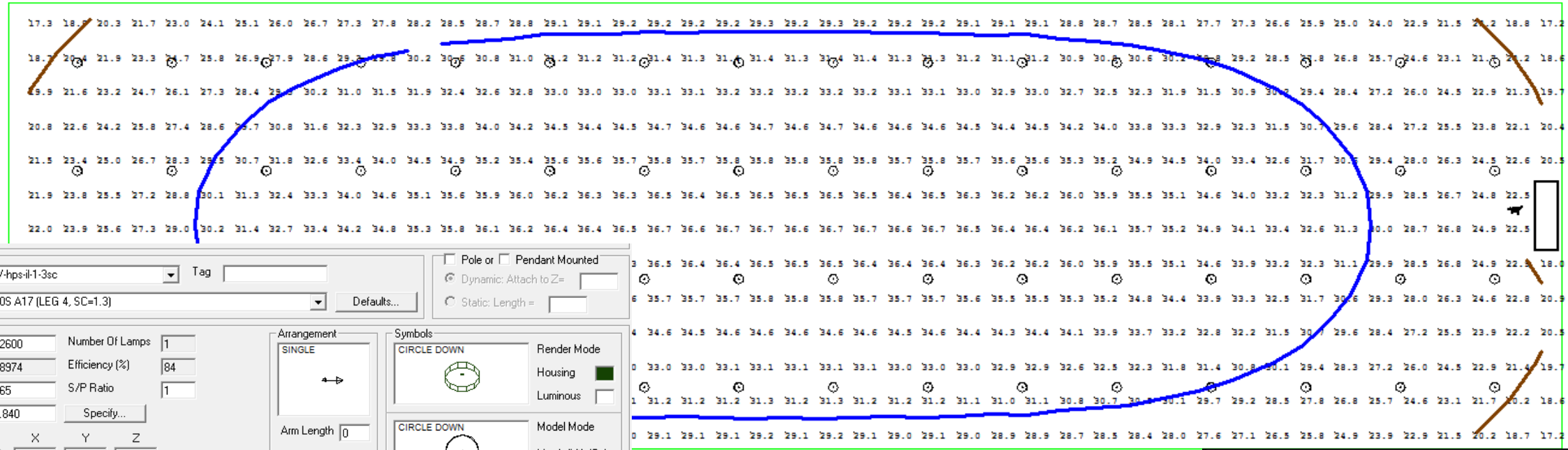
Fixtures mounted at 61’ (est.) in 4 rows of 16 per plans

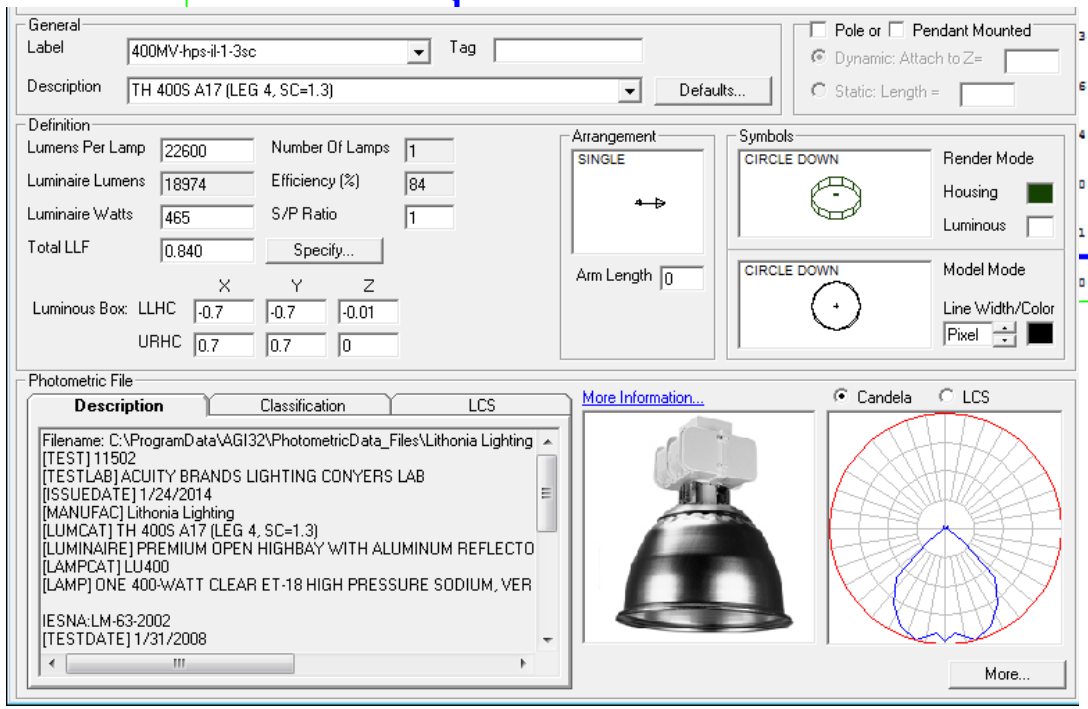


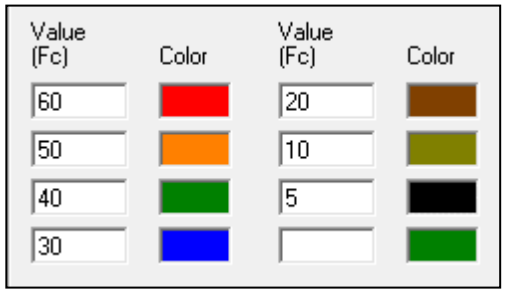
lighting design lab

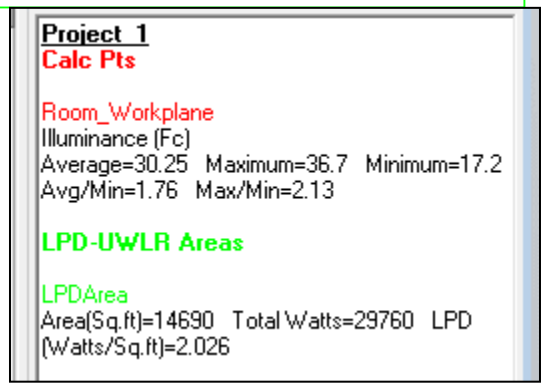
Model summary
Mercury Vapor

Fixture	Wattage	Avg FC*	Max/Min	LPD	Fixture quantity	Notes
Merc. Vapor	400 / 465	30	2.1 : 1	2.0	64	Luminaire= 84% efficient





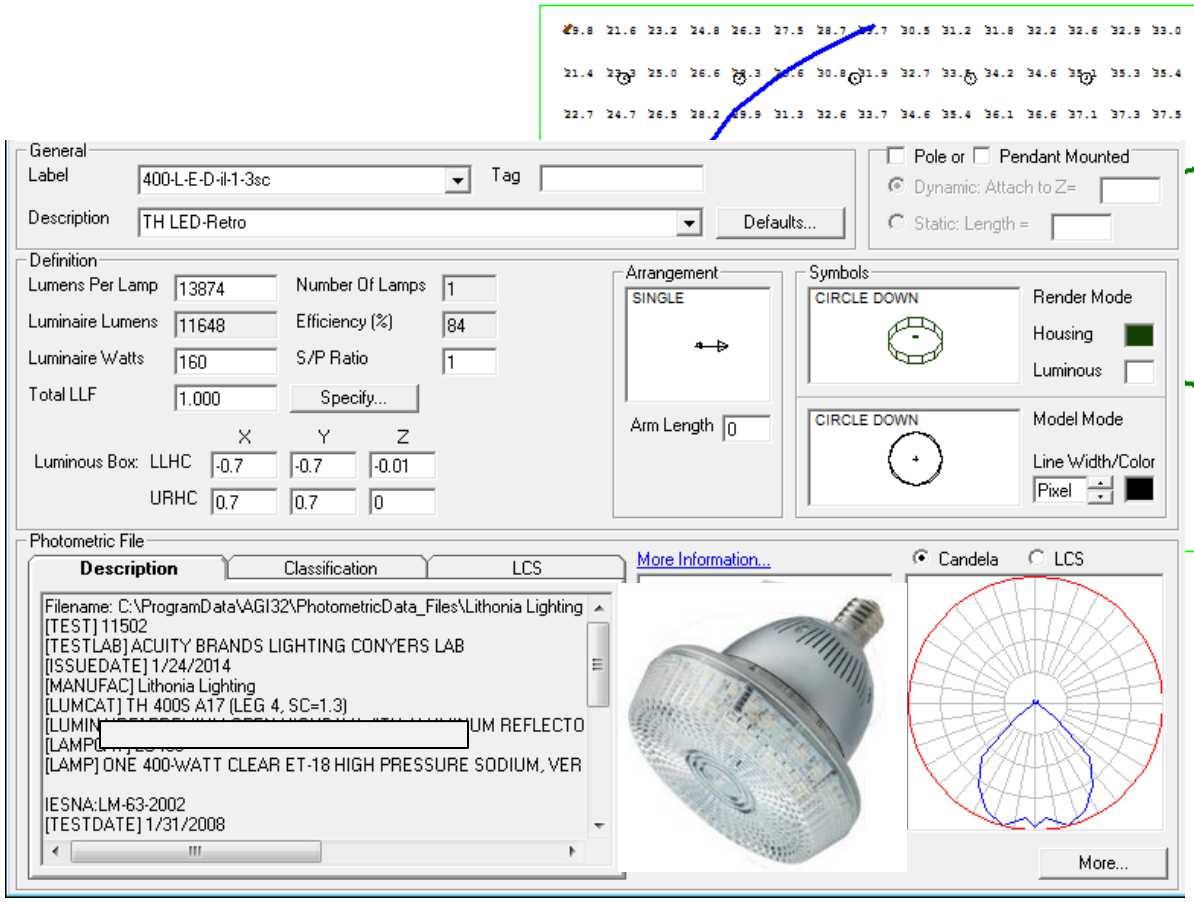


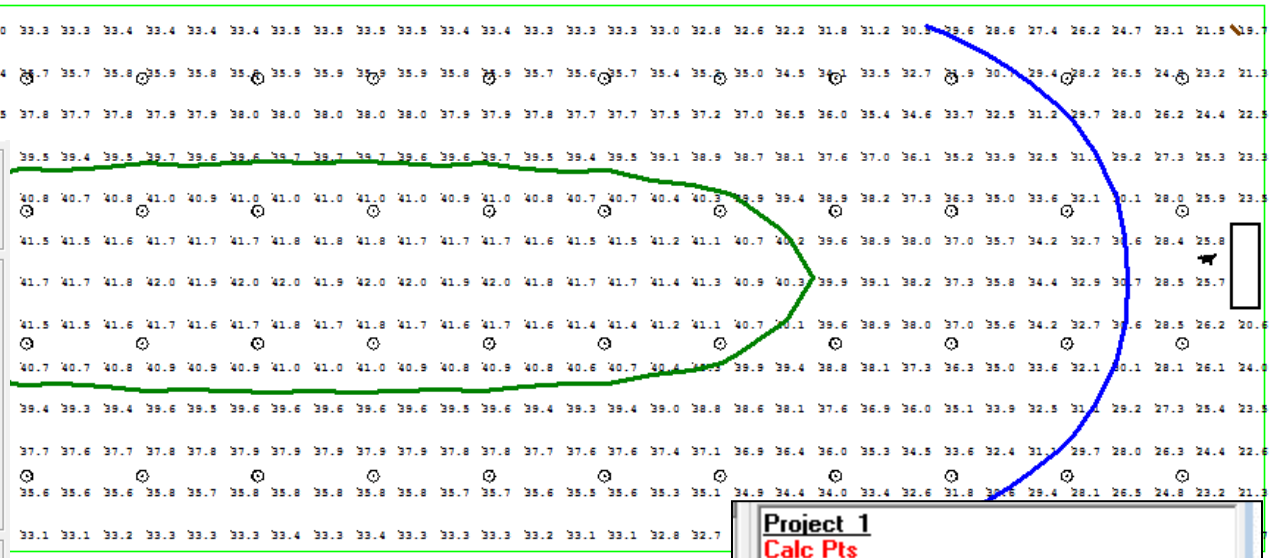


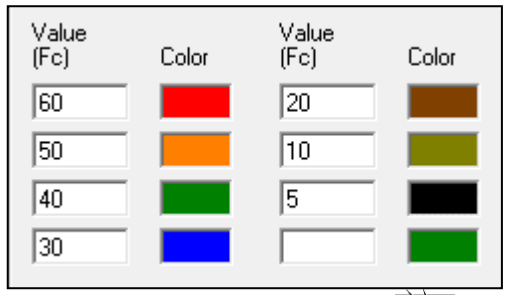
lighting design lab

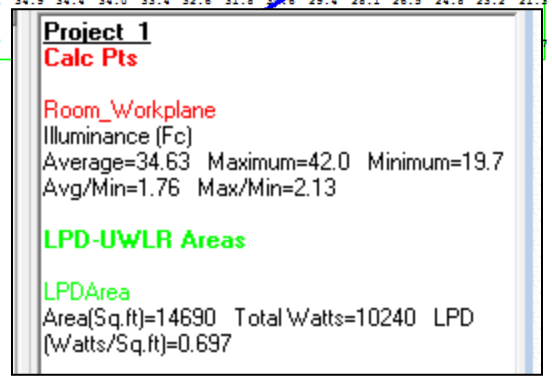
Model summary Light Efficient Design- Fixture retrofit

Fixture	Wattage	Avg FC*	Max/Min	LPD	Fixture quantity	Notes
Merc. Vapor	400 / 465	30	2.1 : 1	2.0	64	Luminaire= 84% efficient
Light Efficient Dsgn.	160	35	2.1 : 1	0.7	64	**Retrofit existing.** Luminaire= 84% efficient





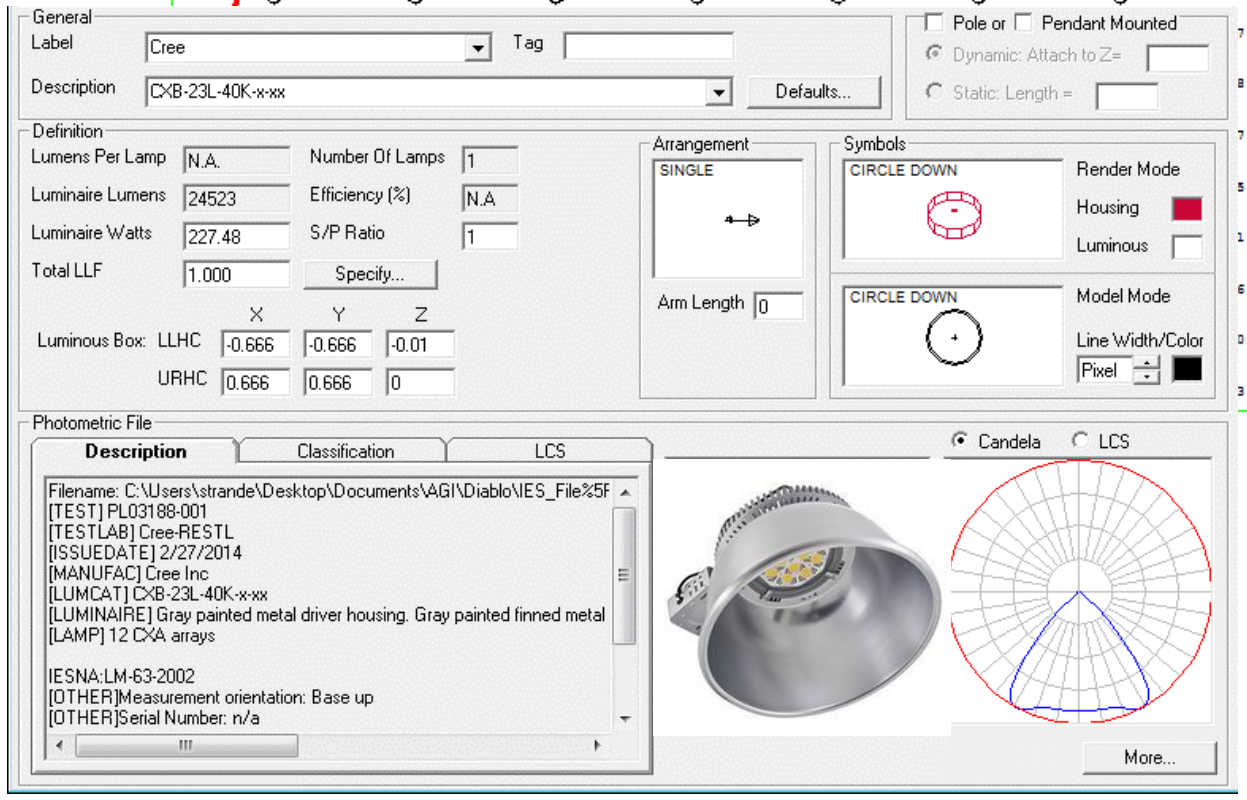


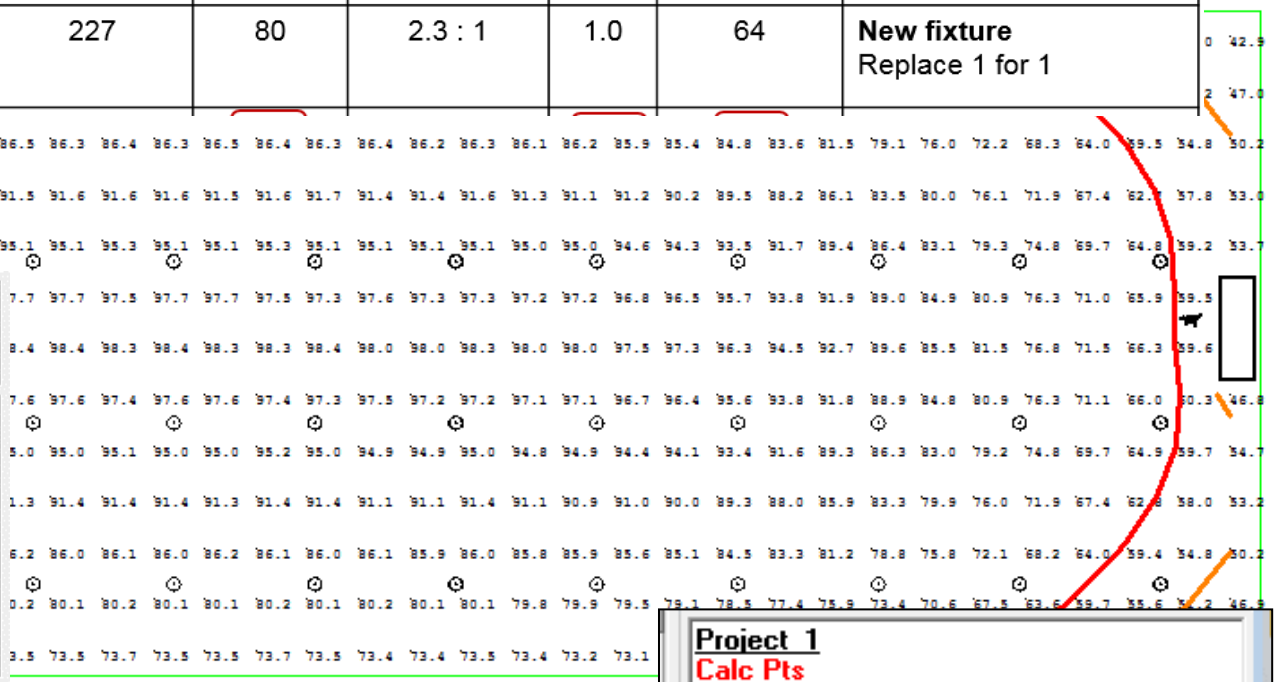


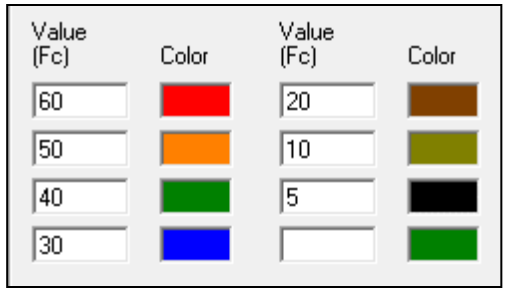
lighting design lab

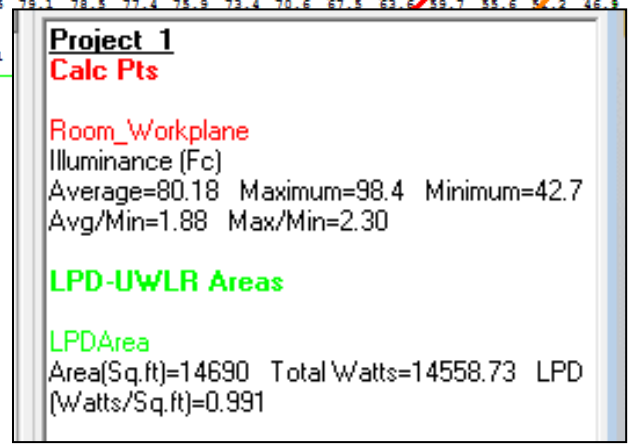
Model summary Cree CXB- New fixtures 1 for 1 = **64** fixtures

Fixture	Wattage	Avg FC*	Max/Min	LPD	Fixture quantity	Notes
Merc. Vapor	400 / 465	30	2.1 : 1	2.0	64	Luminaire= 84% efficient
Cree- CXB	227	80	2.3 : 1	1.0	64	**New fixture** Replace 1 for 1









lighting design lab

Model summary- Industrial retrofit case study

Fixture	Wattage	Avg FC*	Max/Min	LPD	Fixture quantity	Notes
Merc. Vapor	400 / 465	30	2.1 : 1	2.0	64	Luminaire= 84% efficient
Light Efficient Dsgn.	160	35	2.1 : 1	0.7	64	**Retrofit existing.** Luminaire= 84% efficient
DEG-LED	220	40	2.0 : 1	0.96	64	**Retrofit existing.** Luminaire= 100% efficient
Cree- CXB	227	80	2.3 : 1	1.0	64	**New fixture** Replace 1 for 1
Cree- CXB	227	42	2.2 : 1	0.53	34	**New fixture** Eliminate ~ 50% of existing fixtures

64x$300= $19,200

34x$550= $18,700

lighting design lab

Pop Quiz- Before doing a LED lamp only retrofit, always check to see which of the following?

- That the fixture is in good shape.
- That the lamp is compatible with the electronics (ballasts and existing controls).
- That the optics are appropriate.
- That the utility is agreeable.
- That the customer has enough money…

lighting design lab

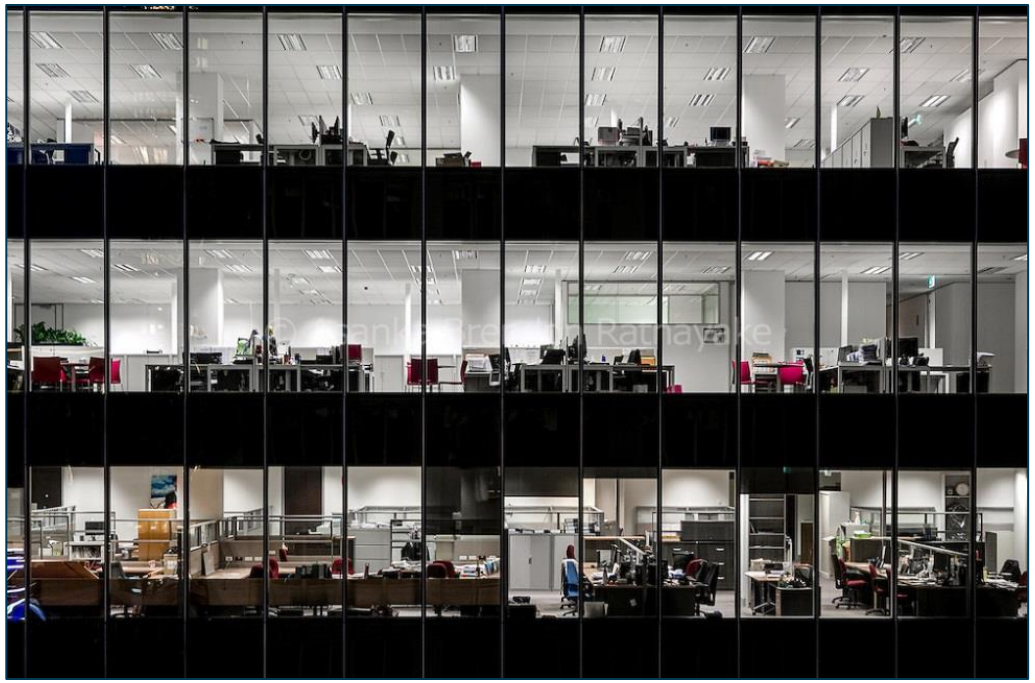
Luminaire Level Lighting Control (LLLC) and Networked Lighting Control (NLC)

Presented by Eric Strandberg LC

Courtesy; Acuity, Enlighted

lighting design lab

Why use lighting controls at all?

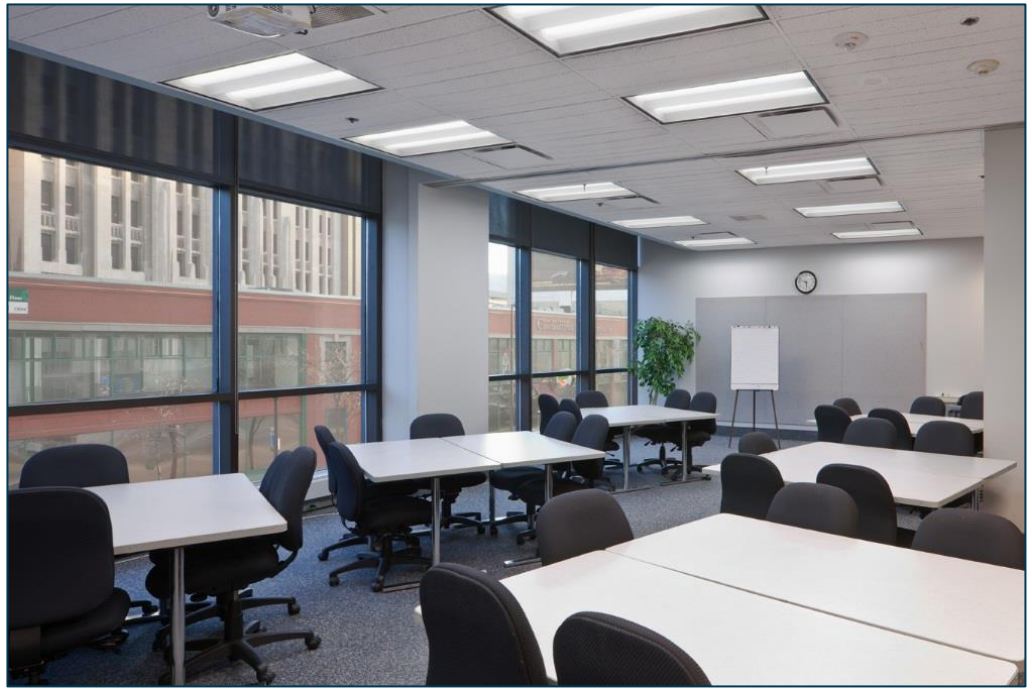


Save energy costs

Save on maintenance cost

lighting design lab

Which lights to control and how?



It shouldn't be all or nothing.

lighting design lab

Is this space “occupied”

- Lights on when occupied.
- What is wrong with this picture?

Is this space lit?

Productivity and security are important factors

lighting design lab

Varying tasks and a variety of lighting conditions.

Intensity

Occupancy

Daylight

Preference

Tasks

lighting design lab

What kinds of control?

On/Off switches

Manual dimmers

Occupancy sensors

Daylight sensors

Time clocks

lighting design lab

Setting a wall box device

So simple, **just one button**

OPERATIONAL SETTINGS

NOTE: (*) Indicates factory default (unless otherwise marked)

2 = Occupancy Time Delay

Time sensor keeps lights on after last occupancy detection.

1 30 sec **4** 7.5 min **7** 15.0 min **10** 30.0 min
2 2.5 min **5** 10.0 min* **8** 17.5 min
3 5.0 min **6** 12.5 min **9** 20.0 min

For additional time settings, contact technical support at 1.800.PASSIVE

3 = On Mode

Automatic On turns lights on when occupancy is detected. Manual On requires a button press to turn the lights on. Reduced Turn-On directs the sensor to only detect large motions, such as a person entering a room. Weaker signals, such as reflections from glass, are ignored. Once lights are on, the sensor returns to maximum sensitivity.

1 Automatic On* **2** Manual On** **3** Reduced Turn-On

* *Standard Factory Default*
** *Factory Default for -SA and -NL versions*

4 = Switch Modes

These modes dictate switch functionality. Pressing the button in Override Off mode (setting 1) turns off and keeps lights off until pressed again. Disabling the Switch (setting 2) prevents the button from turning the lights on.

Predictive Mode (setting 3) automatically determines if a user has left the room after the lights are switched off. It does this by monitoring the space for a period after the button is pressed (Predictive Grace Time), following a certain delay (Predictive Exit Time). If occupancy is detected the device will disable auto-on and hold the lights off until manually switched. If no occupancy is detected the sensor instantly reverts to auto-on mode. (continued next column)

If Predictive Mode with Expiration (setting 4) is enabled, once the sensor has disabled auto-on it will continue to monitor the space. When no occupancy is detected for a duration equal to the occupancy time delay, the sensor will revert to auto-on mode.

1 Override Off **
2 Switch Disable
3 Predictive Mode
4 Predictive Mode with Expiration*

* *Standard Factory Default*
** *Factory Default for -SA and -NL versions*

5 = Photocell Set-Point

The ambient light level at which the sensor prevents the lights from initially turning on. Once on, the lights will remain on until the occupancy time delay expires and turns them off.

1 Disabled* **6** 4 fc
2 Auto Setpoint **7** 8 fc
3 0.5 fc **8** 16 fc
4 1 fc **9** 32 fc
5 2 fc **10** 64 fc

Note: Sensor will be changed to Automatic On mode if photocell is enabled. Photocell not present in -NL versions. LED flashes while Auto-Setpoint mode is running.

7 = LED Operation

Indicates behavior of device's LED.

1 Occupancy Indication* **3** Disabled
2 Relay Indication **4** Override On***

Standard Factory Default* * *Factory Default for -NL version*

9 = Restore Factory Defaults

Returns all functions to original settings.

1 Maintain Current* **2** Restore Defaults

after each switch on, met, lights resume

5 60 min

od

urn off that they can be

15 sec*

12 = Dual Technology (Microphonics™)

Relative responsiveness of Microphonics detection. Included in -PDT versions only.

1 Normal* **3** Medium **5** Phase Off
2 Off **4** Low (15-10-5 min)

13 = Microphone Grace Period

Time period after lights are automatically turned off that they can be voice reactivated. Included in -PDT versions only.

1 0 sec **3** 20 sec **5** 40 sec **7** 60 sec
2 10 sec* **4** 30 sec **6** 50 sec

15 = Predictive Mode Exit Time

Time period after manually switching lights off for occupant to leave the space.

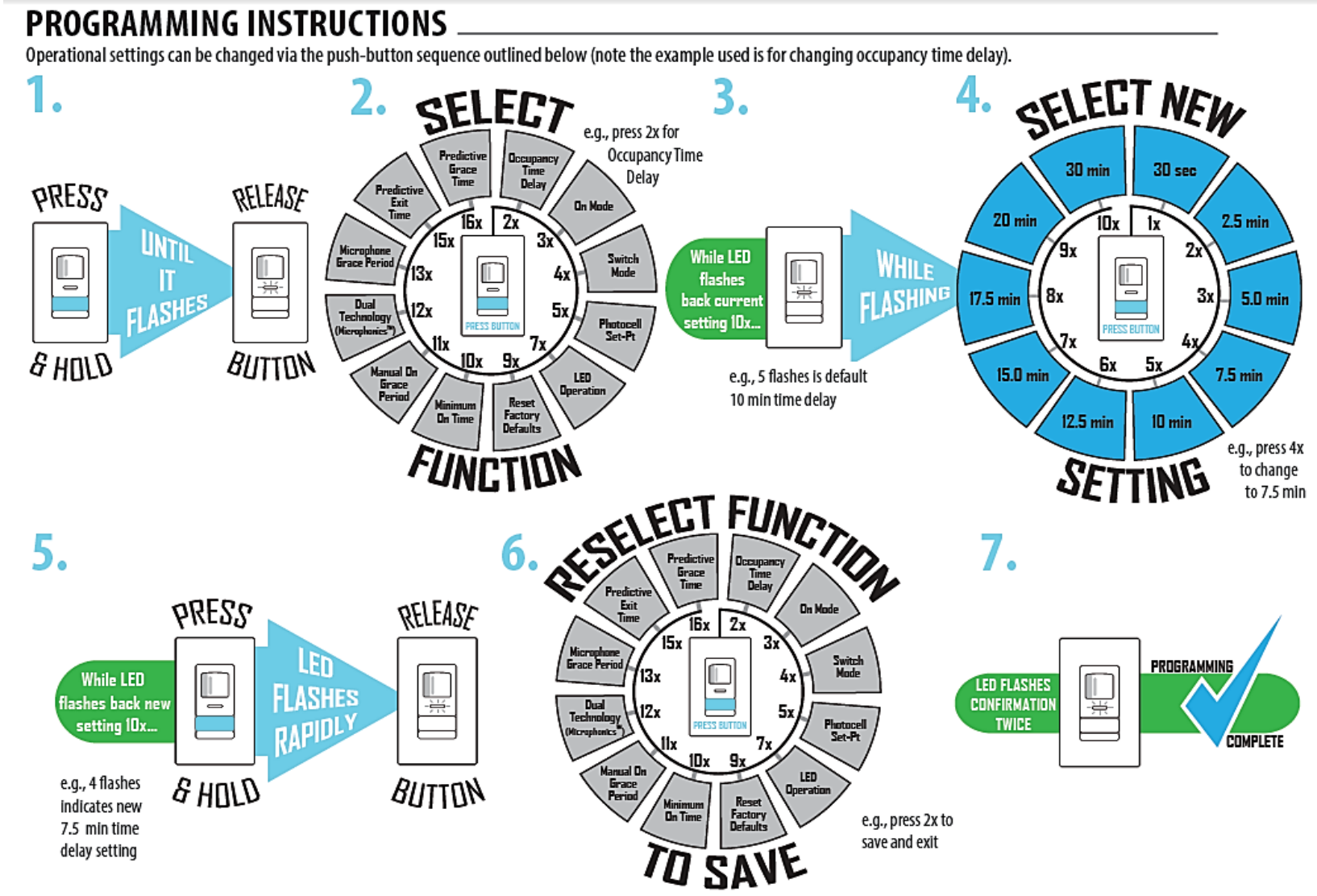
1 5 sec **3** 7 sec **5** 9 sec **7** 15 sec **9** 30 sec
2 6 sec **4** 8 sec **6** 10 sec* **8** 20 sec

16 = Predictive Mode Grace Time

Time period after Predictive Mode Exit Time that sensor rescans the room for remaining occupants.

1 0 sec **3** 10 sec **5** 30 sec* **7** 50 sec
2 5 sec **4** 20 sec **6** 40 sec **8** 60 sec

Programing *each* occupancy sensor



There is only one button to do everything…

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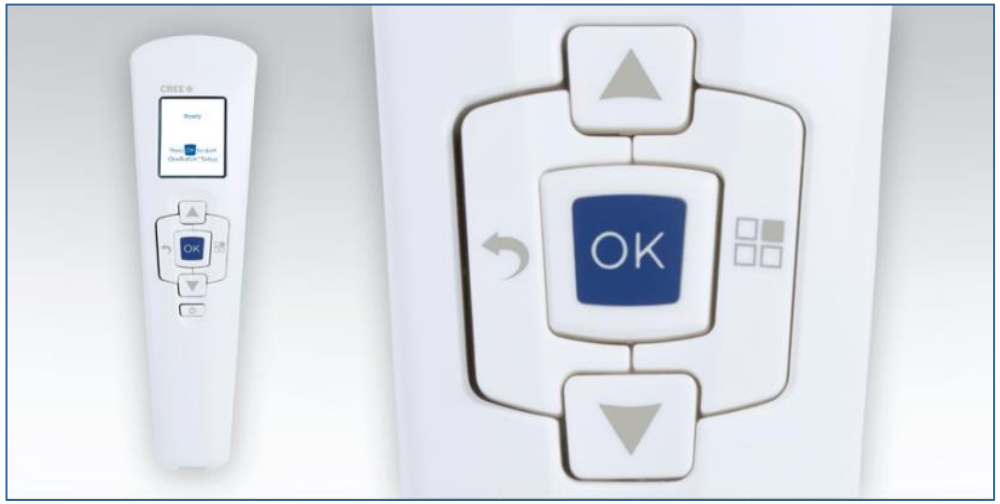
SmartCast



- **Self-programming** wireless lighting control
- Integrated sensors
- Daylight harvesting
- Task tuning
- **One button set-up**
  Automated luminaire association and configuration

CREE

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NLCS can have:

Graphical User Interface (GUI) to make programing easier

FXLuminaire®

AcuityControls

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Why use controls?.. Energy Codes

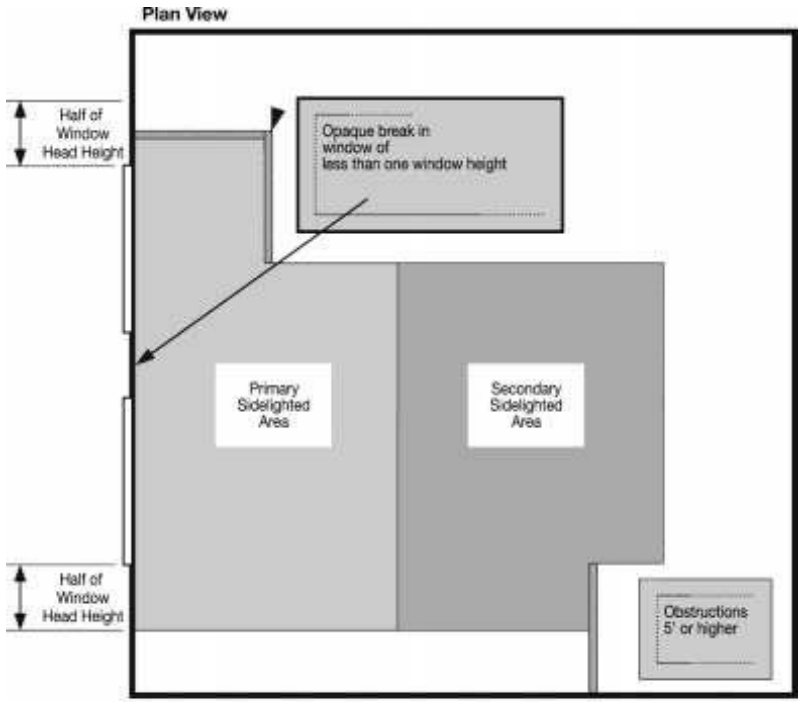
WASHINGTON STATE ENERGY CODE, COMMERCIAL PROVISIONS

C405.2 Lighting controls (Mandatory). Lighting systems shall be provided with controls as specified in Sections C405.2.1 through C405.2.8.

C405.2.4 Daylight responsive controls. *Daylight responsive controls* complying with Section C405.2.4.1 shall be provided to control the lighting within *daylight zones* in the following spaces:

1. Sidelight daylight zones as defined in Section C405.2.4.2 with more than two general lighting fixtures within the primary and secondary sidelight daylight zones.
2. Toplight daylight zones as defined in Section C405.2.4.3 with more than two general lighting fixtures within the daylight zone.

FIGURE C405.2.4.2(1)
DAYLIGHT ZONE ADJACENT TO FENESTRATION IN A WALL



Computing the secondary sidelighted area.

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Office plan controls

RSC

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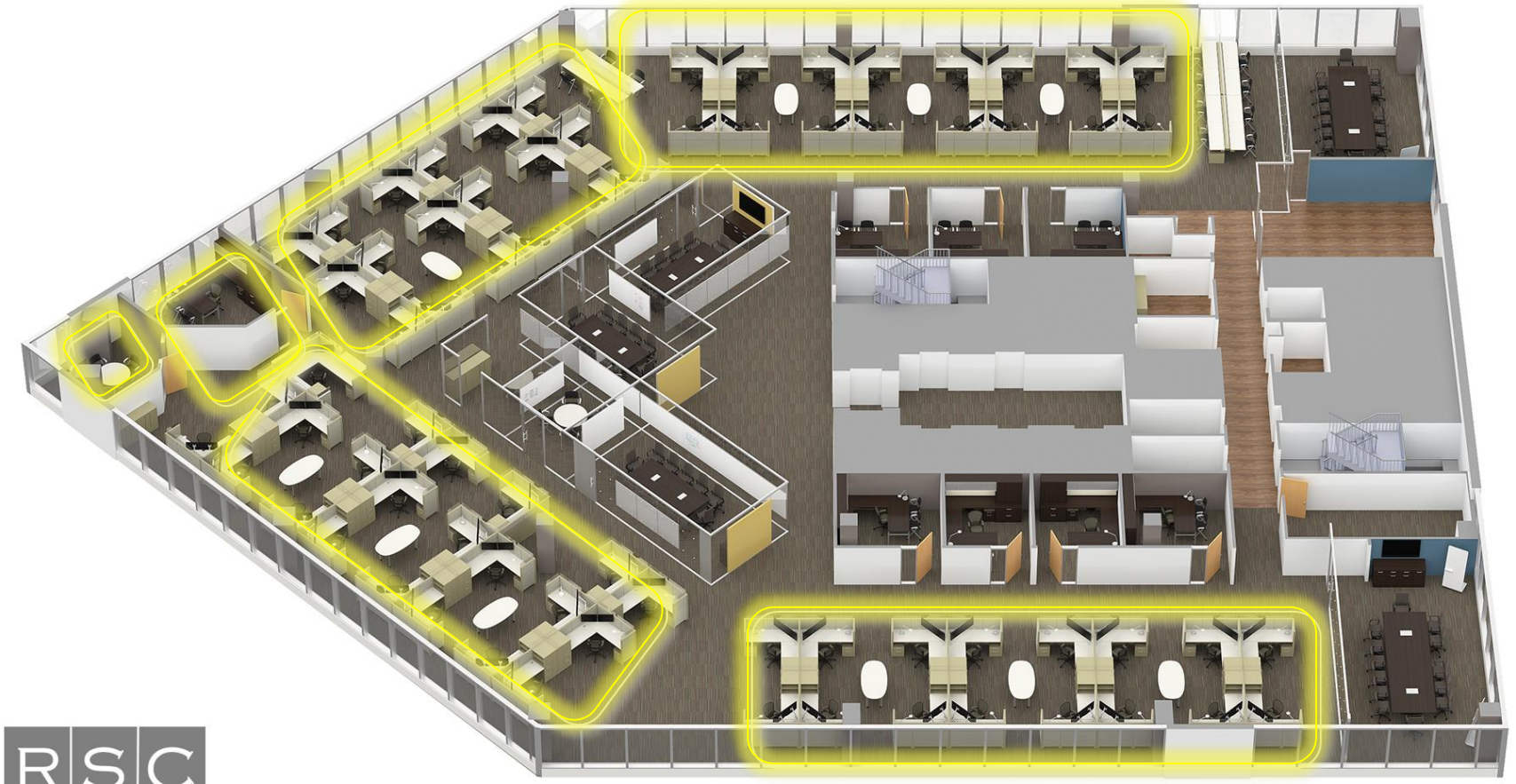
Office plan controls
Daylight zones



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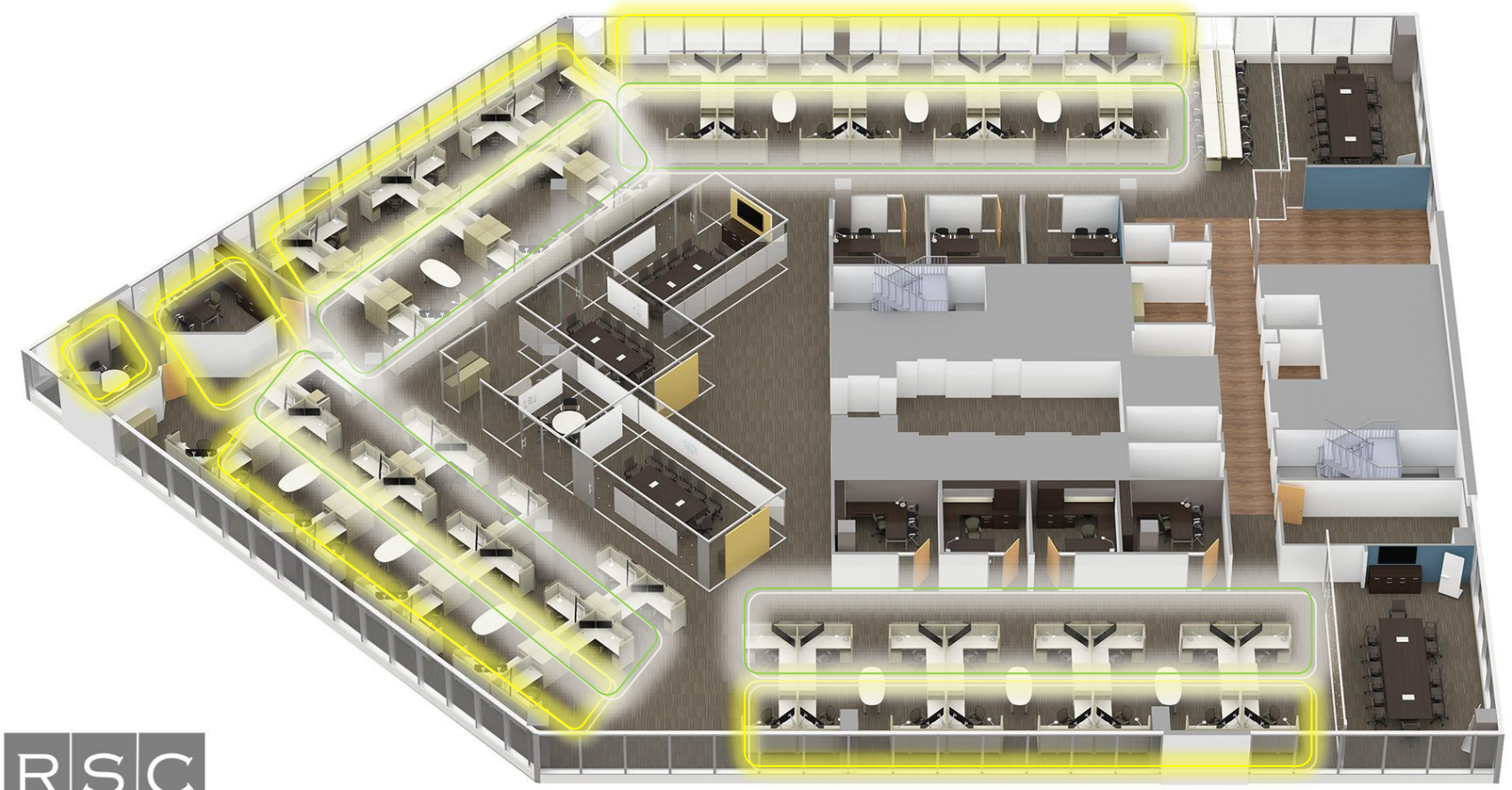
Office plan controls
Daylight zones- Primary and Secondary



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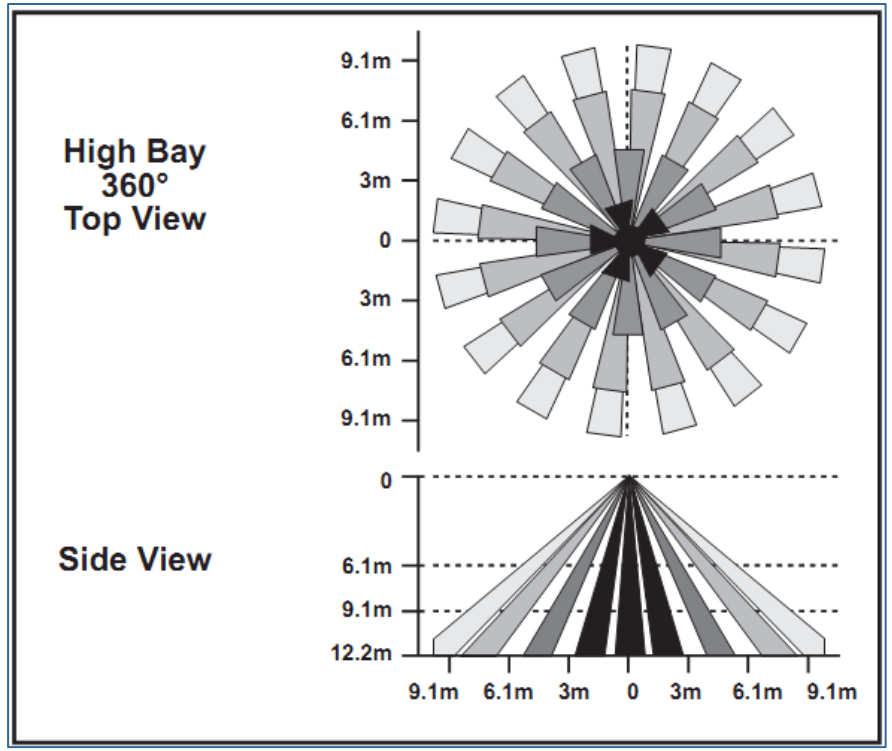
Why use controls- Energy Codes

WASHINGTON STATE ENERGY CODE, COMMERCIAL PROVISIONS

C405.2 Lighting controls (Mandatory). Lighting systems shall be provided with controls as specified in Sections C405.2.1 through C405.2.8.

C405.2.1 Occupancy sensor controls. Occupancy sensor controls shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Conference/ meeting/multipurpose rooms.
3. Copy/print rooms.
4. Lounges.
5. Employee lunch and break rooms.
6. Private offices.
7. Restrooms.
8. Storage rooms.
9. Janitorial closets.
10. Locker rooms.
11. Other spaces 300 square feet (28 m^2) or less that are enclosed by floor-to- ceiling height partitions.
12. Warehouse spaces.



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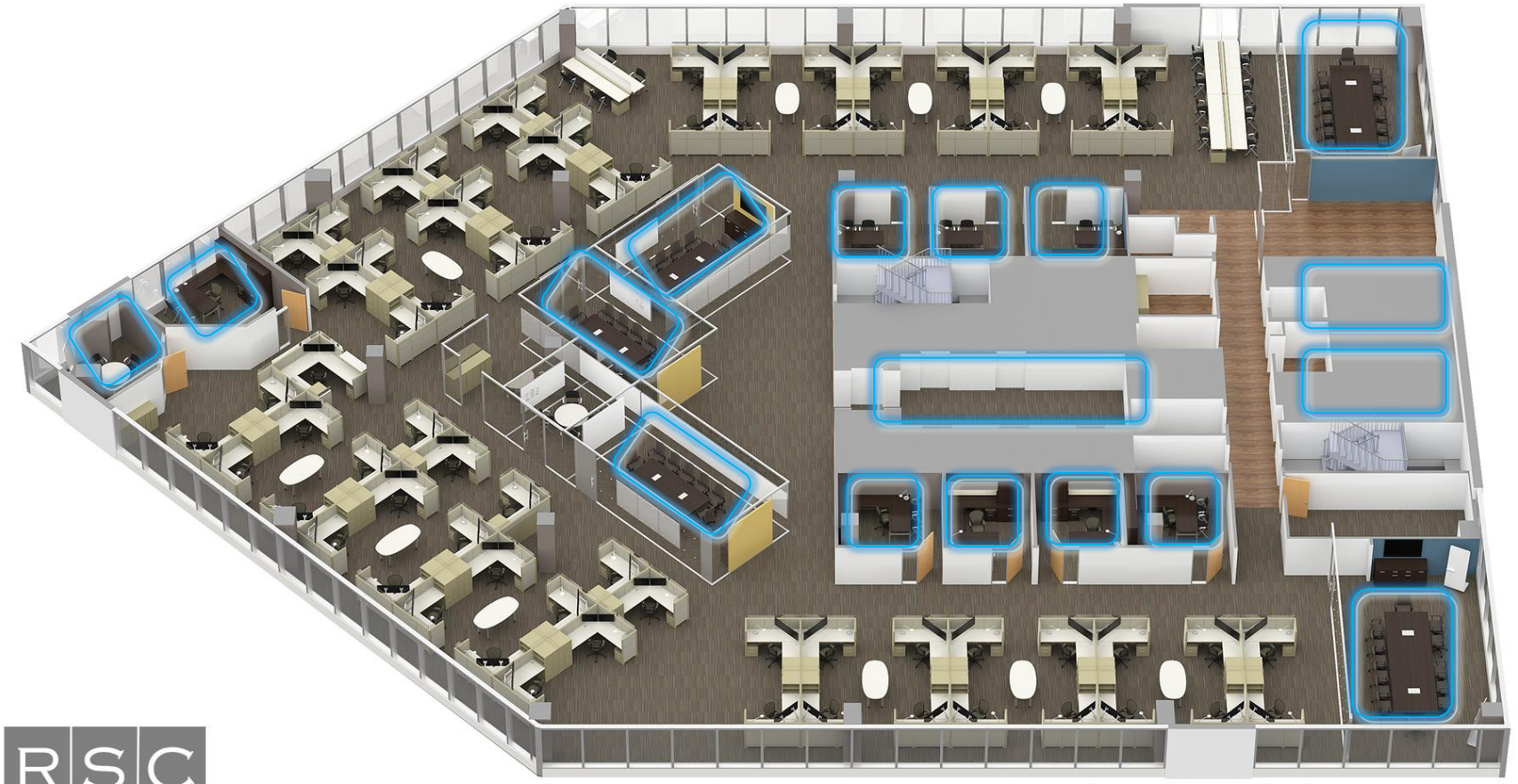
Office plan controls
Occupancy zones



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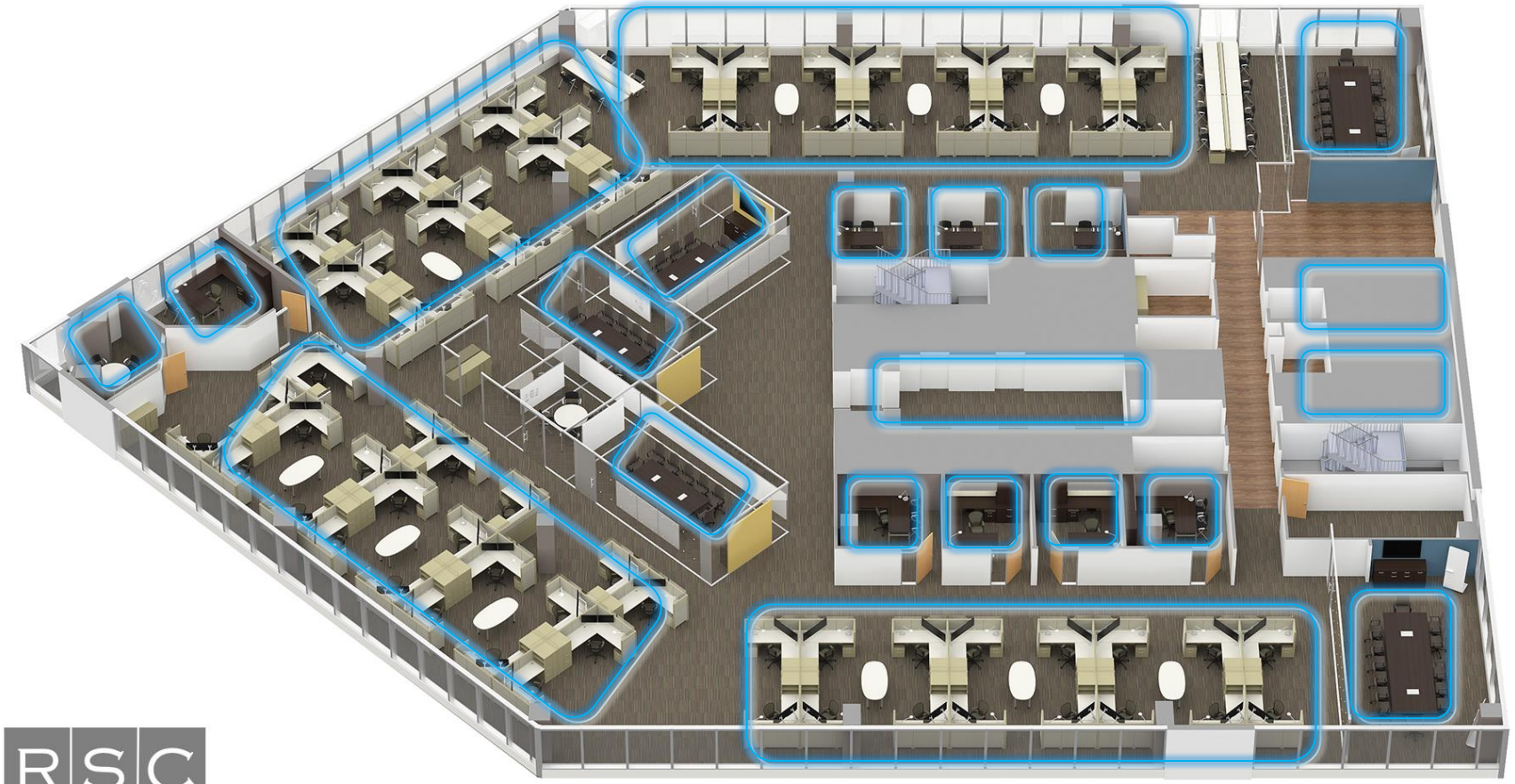
Office plan controls
Occupancy zones- Open Office too



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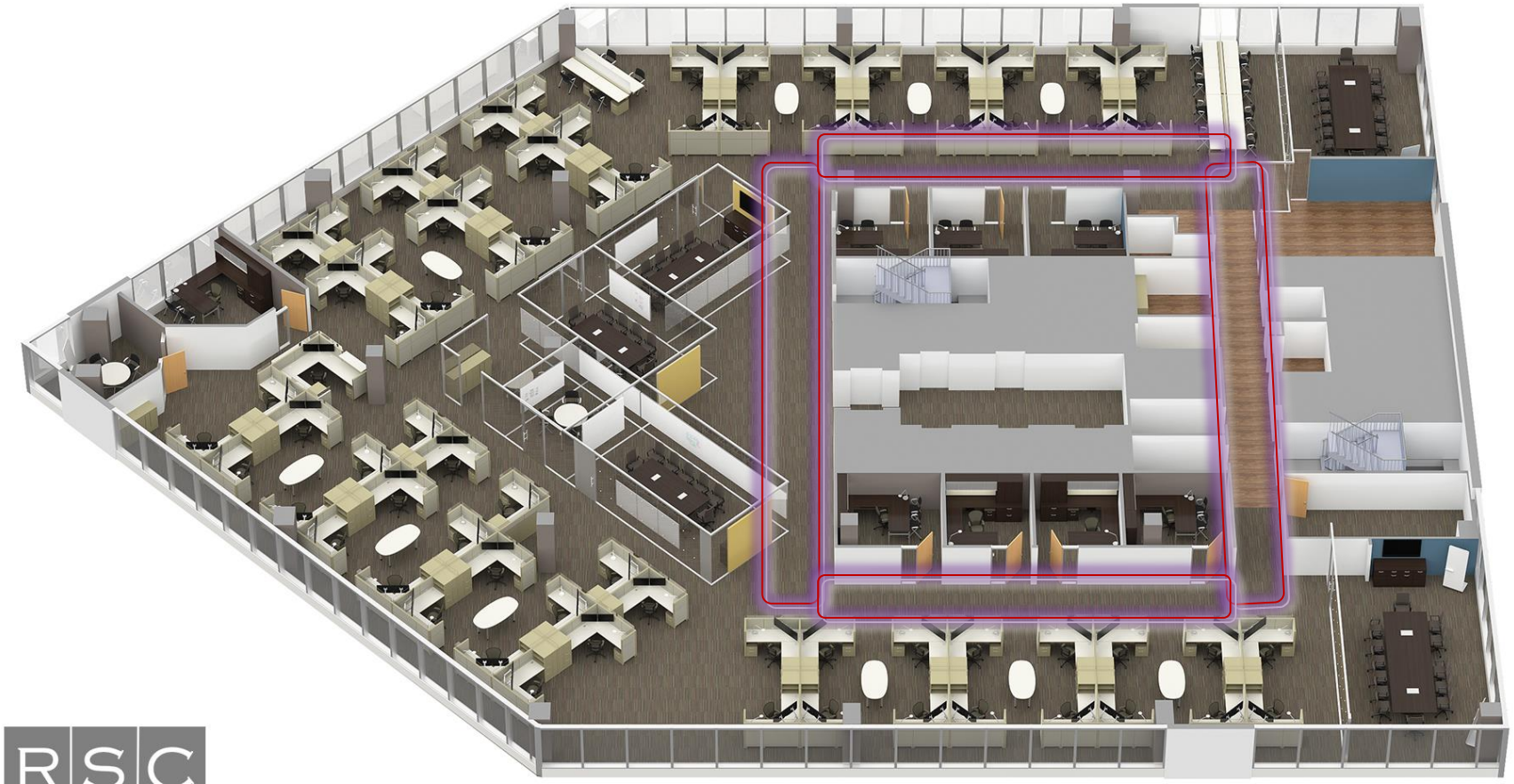
Office plan controls
Corridor/ Egress path



RSC

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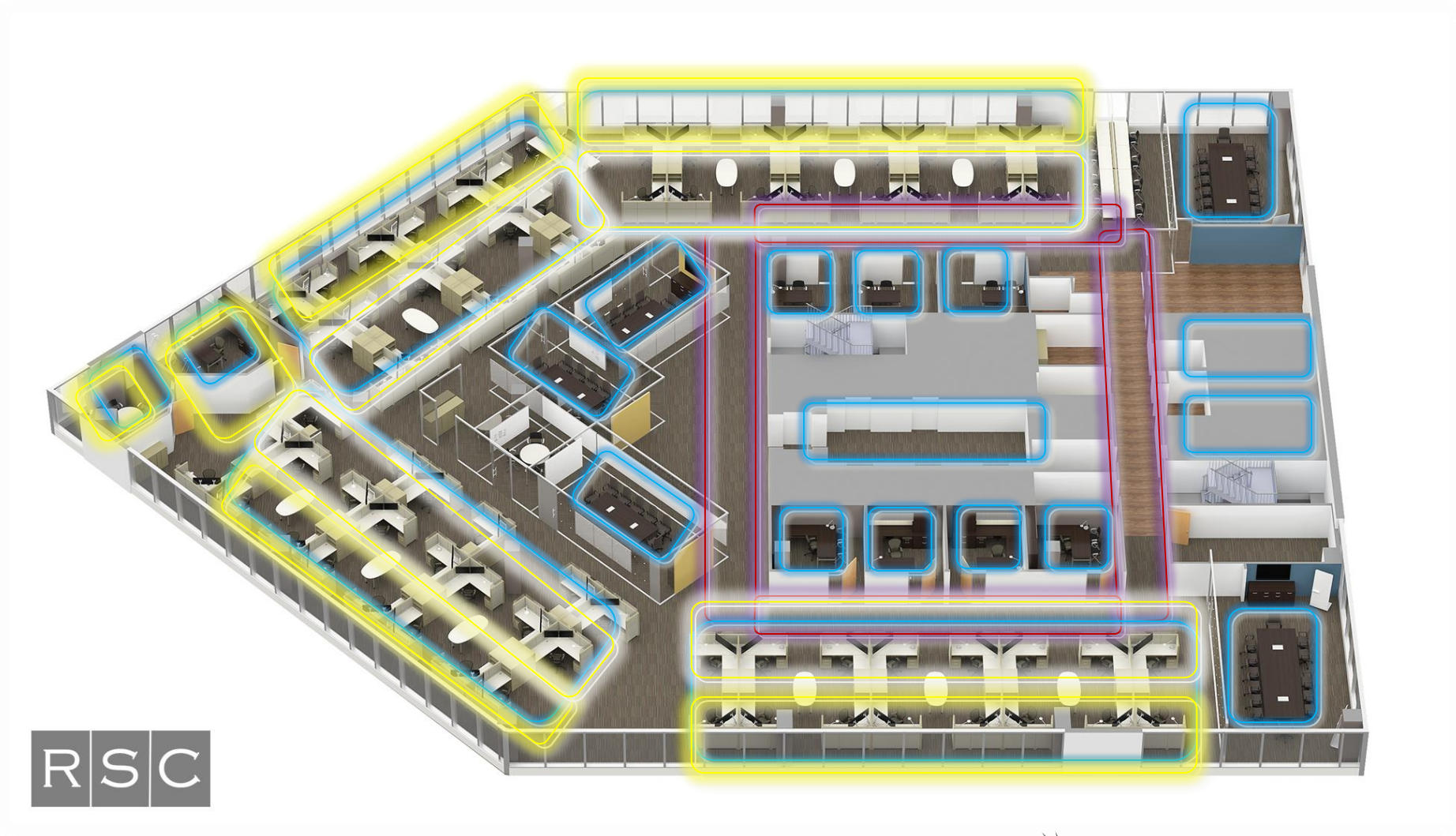
Office plan controls
Combined- It gets complicated.



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Combining Control Strategies

Room empty lights on.

Not good.

Room empty lights off and lots of daylight.

Good, but what happens when room is occupied?

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Combining Control Strategies

Occupied, daylit, lights off…success.

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Controls Exceptions

C405.2 Lighting controls (Mandatory). Lighting systems shall be provided with controls as specified in Sections C405.2.1 through C405.2.8.

Exception: Except for specific application controls required by Section C405.2.5:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.
4. Industrial or manufacturing process areas, as may be required for production and safety.
5. Luminaire-level lighting controls (LLLC) that control interior lighting. The LLLC luminaire shall be independently configured to:
   - 5.1. Monitor occupant activity to brighten or dim its lighting when occupied or unoccupied, respectively.
   - 5.2. Monitor ambient light (both electric light and daylight) and brighten or dim electric light to maintain desired light level.
   - 5.3. Configuration and reconfiguration of performance parameters, including bright and dim setpoints, time-outs, dimming, fade rates, sensor sensitivity adjustments, and wireless zoning configurations, for each control strategy.
   - 5.4. Meet the operational and commissioning requirements of Sections C405.2.1, C405.2.2, C405.2.3, C405.2.4, and C408.

LUMINAIRE-LEVEL LIGHTING CONTROL. A lighting system consisting of one or more luminaire(s) with embedded lighting control logic, occupancy and ambient light sensors, wireless networking capabilities, and local override switching capability.

Each fixture has its own controls? That could never happen...

Individual controls is not a new idea

Each fixture has a **Photocell.**

They each do their own thing.

What about interior?

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Individual controls
High-bay

Each fixture has an **Occupancy Sensor**

Why couldn’t we do this in the past?

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What if each fixture had its own controls in an office?

Offices have a lot **higher fixture density** per Sq. Ft.

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Convergence of Technologies and Timing

Miniaturization of Control Devices

Not the price…

Controllable Light Sources

Higher Data Bandwidth

ASHRAE

More demanding Energy Codes

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What are the advantages of LLLCs

- More savings due to **higher granularity**
- **No rewiring** needed due to wireless functionality
- Ability to **re-zone** if area use changes

Lighting is a handy place to put these devices

Because its everywhere, and it has power already

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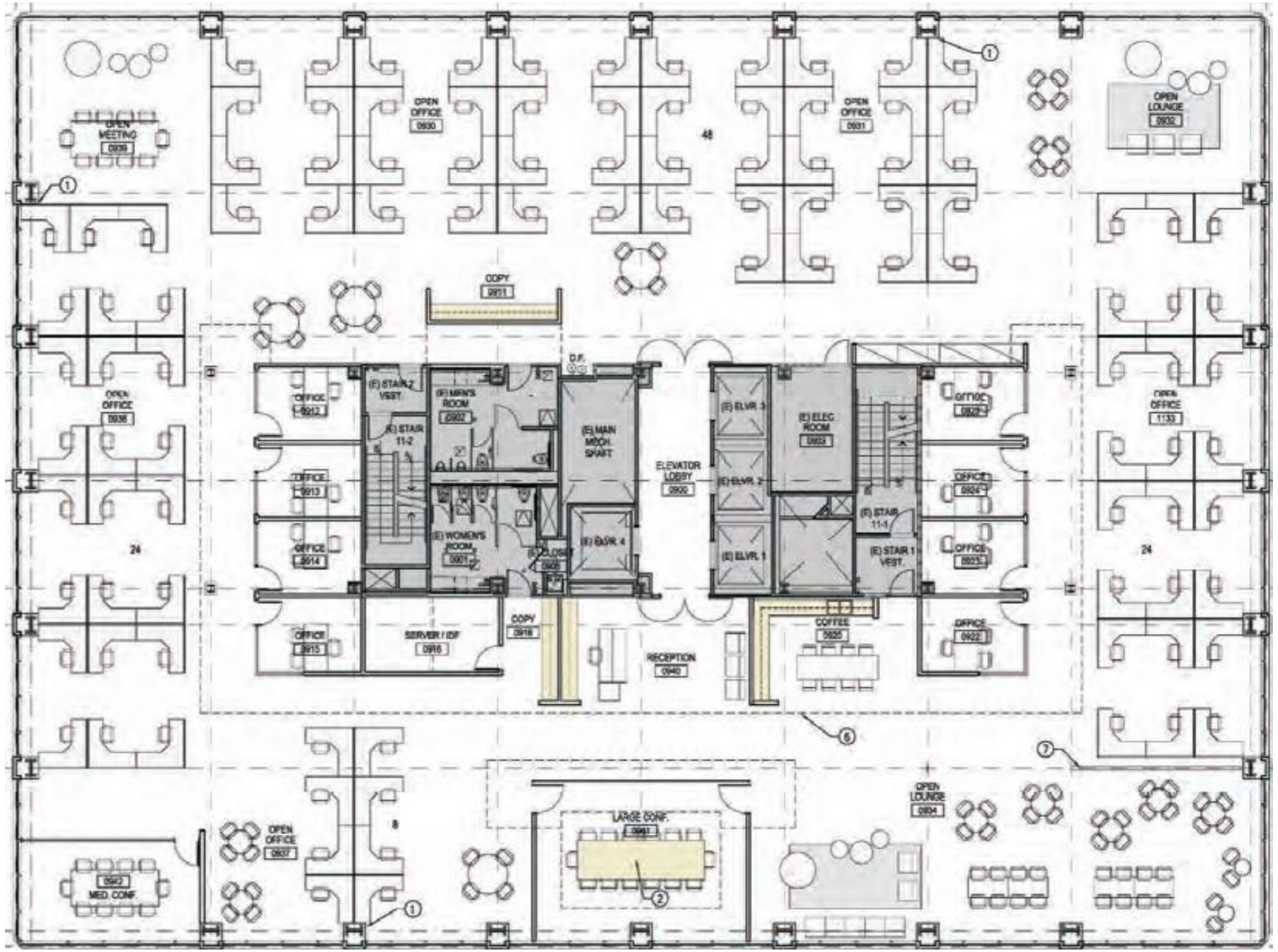
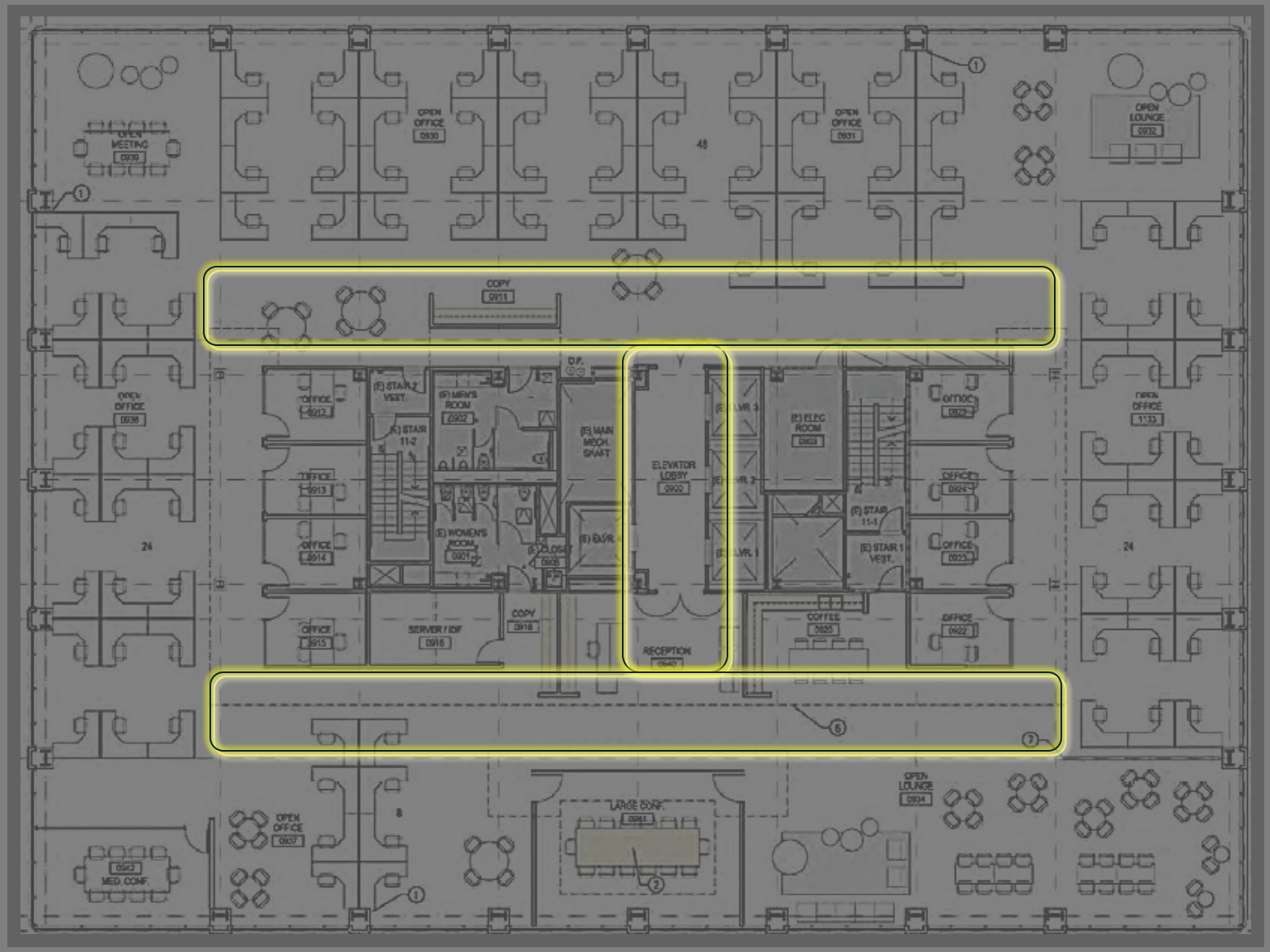
LLLC = High Granularity. Traffic patterns



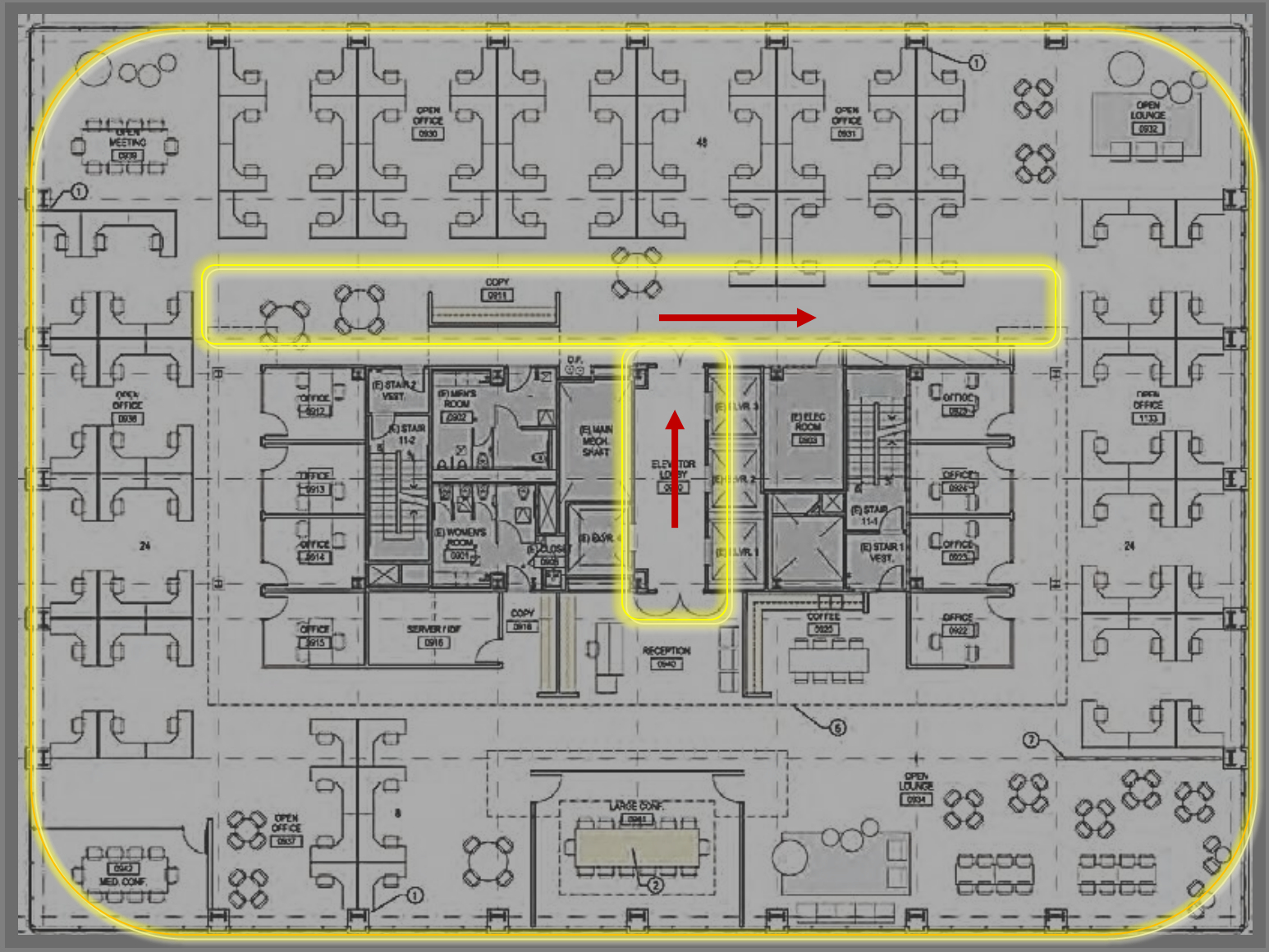
Traffic patterns-

Night- Minimum lighting for egress at 10%



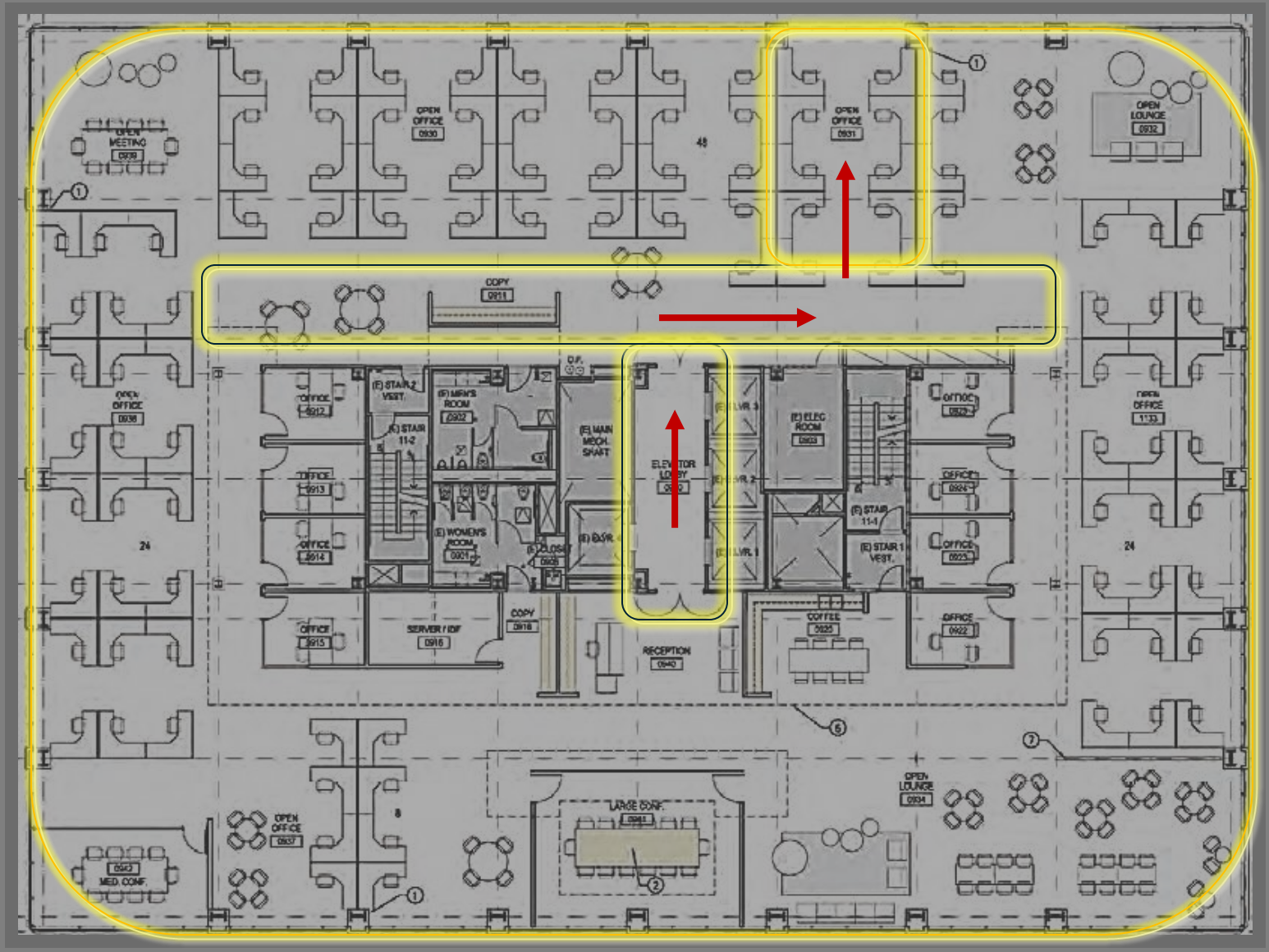
Traffic patterns-

First entry- ambient to 30%, traffic to 90%



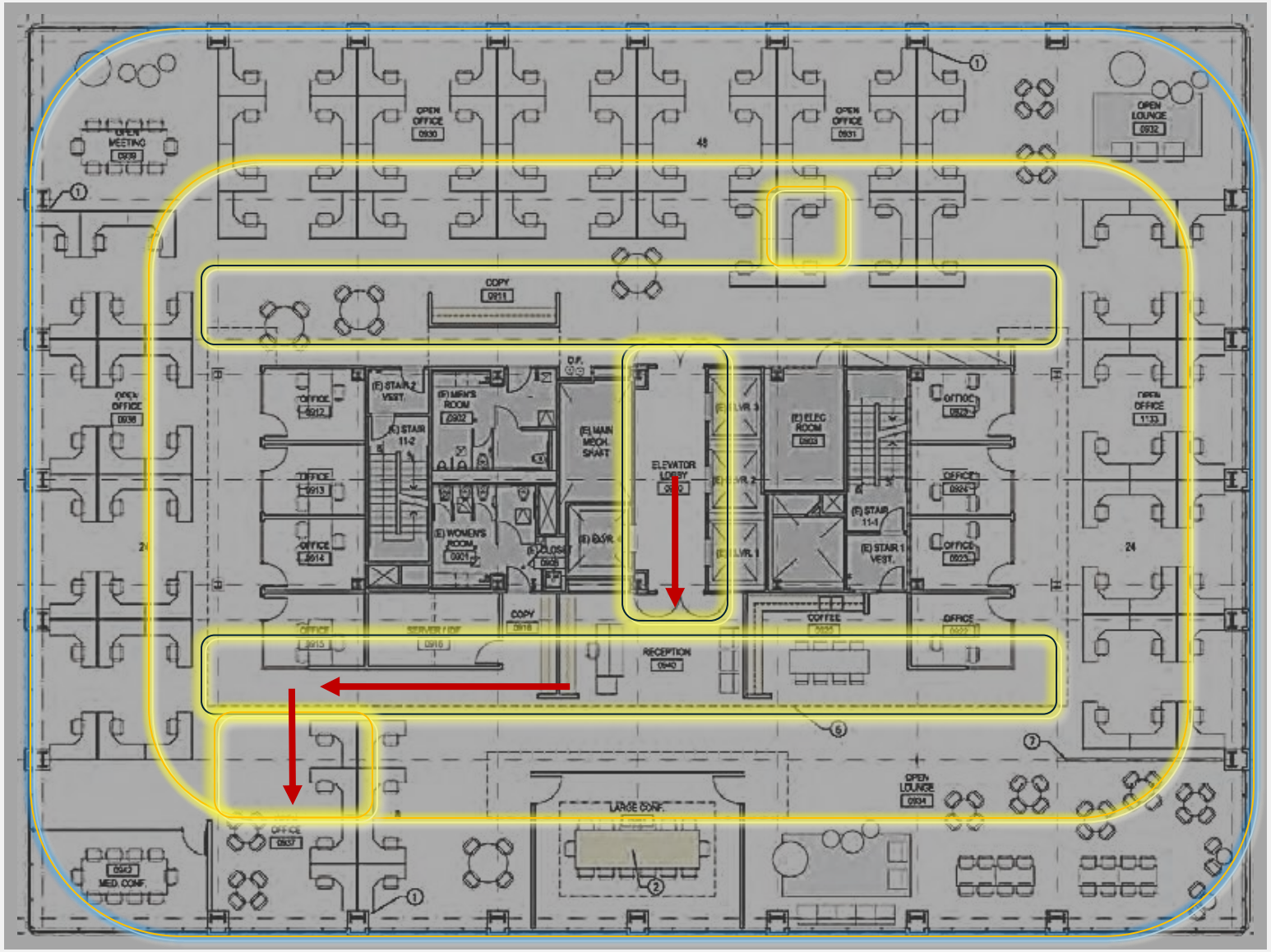
Traffic patterns-

First entry- ambient to 30%, traffic to 90%



Traffic patterns-

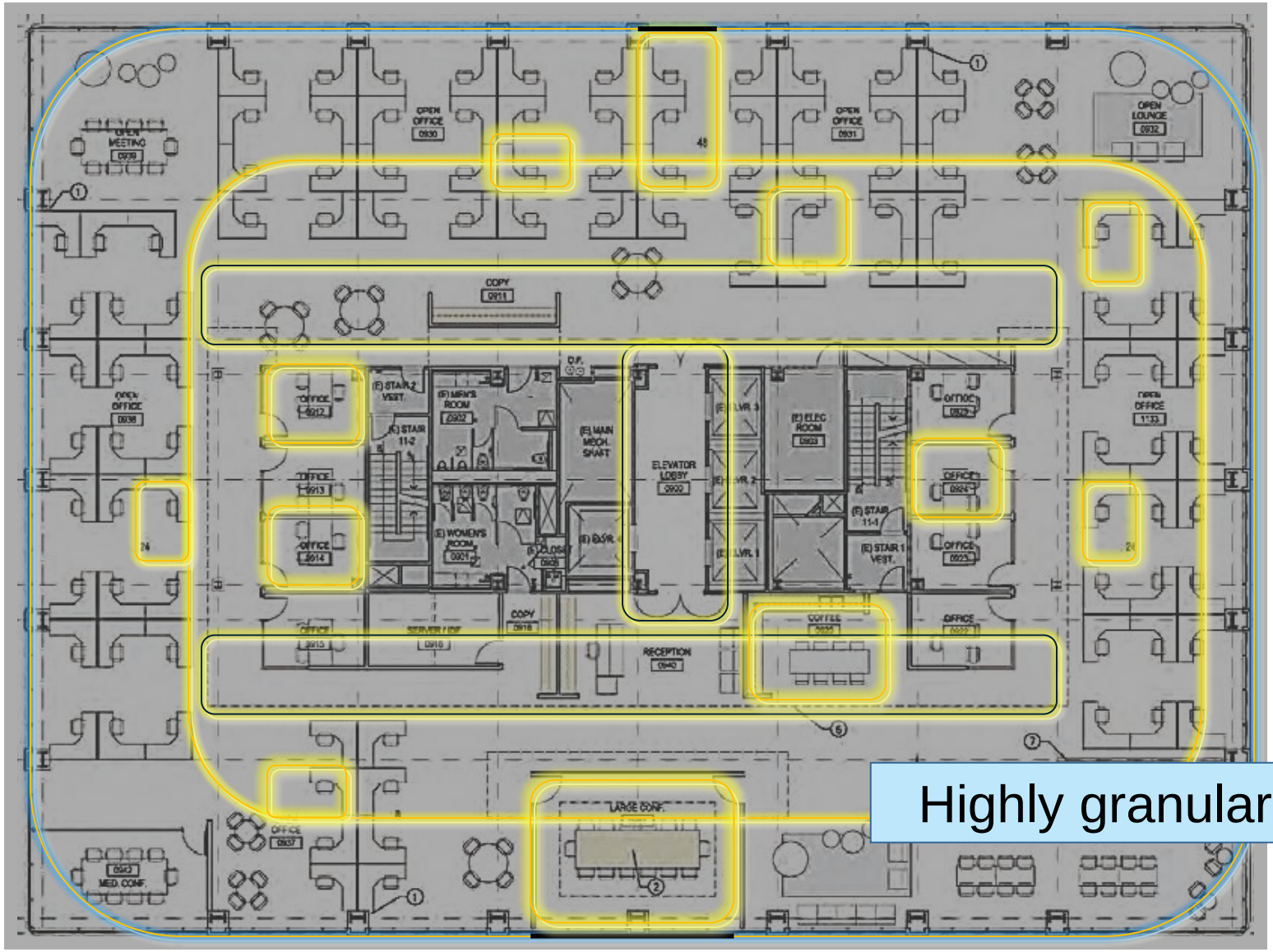
Daytime- ambient to 30%, traffic to 90%, daylight zone off if ok



It is summer

Traffic patterns-

Daytime- ambient to 30%, traffic to 90%, daylight zone off if ok



It is summer… and almost everyone is on vacation.

Highly granular control

LLLCs don’t have to be troffers.

What control effects do you see?

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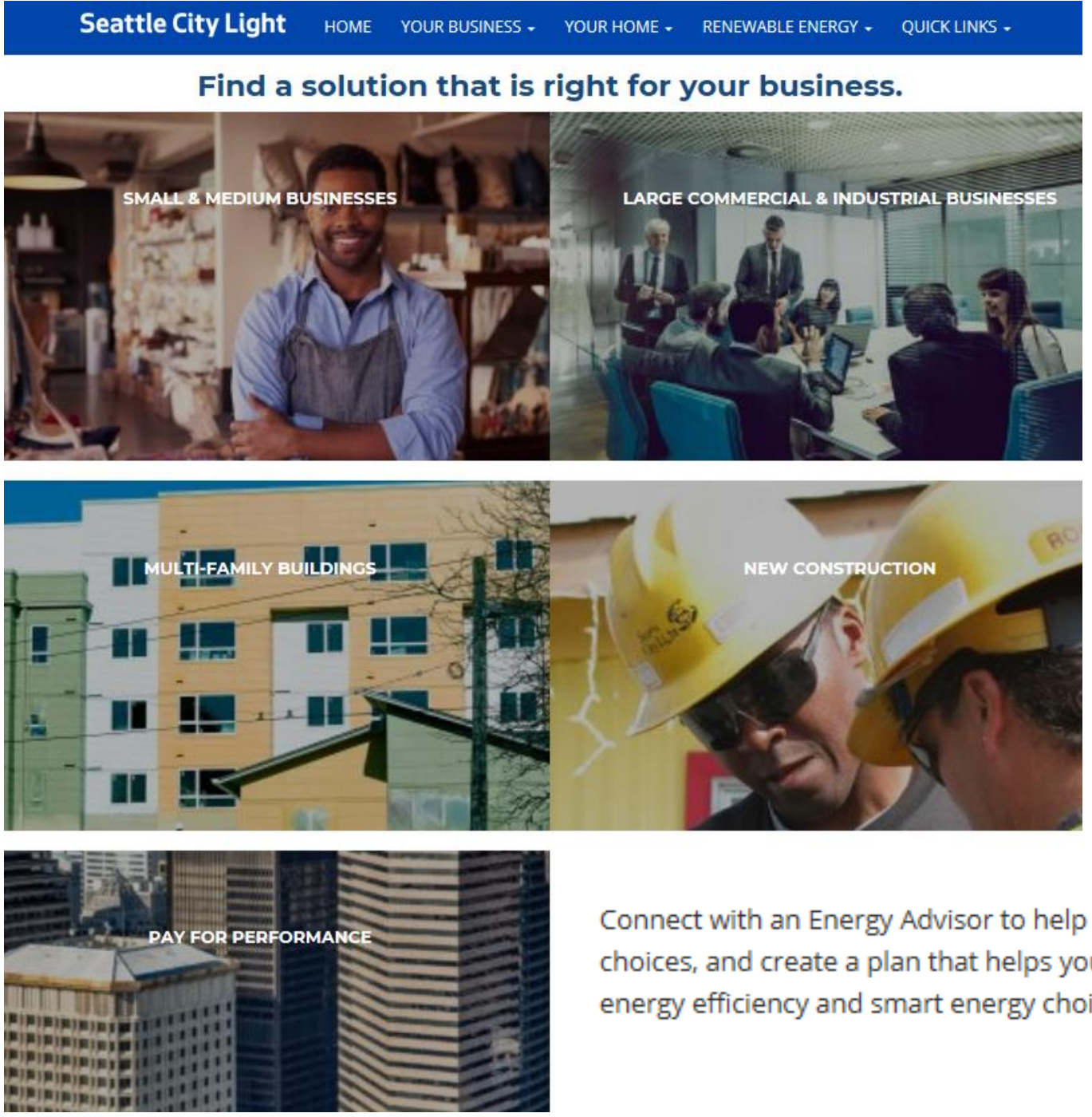
Pop Quiz- The most effective retrofit luminaire:

A. Is energy efficient.
B. Has appropriate color qualities.
C. Puts light where it is needed.
D. Has low operating costs.
E. Is controllable.



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Email SCLEnergyAdvisor@seattle.gov

Connect with an Energy Advisor to help you better understand energy options, navigate your choices, and create a plan that helps your home or business save energy and money. Conservation, energy efficiency and smart energy choices are within reach.

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NW Utility Incentive Programs

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Save on upgrades to energy-efficient business lighting

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Have questions about PSE's green options, including energy efficiency tips and rebates, electric cars and other renewable energy options? We're here to help.

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Business Lighting Incentive Program

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Host a bulb recycling collection box

VIEW OPTIONS >

If you need help with your application, call an Energy Advisor at 1-800-562-1482, Monday through Friday from 8 a.m. to 5 p.m.

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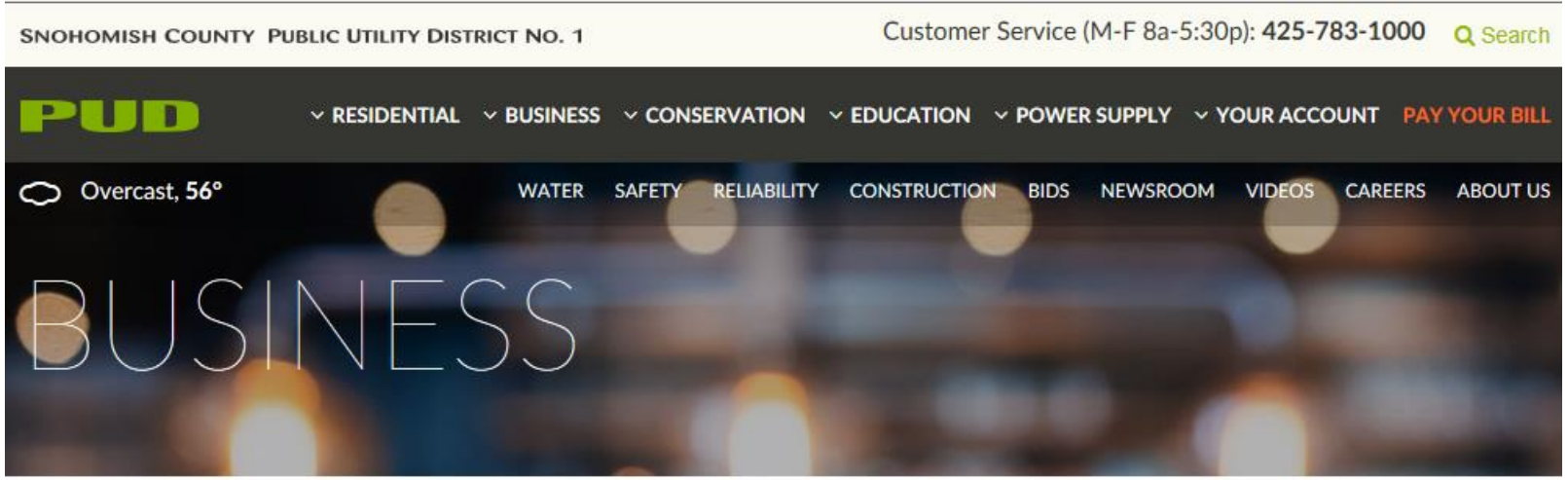
NW Utility Incentive Programs



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- For Small Businesses
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- Energy Efficiency Tools
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- Troubleshooting
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Energy solutions tailored for your business!

Rebates & Incentives
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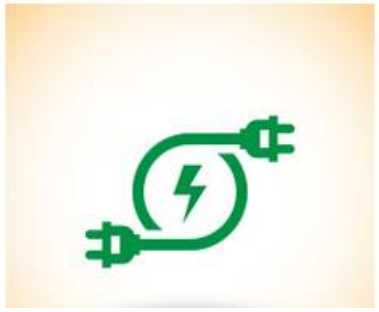
Investing in energy-efficiency upgrades and incentive programs will save money for the future!



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SAVE WITH LIGHTING

Bright Rebates Program
BrightRebates@cityoftacoma.org
(253) 502-8619

Updating your lighting is one of the most cost-effective options for saving money and energy - it may also reduce maintenance and operation costs in your business.
With Bright Rebates, you can get a rebate for up to 60% of the project cost. You will also enjoy monthly savings on your electric bill.

Update Your Lighting & Save

Rebate-Eligible Changes Include:

- Incandescent to CFL or LED fixtures and lamp replacements
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- Magnetic HID to electronic ballasted HID, fluorescent or LED
- Incandescent to LED exit signs
- Occupancy sensors/lighting controls

There are several options for updating your lighting. Start exploring the best option for your space by reading our Lighting Guide.

Bright Rebates Application

NW Utility Incentive Programs

Residential: (253) 502-8363

- Email: RConservation@CityofTacoma.org

Multifamily & Condo: (253) 502-8363

- Email: Multifamily@CityofTacoma.org

Business: (253) 502-8619

- Email: BizRebates@CityofTacoma.org

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Northwest Utility Programs

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View Website	Pacific Power – Washington
View Website	Pacific Power – Washington wattsmart Business Vendor network (for trade allies)
View Website	Portland General Electric - Savings
View Website	Puget Sound Energy - Contractor Alliance Network (CAN)
View Website	Puget Sound Energy - Incentives
View Website	Seattle City Light - Business Services
View Website	Snohomish PUD - Business Support
View Website	Tacoma Power - Rebate Program

Or you can just go to our web site to find the links and lots of other great stuff!

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Thanks

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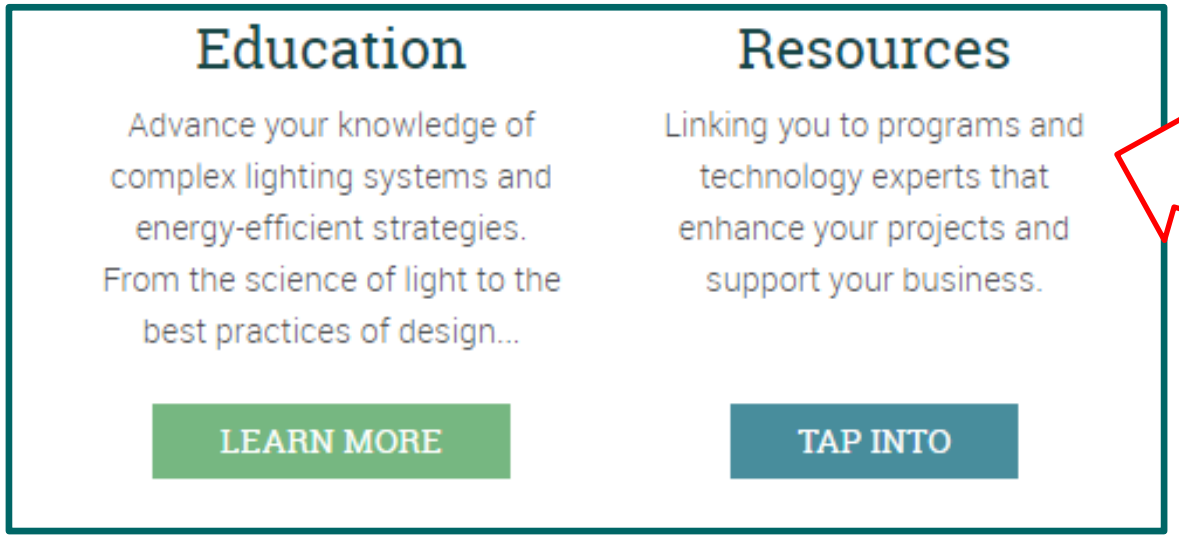
And now – a few words from LDL

Click – Call – Connect

- Eric Strandberg
  - 206-817-7142
  - eric.strandberg@seattle.gov

Visit us online



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