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Lighting Design: Bridging the Gap between LEED and WELL

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Reiko Kagawa is a Principal Lighting Designer at Sladen Feinstein Integrated Lighting and has been with the firm since 2004. She has led many of the firm's award-winning academic, commercial, and educational projects, and was selected as one of Lighting Magazine's top 40 under 40 international lighting designers in 2018. Reiko's work always begins by collaborating with the client and design team. Then, she envisions how to make the space come alive with the element of light. She draws many sketches and details, conducting lighting analysis and mock-ups to make the vision truly successful. Reiko feels a great amount of responsibility on sustainable design and human well-being in her lighting design practice and has led many projects that involved Living Building Challenge, Net-Zero energy building, LEED, and WELL. She received her degree in Architecture from Oyama National College of Technology in Japan and earned her Architectural License in Japan in 2002. Reiko holds a Bachelor of Science in Interior Design from Mount Ida College in Massachusetts.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Learning Objectives

At the end of the this course, participants will be able to:

1. Attendees will discover what WELL is and why it is so important to the future of sustainable design and construction.

2. Attendees will understand lighting credits for both WELL and LEED and how to achieve them.

3. Attendees will be able to identify similarities and differences of lighting in WELL and LEED.

4. Attendees will be able to implement the lighting concepts of WELL to any future building and construction type creating healthier environments for building occupants.

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What is LEED and WELL

LEED Building Design and Construction
LEED Building Operations + Maintenance
LEED Interior Design + Construction
LEED Homes
LEED Neighborhood Development

V2 for all project types

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What is WELL V2?

Lighting in WELL

WELL Intent for Lighting

The WELL Lighting concept promotes exposure to light and aims to create lighting environments that are optimal for visual, mental and biological health.

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Concepts

LEED BD+C V4

- Location and Transportation
- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Material and Resources
- Indoor Environmental Quality

WELL V2

- Air
- Water
- Nourishment
- Light
- Movement
- Thermal Comfort
- Sound
- Materials
- Mind
- Community

Scoring System

LEED BD+C V4

LEED Platinum / 80+ credits

LEED Gold / 60-79 Credits

LEED Silver / 50-59 Credits

LEED Certified / 40-49 Credits

*LEED Credit counted with Credit

WELL V2

WELL Platinum / 80+ Points

WELL Gold / 60-79 Points

WELL Silver / 50-59 Points

*WELL features counted with Points

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Lighting Related Credit in LEED V4

1. Light Pollution Reduction (BD+C only)
2. Optimized Energy Performance
3. Interior Lighting
    1) Lighting Control
    2) Lighting Quality
4. Daylight
5. Quality Views

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Lighting Related Credit in LEED V4

1. Light Pollution Reduction (BD+C only)
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   1) Lighting Control
   2) Lighting Quality
4. Daylight
5. Quality Views

LEED specific focus

Alignment or similar intent with WELL

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WELL Lighting Features

	FEATURE	PART
FEATURE 01 (P)	Light Exposure and Education	1. Ensure Indoor Light Exposure (ASE Calc) 2. Promote Lighting Education
FEATURE 02 (P)	Visual Lighting Design	1. Light Levels for Visual Acuity
FEATURE 03 (O)	Circadian Lighting Design	1. Lighting for the Circadian System
FEATURE 04 (O)	Glare Control	1. Solar Glare Control
		2. Electric Glare Control
FEATURE 05 (O)	Enhanced Daylight Access	1. Implement Enhanced Daylight Plan
		2. Implement Enhanced Daylight Simulation (sDA Calc)
		3. Ensure Views
FEATURE 06 (O)	Visual Balance	1. Manage Brightness
FEATURE 07 (O)	Electric Light Quality	1. Ensure Color Rendering Quality
		2. Manage Flicker
FEATURE 08 (O)	Occupant Control of Lighting Environments	1. Enhance Occupant Controllability
		2. Provide Supplemental Lighting

P: Prerequisite feature, O: Optimization feature

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WELL Lighting Features Aligned with LEED

	FEATURE	PART
FEATURE 01 (P)	Light Exposure and Education	1. Ensure Indoor Light Exposure (ASE Calc) 2. Promote Lighting Education
FEATURE 02 (P)	Visual Lighting Design	1. Light Levels for Visual Acuit
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FEATURE 08 (O)	Occupant Control of Lighting Environments	1. Enhance Occupant Controllability
		2. Provide Supplemental Lighting

*LEED alignment

Alignment or similar intent with LEED


Too much...
Photo by Christian Erfurt on Unsplash

LEDucation LEED+WELL Crosswalk in Lighting

LEED BD+C V4	WELL V2
EQc Interior Lighting 2G-2H	L6.1 Manage Brightness
EQc Interior Lighting 2B	L7.1 Ensure Color Rendering Quality
EQc Daylight	L1.1 Ensure Indoor Light Exposure
	L4.1 Control Solar Glare
	L5.2 Implement Enhanced Daylight Simulation
EQc Quality Views	L5.3 Ensure Views

LEEDucation LEED+WELL Proof Lighting

LEED BD+C V4	WELL V2
Energy Efficient Design	**L2 Visual Lighting Design (P)**
EQc Interior Lighting 2G-2H	L6.1 Manage Brightness
EQc Interior Lighting 2B	L7.1 Ensure Color Rendering Quality
EQc Daylight	L1.1 Ensure Indoor Light Exposure
	L4.1 Control Solar Glare
	L5.2 Implement Enhanced Daylight Simulation
EQc Quality Views	L5.3 Ensure Views

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15 Recommended Lighting Practice

For LEED and WELL proof design

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Light Pollution Reduction

LEED BD+C / SSc

Uplight

- BUG Rating Method
- Calculation Method

Light Tresspass (Backlight and Glare)

- BUG Rating Method
- Calculation Method

Signage Lighting

Low Energy Lighting Design

LEED EAc / Optimized Energy Performance

Lighting Power Density

Reduced connected lighting power density below that which is allowed by ASHRAE/IESNA Standard 90.1–2010.

10%	20%	30%	40%
1 pt	2 pts	3 pts	4 pts

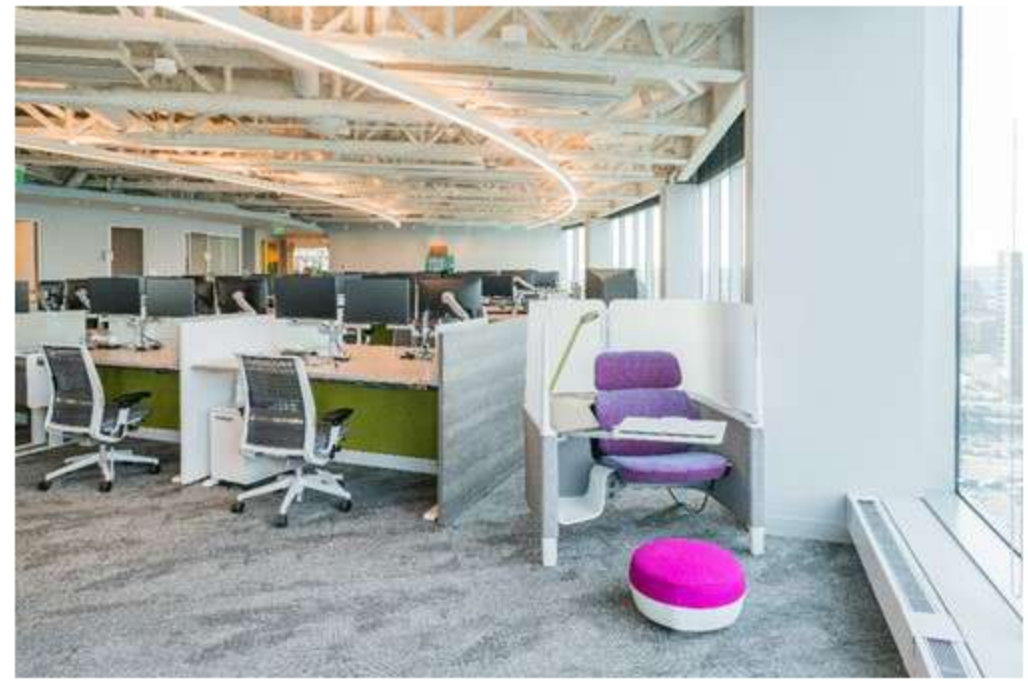
Interior Lighting Controls

Daylighting Controls

Install daylight-responsive controls in all regularly occupied daylit spaces within 15 feet of windows and under skylights.

Occupancy Sensor Lighting Controls

Install occupancy sensors for at least 75% of the connected lighting load.



Lighting Control

LEED EQc Interior Lighting / Option 1
WELL L08 Occupant Control of Lighting / Supplemental Lighting

Individual Space:
Provide individual lighting controls that enable occupants to adjust the lighting with at least three lighting levels or scenes (on, off, midlevel).

Shared Offices:

- Multizone control systems that enable occupants to adjust the lighting to meet group needs with at least three lighting levels or scenes (on, off, midlevel).
- Lighting for any presentation or projection wall must be separately controlled.
- Control devices must be located within the same space.

Require Task Light

Electric Glare Control

LEED EQc Interior Lighting Option 2-A/D

WELL V2 L4.2 Electric Glare Control

Luminance Value

LEED Eqc Interior Lighting / Option A

- Less than 2,500cd/sqm between 45 and 90 degrees from nadir.

WELL / L4.2 Electric Glare Control

- Less than 10,000 cd/sqm between 45 and 90 degrees from nadir

Direct Light VS Indirect Light

LEED Eqc Interior Lighting / Option D

- Use less than 25% of total connected load to be direct-only light

WELL L4.2 Electric Glare Control

- Specify only indirect fixtures (except accent light)

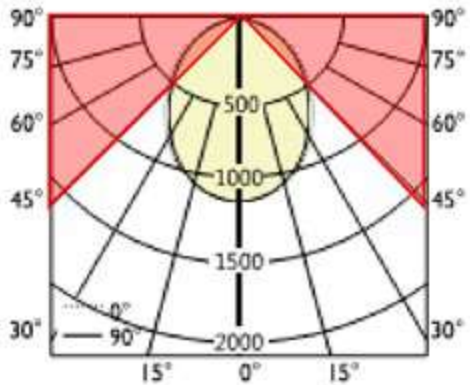
Direct/Indirect luminaire with low luminance value for direct light

Luminance Data

6” Wide Aperture LED Luminaire

500 lm/ft

PHOTOMETRIC CURVE



Luminaire Lumens: 500 lm/ft
Input Watts: 4.3 W/ft
Efficacy: 116 lm/W
IES FILE: B6RLED-500-80-35-SO.IES

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	861	862	860	863	865
5	804	805	796	791	792
15	707	702	687	675	671
25	582	575	554	536	528
35	448	440	419	400	393
45	316	310	293	278	271
55	195	190	180	170	167
65	90	88	84	79	78
75	47	46	43	41	40
85	11	10	9	8	8
90	0	0	0	0	0

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	82
10-20	230
20-30	331
30-40	368
40-50	350
50-60	290
60-70	206
70-80	113
80-90	30
90	

LUMINANCE DATA (cd/m²)

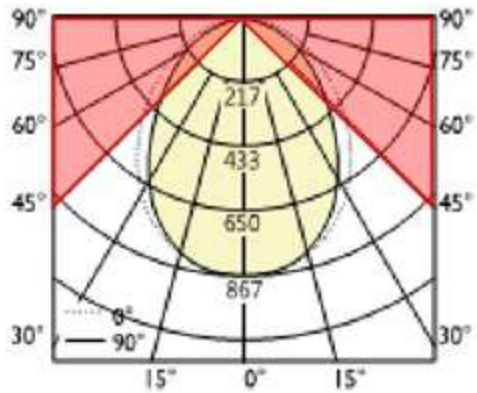
	Horizontal Angles		
Vertical Angle	0	45	90
45	4555	4281	4031
55	4064	3774	3496
65	3540	3270	3024
75	2944	2730	2529
85	2186	1987	1788

Luminance Data

2” Wide Aperture LED Luminaire

500 lm/ft

PHOTOMETRIC CURVE



Luminaire Lumens: 500 lm/ft
Input Watts: 4.7 W/ft
Efficacy: 106 lm/W

IES FILE: BRLED-500-80-40-FLIES
TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	863	863	863	863	863
5	855	858	855	862	863
15	817	820	813	812	813
25	738	737	720	708	703
35	623	615	587	560	550
45	483	472	435	405	393
55	337	325	295	270	260
65	205	197	178	162	155
75	97	95	85	77	73
85	22	18	20	18	18
90	0	0	0	0	0

ZONAL LUMENS

	Lumens
Zone	
0	
0-10	81
10-20	229
20-30	331
30-40	367
40-50	337
50-60	266
60-70	178
70-80	92
80-90	23
90	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	10690	9620	8700
55	9180	8044	7089
65	7586	6599	5736
75	5841	5136	4431
85	3888	3589	3290

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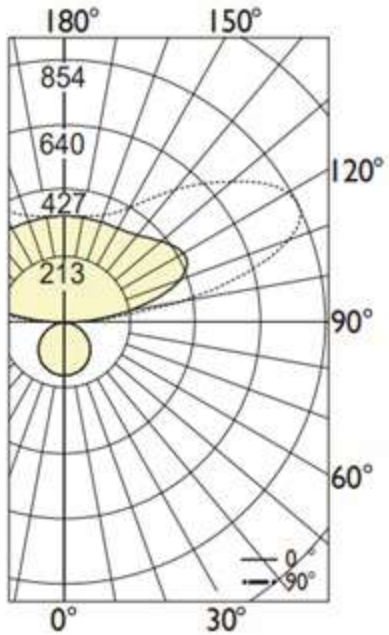
Luminance Data

Direct (80% up)/Indirect (20% down) luminaire

80% up / 20% down at 800 lm/ft

PHOTOMETRIC CURVE



Total Lumens: 3200 lm (for 4ft)
Luminaire Lumens: 800 lm
Input Watts: 38.4 W
Efficacy: 83 lm/W
IES FILE: CUBLED-SL75_25-800-80-35-SO.ies

TESTED ACCORDING TO IES LM-79-2008

CANDELA DISTRIBUTION

	Horizontal Angles				
Vertical Angle	0	22.5	45	67.5	90
0	173	173	173	173	173
5	172	172	172	172	172
15	167	167	166	167	166
25	157	157	156	156	156
35	142	142	141	140	140
45	121	121	121	120	119
55	95	95	96	96	94
65	67	67	68	68	65
75	38	39	39	38	36
85	14	14	14	13	13
90	9	7	7	6	4
95	134	109	97	90	89
105	609	561	437	344	318
115	851	773	604	480	441
125	789	704	571	469	435
135	638	557	472	410	388
145	491	442	402	370	359
155	393	381	367	353	349
165	359	356	351	346	346
175	347	347	346	346	346
180	347	347	347	347	347

ZONAL LUMENS

Zone	Lumens
0	
0-10	16
10-20	47
20-30	72
30-40	88
40-50	93
50-60	85
60-70	66
70-80	41
80-90	16
90-100	128
100-110	467
110-120	611
120-130	527
130-140	380
140-150	259
150-160	171
160-170	100
170-180	33
180	

LUMINANCE DATA (cd/m²)

	Horizontal Angles		
Vertical Angle	0	45	90
45	1806	1809	1781
55	1752	1769	1731
65	1667	1693	1636
75	1566	1589	1485
85	1705	1739	1580

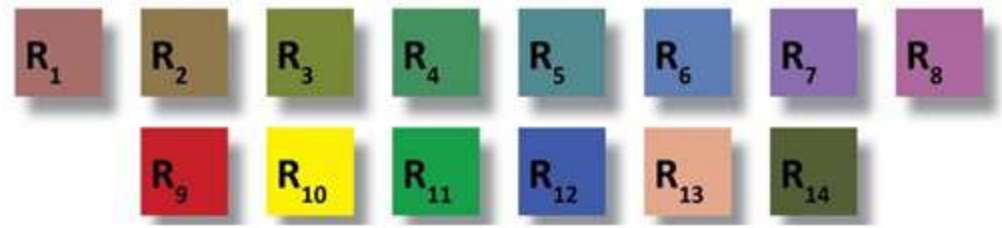
Lighting Quality / Ensure Color Rendering Quality

LEED EQc Interior Lighting Option 2-B
WELL V2 L7.1 Ensure Color Rendering Quality

Color Rendering Index

LEED Eqc Interior Lighting / Option B

- Specify CRI 80 or higher for all light source



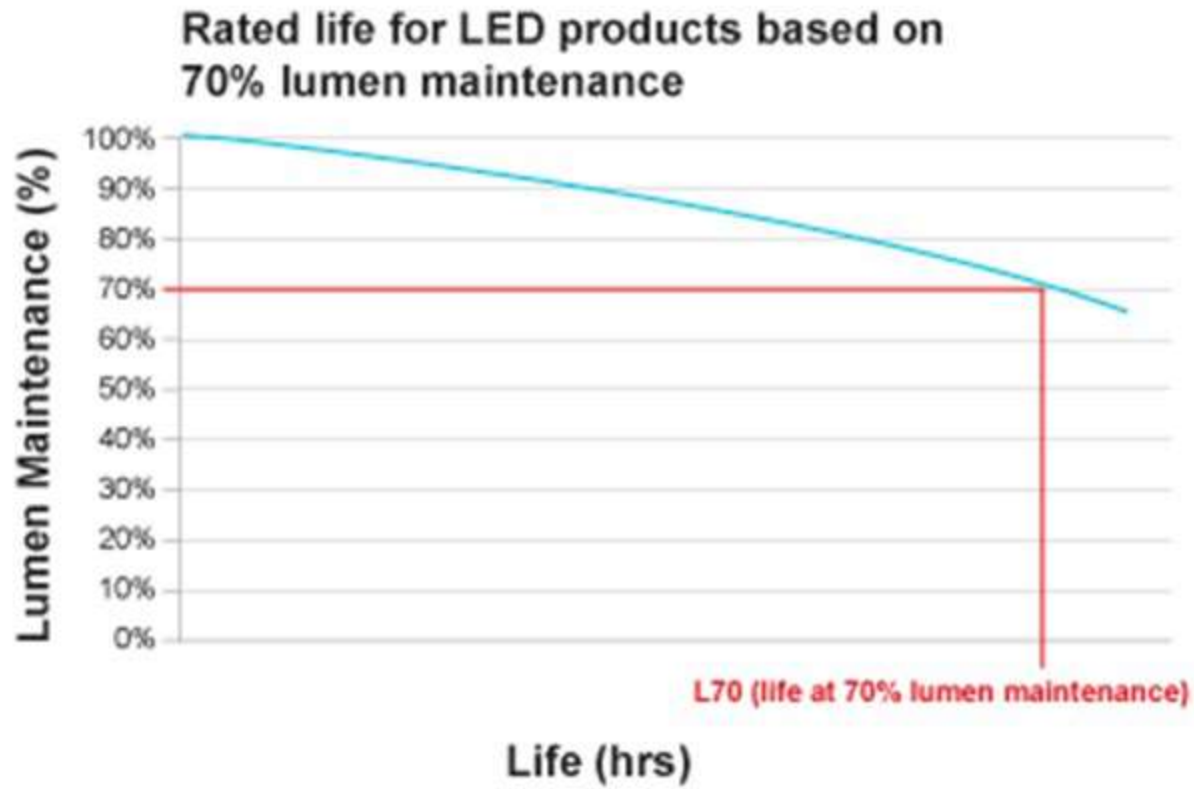
WELL / L7.1 Ensure Color Rendering Quality

- CRI of 90 or higher
- CRI 80 with R9 50
- IES TM-30-18

Lighting Quality / Lamp Life

LEED EQc Interior Lighting Option 2-C

For 75% of the total connected lighting load, use light sources that have a rated life (L70) of 24,000+ hours.



Lighting Quality / Reflectance Value of Surfaces

LEED EQc Interior Lighting Option 2-E/F

E. 90% of the RoS must meet or exceed the following thresholds for the area-weighted average surface reflectance:

- 85% for ceilings
- 60% for walls
- 25% for floors

F. Select furniture finishes to meet or exceed the following thresholds for the area-weighted average surface reflectance:

- 45% for work surfaces
- 50% for movable partitions

Request these reflectance value to architect/interior designer

Lighting Quality / Manage Brightness

LEED EQc Interior Lighting Option 2 G/H
WELL V2 L6.1 Manage Brightness

LEED Eqc Interior Lighting

- Uniformity between Wall and Workplane must be within
  1 (ave. wall surface illuminance) **: 10** (ave. workplane illuminance)

- Uniformity between Ceiling and Workplane must be within
  1 (ave. ceiling illuminance) **: 10** (ave. work surface illuminance)

WELL L6.1 Manage Brightness (meet 4 of them)

- The main rooms cannot be 10 times brighter than adjacent space
- Wall illumination shall be less than uniformity of 1:3 to adjacent walls
- Wall illumination shall be less than uniformity of 1:10 to another remote surface.
- Ceiling lighting uniformity shall be less than 1:10
- Light level change (Scene change) must use fade time of 30+ minutes

Daylight / Ensure Daylight Exposure

LEED EQc Daylight
WELL V2 L1.1 Ensure Indoor Daylight Exposure
WELL V2 L5.2 Enhanced Daylight Exposure

Projects demonstrate through computer simulations that RoS meets criteria below:

sDA 300,50%	Points
Achieved for > 40% of RoS	1 (LEED) 0 (WELL)
Achieved for > 55% of RoS	2 (LEED) 1 (WELL)
Achieved for > 75% of RoS	3 (LEED) 2 (WELL)

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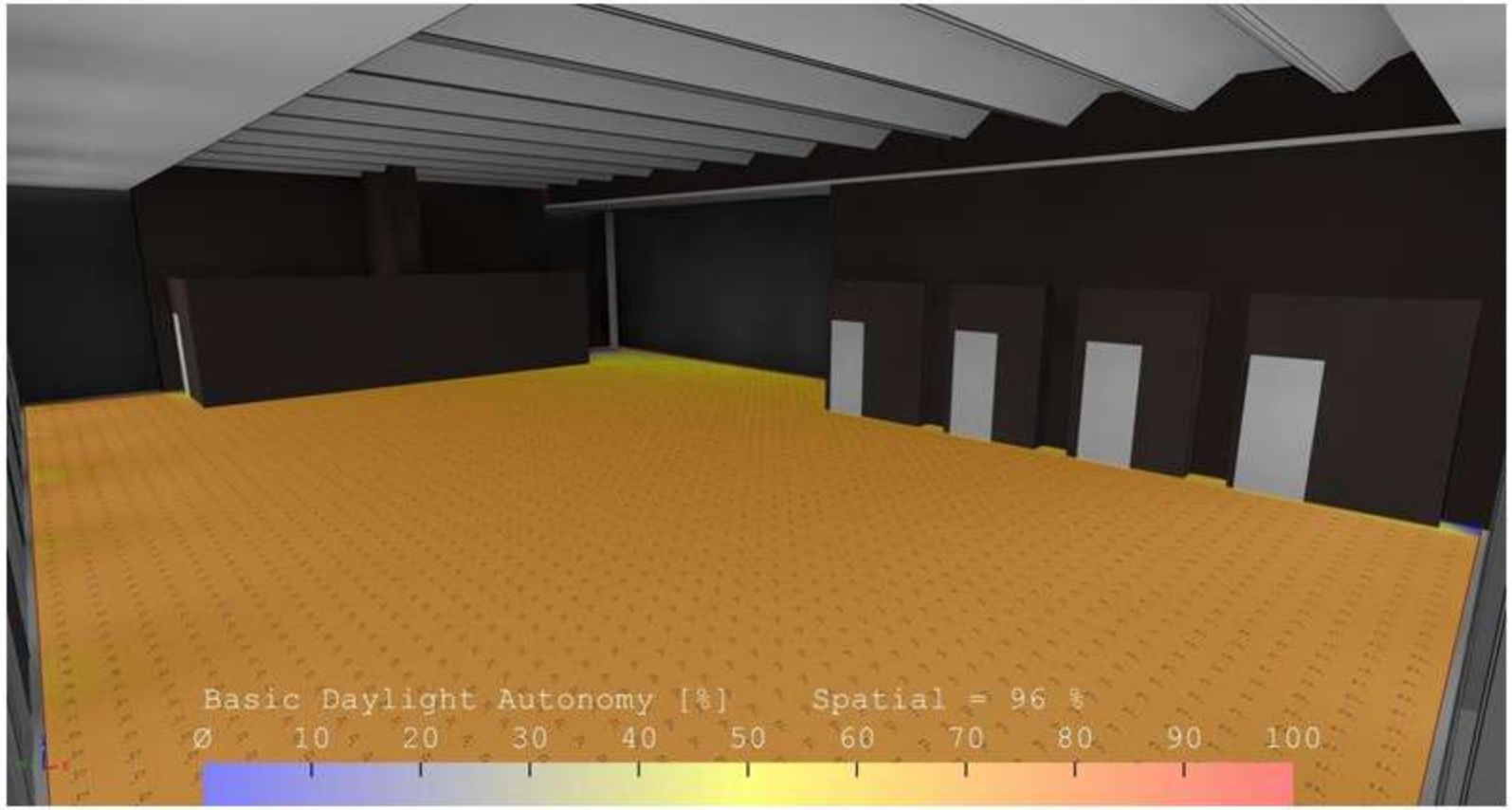
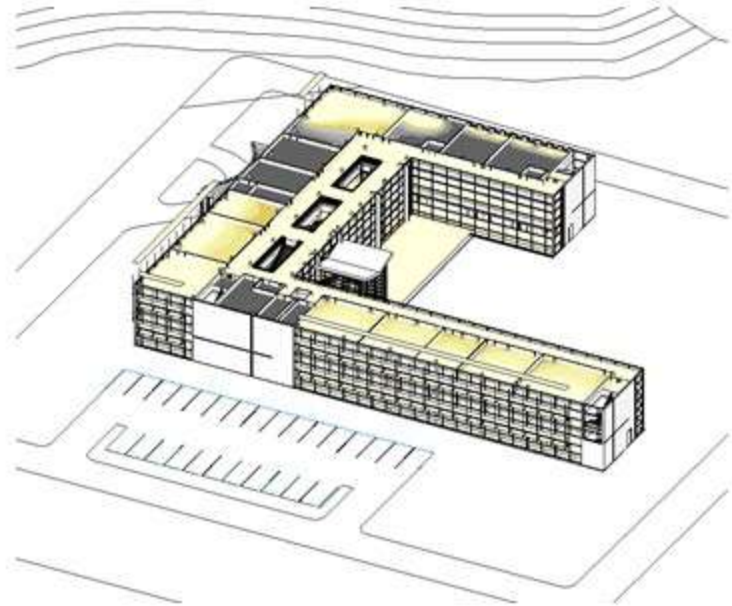
What is Spatial Daylight Autonomy (sDA)?





Spatial Daylight Autonomy of $sDA_{300,50\%}$ is achieved for at least 96% of the space

Daylight / Ensure Daylight Exposure

LEED EQc Daylight
WELL V2 L1.1 Ensure Indoor Daylight Exposure
WELL V2 L5.2 Enhanced Daylight Exposure

Projects demonstrate through computer simulations that RoS meets criteria below:

sDA 300,50%	Points
Achieved for > 40% of RoS	1 (LEED) 0 (WELL)
Achieved for > 55% of RoS	2 (LEED) 1 (WELL)
Achieved for > 75% of RoS	3 (LEED) 2 (WELL)

Daylight / Control Solar Glare

LEED EQc Daylight
WELL V2 L4.1 Control Solar Glare

Install Automatic or Manual Window Shading

Daylight / Control Solar Glare

LEED EQc Daylight
WELL V2 L4.1 Control Solar Glare

Glare Calculation

Annual sunlight exposure of $ASE_{1000,250}$ is achieved for no more than 10% of regularly occupied space.

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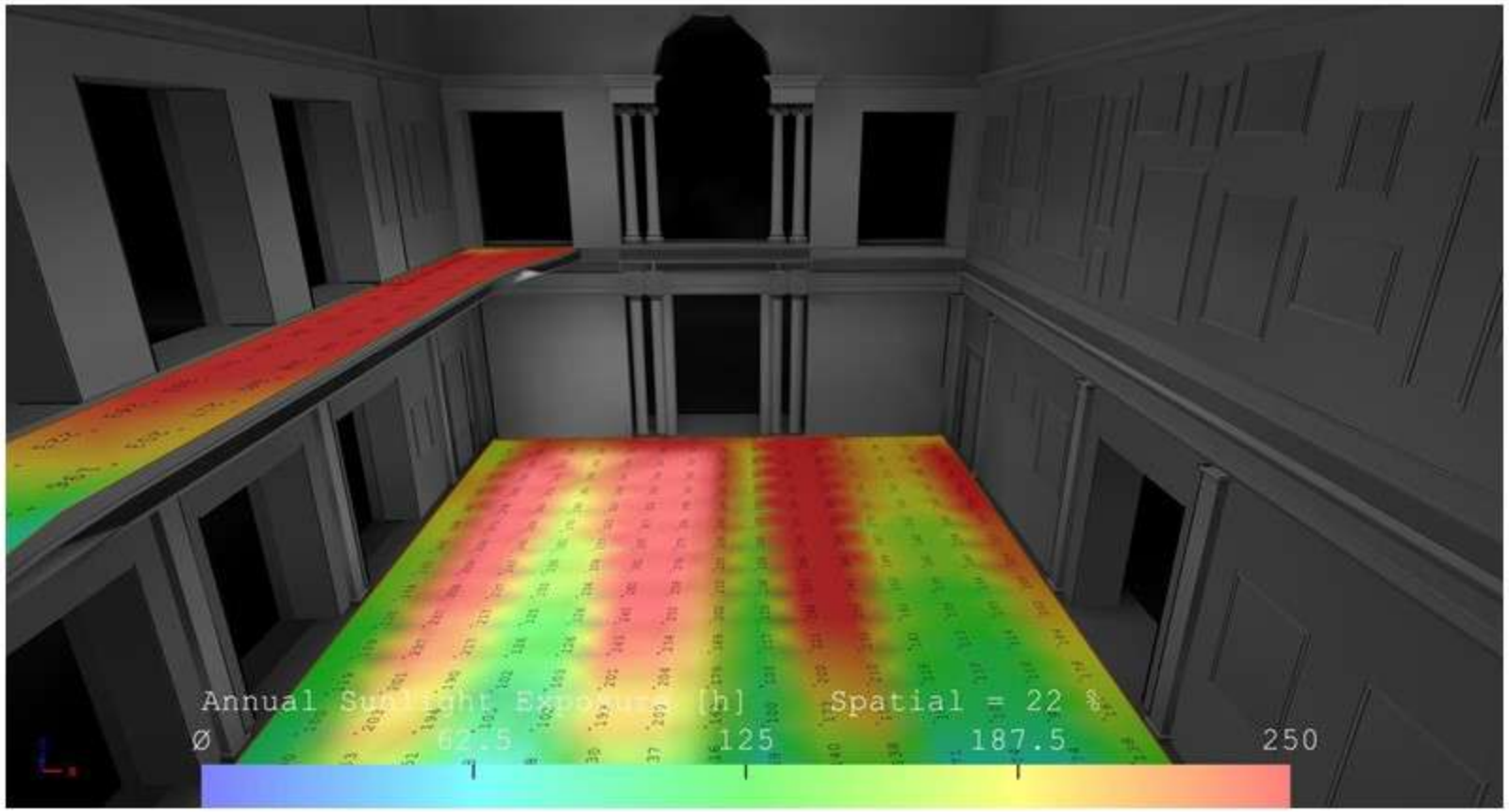
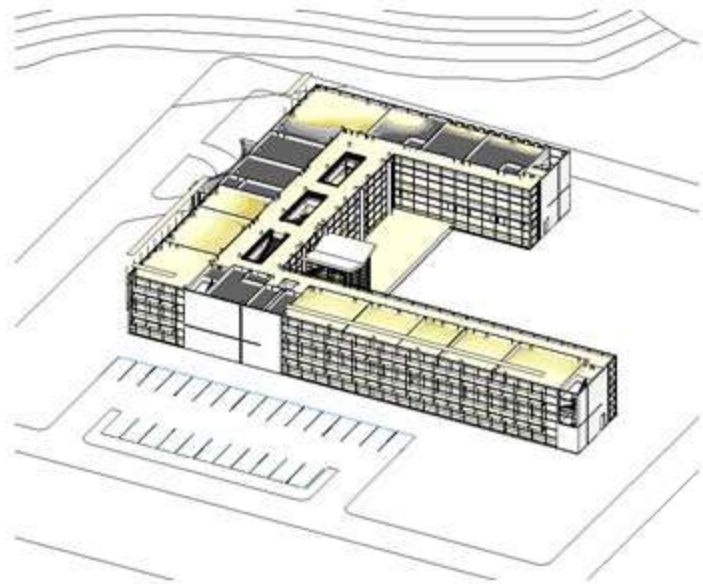
What is Annual Sunlight Exposure (ASE)?





Annual Sunlight Exposure of $ASE_{1000,250}$ is detected at 22% of the space

Daylight / Control Solar Glare

LEED EQc Daylight
WELL V2 L4.1 Control Solar Glare

Glare Calculation

Annual sunlight exposure of $ASE_{1000,250}$ is achieved for no more than 10% of regularly occupied space.

Daylight Views

LEED EQc Quality Views
WELL V2 L5.3 Ensure Views

LEED Eqc Quality Views
Achieve a direct line of sight to the outdoors via vision glazing for **75% of all regularly occupied floor area**.

WELL L5.3 Ensure Views
Meet two criteria for **50% of Regular Building Occupants**

- If at ground floor, maintain 25 ft from the window to the roadway
- View factor of 3
- Achieve a direct line of sight to the ground or sky

Visual Lighting Design

WELL V2 L2 Visual Lighting Design

A- Comply with illuminance recommendations specified in the IES lighting handbook or recommended practice.

B- Annotated lighting plan showing the following information:

1- Visual tasks considered in the lighting design

2- Height of work plane

3- Age ranges

Circadian Lighting Design

WELL V2 L3 Circadian Lighting

The light levels are achieved between at least 9 a.m. and 1 p.m. and may be lowered after 8 p.m. at night:

Option 1 Electric light only method
At least 150 EML = 1 point
At least 240 EML = 3 points

Option 2 Electric and daylight (L05: Daylight) combined method
At least 120 EML (from Elec Light) = 1 point
At least 180 EML (from Elec Light) = 3 points

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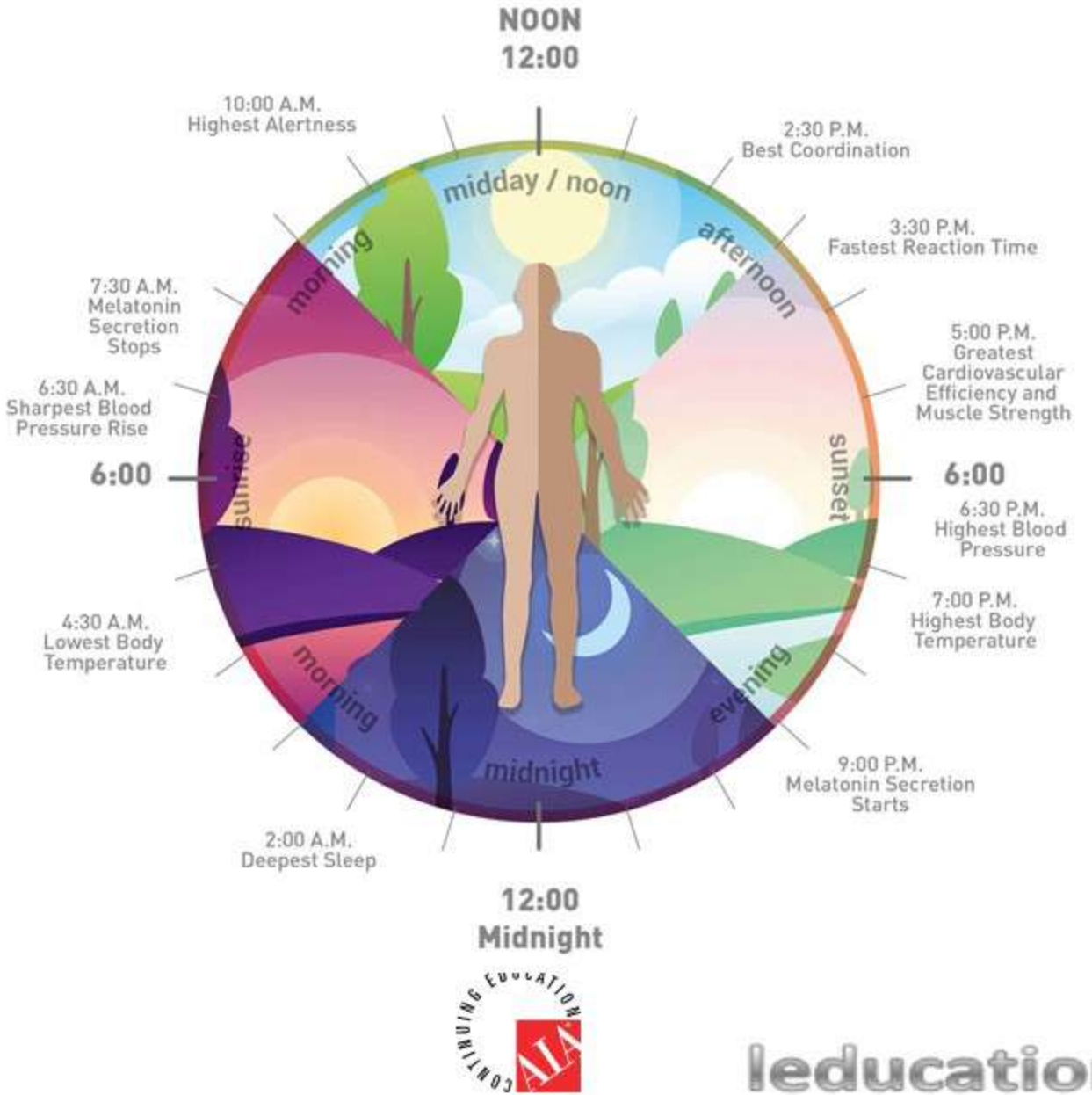
Lighting in WELL

Circadian Rhythm

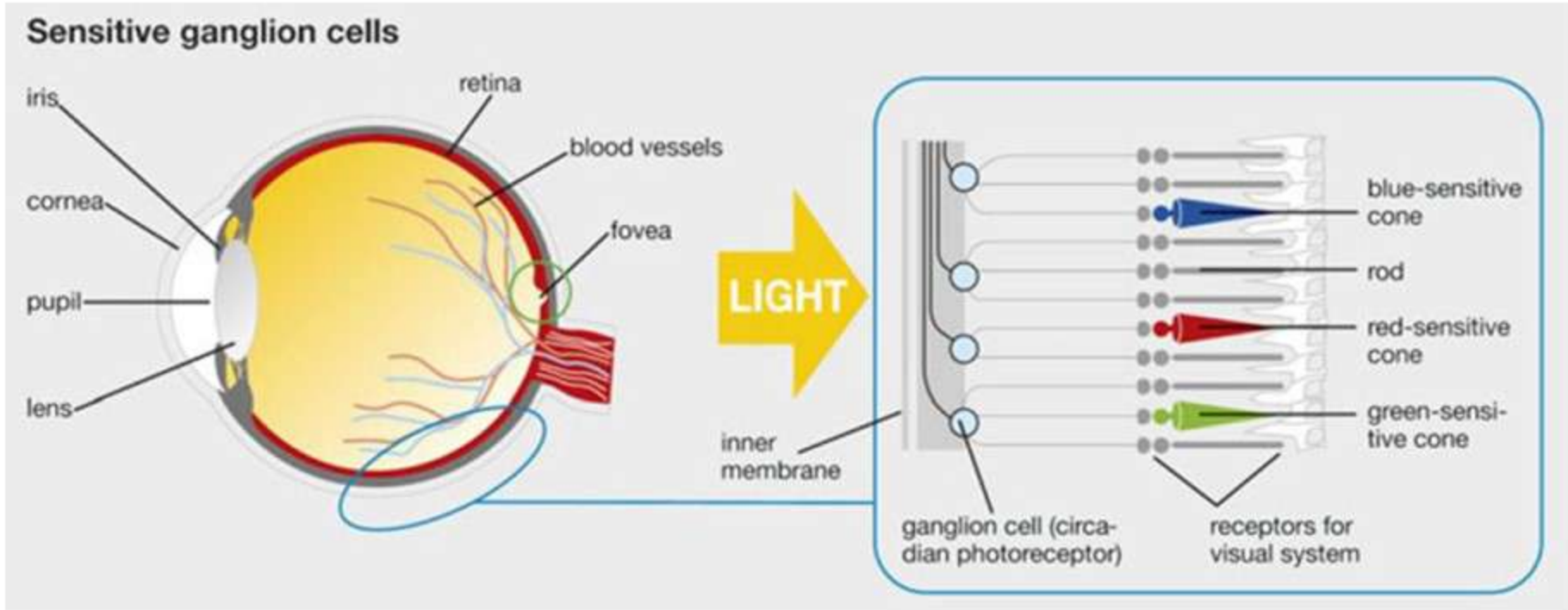
Internal clock that keeps the body's hormones and bodily processes on a roughly 24-hour cycle, even in continuous darkness.



Lighting in WELL

Why Lighting Matters?

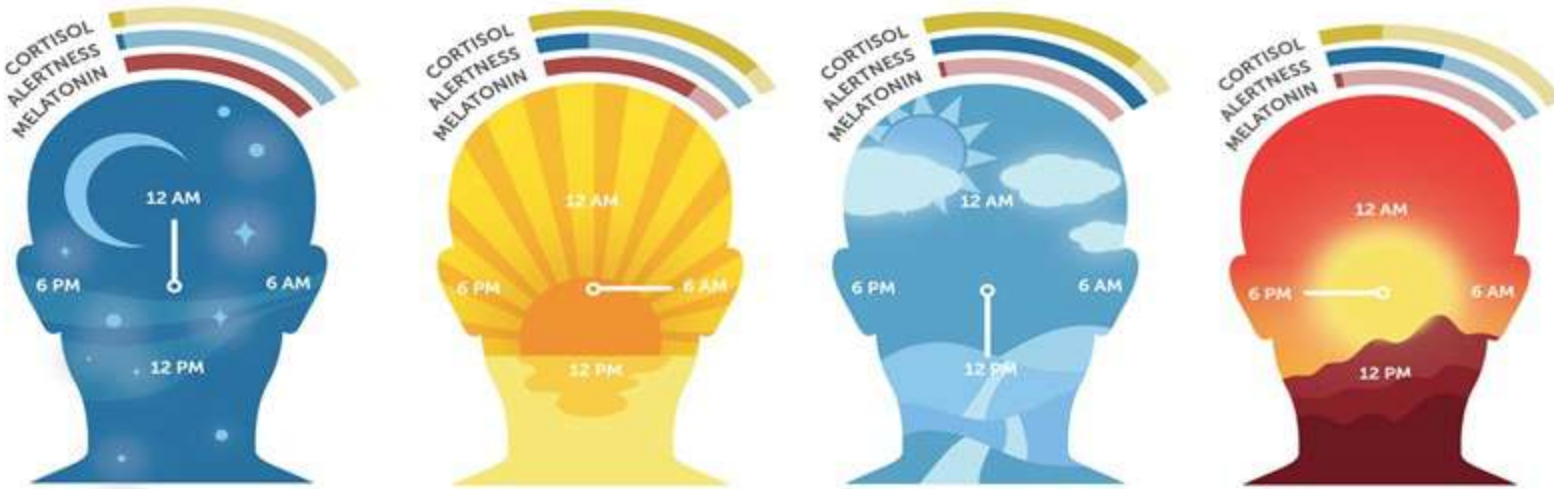
Role of IPRGCs (Intrinsically Photosensitive Retinal Ganglion Cells)



Lighting in WELL

Light As a Regulator

Light exposure stimulates the circadian system, which starts in the brain and regulates physiological rhythms throughout the body, including hormone levels and the sleep-wake cycle.



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What is Equivalent Melanopic Lux? (EML)

Equivalent Melanopic Lux = Photopic Lux x Melanopic Ratio

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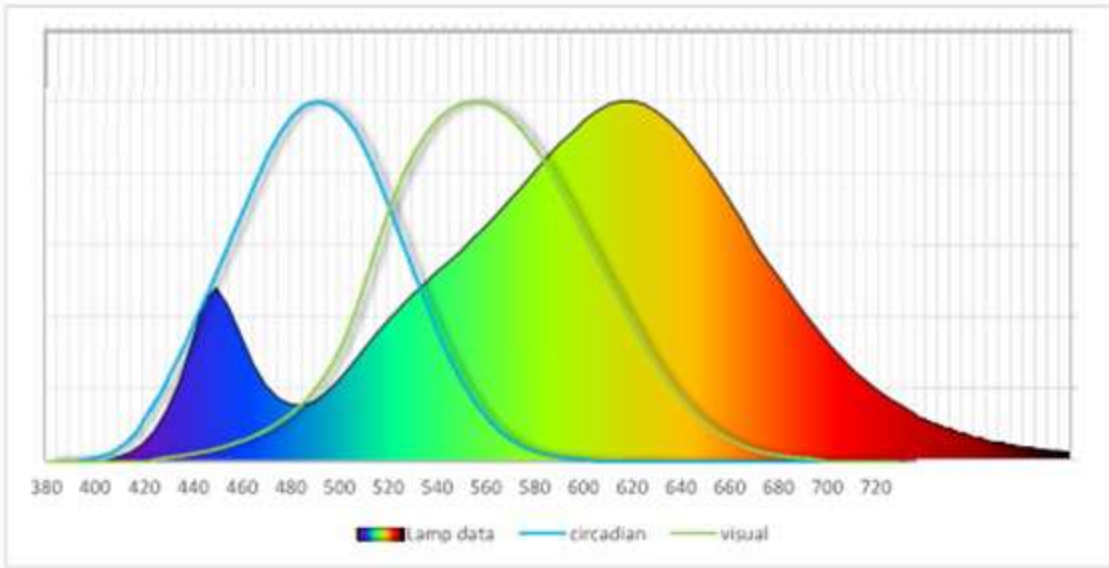
How does Equivalent Melanopic Lux effect WELL Design? (EML)

Source
User 2 2700K LED

Melanopic Ratio
0.469
Click here for data input

Instructions
1. Select built-in sample source, or user-entered source (above).
2. For user data, paste lamp spectral power distribution (5 nm increments) into Data sheet.
3. To add more user sources, insert columns to the left of User 2 on the Data sheet.
4. Multiply the Melanopic Ratio by measured or modeled lux to calculate equivalent melanopic lux.



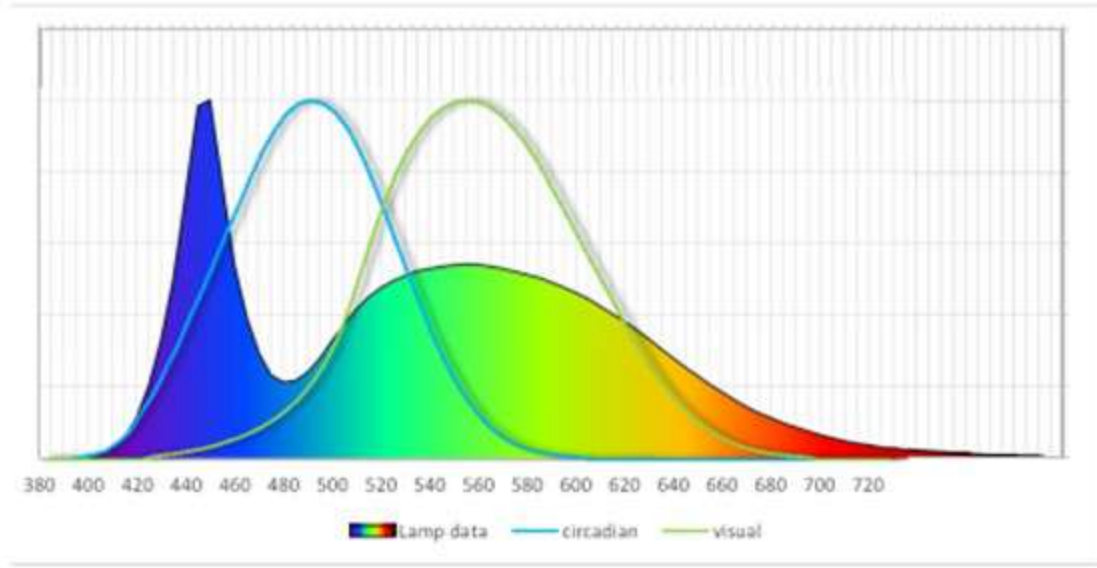
Equivalent Melanopic Lux = 300 lux x 0.469

Equivalent Melanopic Lux = 140 EML

Source
User 2 6000K LED

Melanopic Ratio
0.903
Click here for data input

Instructions
1. Select built-in sample source, or user-entered source (above).
2. For user data, paste lamp spectral power distribution (5 nm increments) into Data sheet.
3. To add more user sources, insert columns to the left of User 2 on the Data sheet.
4. Multiply the Melanopic Ratio by measured or modeled lux to calculate equivalent melanopic lux.



Equivalent Melanopic Lux = 300 lux x 0.903

Equivalent Melanopic Lux = 270 EML

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Where to Find Melanopic Ratio

DELIVERED LUMENS (3000K SS40)	07LM	560 lm
	10LM	800 lm
	13LM	1040 lm
	20LM	1600 lm
	27LM	2160 lm
CCT	27K	2700K
	30K	3000K
	35K	3500K
	40K	4000K
	50K	5000K
CRI	97	97CRI
RE	HE40	40° high efficiency diffused lens (0.95)
	HE60	60° high efficiency diffused lens (0.94)
	HE80	80° high efficiency diffused lens (0.98)
DIMMING	DALI[3]	flicker free DALI dimming to 1%
	DALIZ[3]	flicker free DALI dimming to 0%
	DMXZ	flicker free DMX dimming to 0%
	LTE	Lutron Hi-lume 2-Wire (Triac) dimming to 1%
	LUT	Lutron Hi-lume EcoSystem dimming to 1%, Soft-on & Fade-to-Black
	LUTP[r]	Lutron Hi-lume Premier EcoSystem dimming to 0.1%, Soft-on & Fade-to-Black
	ELV[4]	leading & trailing edge (Triac/ELV) dimming to <10%
	ELV1[4]	leading & trailing edge (Triac/ELV) dimming to 1%
MOUNTING OPTIONS	NC	new construction with ceiling fitting plate
	IC[1]	insulation contact housing
	ICAT[1]	insulation contact / airtight housing
	CP[1]	chicago plenum housing
	RET	retrofit, no ceiling fitting plate

Calculated Delivered Lumens =
[Delivered Lumen Value] x [CCT Multiplier] x [Reflector Multiplier]

CCT	2700K	3000K	3500K	4000K	5000K
CCT MULTIPLIER FOR LUMEN OUTPUT	0.96	1.00	1.03	1.08	1.14
EML RATIO[6]	N/A	0.57	0.67	0.76	0.87

CCT	2700K	3000K	3500K	4000K	5000K
CCT MULTIPLIER FOR LUMEN OUTPUT	0.96	1.00	1.03	1.08	1.14
EML RATIO[6]	N/A	0.57	0.67	0.76	0.87

How to Calculate Melanopic Ratio

λ (nm)	Lamp data	circadian	visual	lamp*c	lamp*v
380	0.089	0.0009	0.0000	0.0001	3.6E-06
385	0.088	0.0017	0.0001	0.0001	5.3E-06
390	0.087	0.0031	0.0001	0.0003	1E-05
395	0.809	0.0059	0.0002	0.0048	0.00018
400	2.477	0.0114	0.0004	0.0283	0.00099
405	1.068	0.0228	0.0006	0.0244	0.00068
410	0.848	0.0462	0.0012	0.0391	0.00103
415	1.449	0.0795	0.0022	0.1151	0.00316
420	2.377	0.1372	0.0040	0.3262	0.00951
425	11.754	0.1871	0.0073	2.1991	0.0858
430	22.863	0.2539	0.0116	5.8042	0.26521
435	6.404	0.3207	0.0168	2.0538	0.10785
440	4.287	0.4016	0.0230	1.7215	0.0986
445	4.122	0.4740	0.0298	1.9537	0.12283
450	4.230	0.5537	0.0380	2.3422	0.16074
455	3.901	0.6297	0.0480	2.4562	0.18724
460	3.572	0.7080	0.0600	2.5289	0.2143
465	3.188	0.7852	0.0739	2.5031	0.23558
470	3.132	0.8603	0.0910	2.6945	0.28495
475	6.117	0.9177	0.1126	5.6133	0.68872
480	10.727	0.9656	0.1390	10.3576	1.4912
485	9.566	0.9906	0.1693	9.4766	1.61958
490	6.190	1.0000	0.2080	6.1900	1.28763
495	3.318	0.9920	0.2586	3.2917	0.85809
500	1.540	0.9660	0.3230	1.4875	0.4974
505	1.211	0.9223	0.4073	1.1167	0.49314
510	0.827	0.8629	0.5030	0.7135	0.41594
515	0.826	0.7852	0.6082	0.6484	0.50225
520	0.934	0.6996	0.7100	0.6535	0.66322
525	5.608	0.6094	0.7932	3.4177	4.44835
530	29.531	0.5193	0.8620	15.3355	25.4554
535	75.415	0.4325	0.9149	32.6196	68.9936
540	61.275	0.3517	0.9540	21.5509	58.4564
545	13.643	0.2791	0.9803	3.8081	13.3737
550	3.533	0.2157	0.9950	0.7621	3.51491
555	1.392	0.1621	1.0000	0.2255	1.39153
560	1.199	0.1185	0.9950	0.1421	1.19303

Source

Sample Fluorescent 4000 K

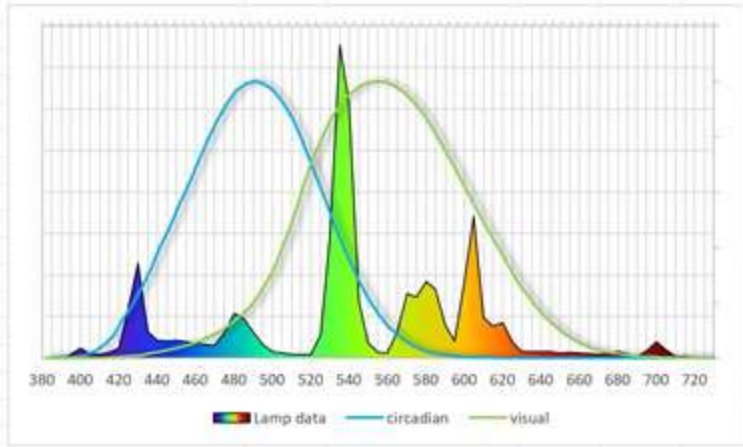
Melanopic Ratio

0.588

Click here for data input

Instructions

1. Select built-in sample source, or user-entered source (above).
2. For user data, paste lamp spectral power distribution (5 nm increments) into Data sheet.
3. To add more user sources, insert columns to the left of User 2 on the Data sheet.
4. Multiply the Melanopic Ratio by measured or modeled lux to calculate equivalent melanopic lux.



INTERNATIONAL WELL BUILDING INSTITUTE™

1. Download Melanopic Ratio Excel file from IWBI website

2. Data input
   Lamp spectral power distribution (5nm increments)

Circadian Lighting Design

WELL V2 L3 Circadian Lighting

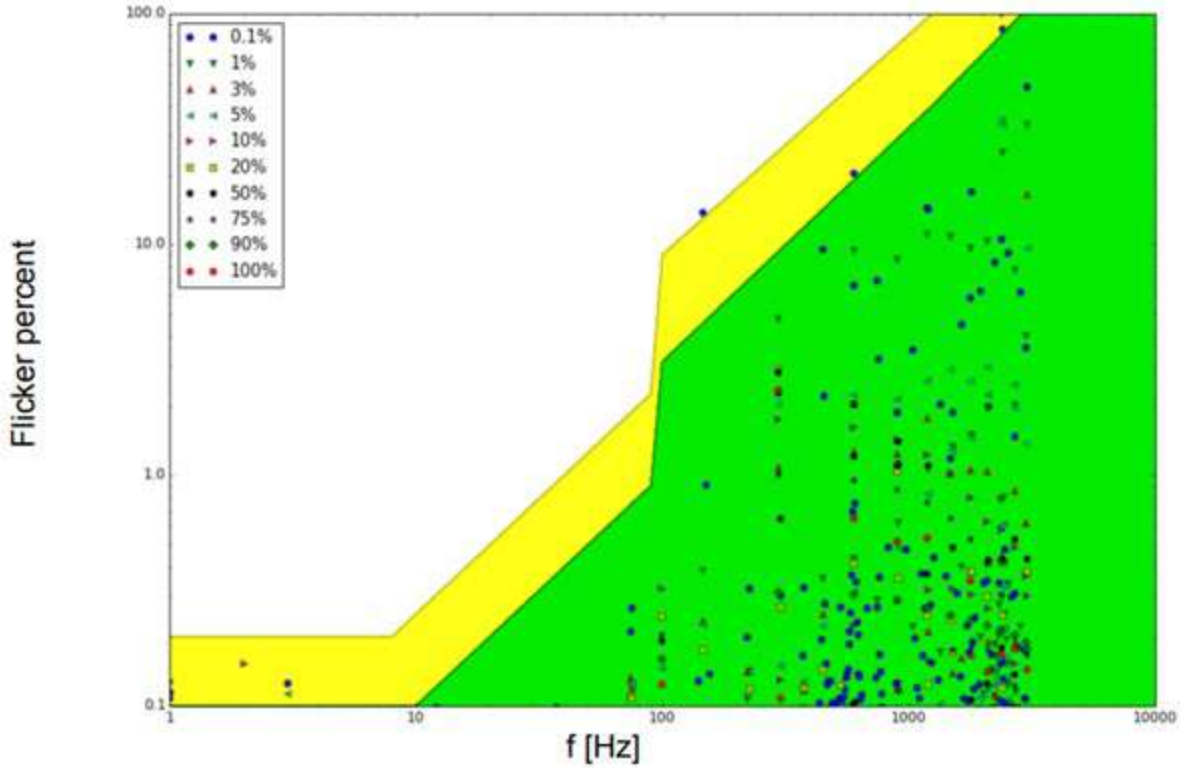
The light levels are achieved between at least 9 a.m. and 1 p.m. and may be lowered after 8 p.m. at night:

Option 1 Electric light only method
At least 150 EML = 1 point
At least 240 EML = 3 points

Option 2 Electric and daylight (L05: Daylight) combined method
At least 120 EML (from Elec Light) = 1 point
At least 180 EML (from Elec Light) = 3 points

Manage Flicker

WELL V2 L7.2 Electric Glare Control



Meet one of the following criteria :

- A minimum frequency of 90 Hz within the range of 10% -100% light output.

- Provide state of compliance with IEEE standard 1789-2015 from the manufacturer for each LED/Driver combination. Include supporting values of full light output and published numerical values.

LEED + WELL Proof Lighting Base Layer

LEDucation

This concludes The American Institute of Architects Continuing Education Systems Course