

Integration of Dayand Electric Light for Meeting Circadian Lighting Metrics

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WELL Building Standard[™] Version 2

CONCEPTS / LIGHT / FEATURE L03 OPTIMIZATION

Circadian Lighting Design

Support circadian health through interventions using electric lighting

Equivalent melanopic lux (EML) thresholds achieved at 100% of workstations for 4+ hours, beginning by noon at the latest, at a height of 18" above the work-plane.

Max

3 Pts

	Electric Lighting Only		Electric Lighting with Enhanced Daylight			
1 point	EML > 150 m-lux	OR	EML > 120 m-lux			
3 points	EML > 240 m-lux	OR	EML > 180 m-lux			

Meeting WELL v2 with Electric Light



Varying simulation parameters:

- Light source color temperature
- Luminaire lumen output
- Surface reflectance
- View directions

Calculated metrics:

- Illuminance
- EML
- Annual Energy Usage

% Lumen Output	ССТ (К)	Avg E _h (lux)	Avg E _v (lux)	Avg EML (m-lux)	% Views 150+ EML	% Views 240+ EML	Meet WELL Requirement?	Annual Energy Usage (kWh)
50	3800	389	191	112	0%	0%	N	2591
100	6200	773	369	305	100%	98%	Y – 1 point	5183

Energy impact of human health and wellness lighting recommendations for office and classroom applications S Safranek, JM Collier, A Wilkerson, RG Davis - Energy and Buildings, 2020

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3 points	EML > 240 m-lux	OR	EML > 180 m-lux						
275 m-lux (WELL v2 2021 Q4)									

New Circadian Lighting Recommendations

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 1 December 2020

doi:10.20944/preprints202012.0037.v1

Recommendations for healthy daytime, evening, and night-time indoor light exposure

Timothy M. Brown¹, George C. Brainard², Christian Cajochen³, Charles A. Czeisler^{4,5}, John P. Hanifin², Steven W. Lockley^{4,5,6}, Robert J. Lucas¹, Mirjam Münch⁷, John B. O'Hagan⁸, Stuart N. Peirson⁹, Luke L. A. Price⁸, Till Roenneberg¹⁰, Luc J.M. Schlangen¹¹, Debra J. Skene¹², Manuel Spitschan¹³, Céline Vetter¹⁴, Phyllis C. Zee^{15,16}, Kenneth P. Wright Jr¹⁷.

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"Daytime light recommendations for indoor environments

Throughout the daytime, the recommended minimum melanopic EDI is 250 Ix at the eye measured in the vertical plane at ~ 1.2 m height (i.e., vertical illuminance at eye level when seated). If available, daylight should be used in the first instance to meet these levels. If additional electrical lighting is required, the polychromatic white light should ideally have a spectrum that, like natural daylight, is enriched in shorter wavelengths close to the peak of the melanopic action spectrum (Fig 1A)."

mEDI = EML / 1.103

250 mEDI [lux] = 276 EML [m-lux]

WELL Defined "Enhanced Daylight"

	CONCEPTS / LIGHT / FEATURE LOS OPTIMIZATION Daylight Design Strategies Provide daylight exposure indoors through design strategies.									
1 point	70% of workstations are within 25 ft of glazing VLT greater than 40%	OR	Glazing area is more than 15% of regularly occupied floor area VLT greater than 40%							
3 points	70% of workstations are within 16 ft of glazing VLT greater than 40%	OR	Glazing area is more than 25% of regularly occupied floor area VLT greater than 40%							

https://v2.wellcertified.com/wellv2/en/light/feature/3

WELL Defined "Enhanced Daylight"

	CONCEPTS / LIGHT / FEATURE L05 Daylight Design Provide daylight exposure indoors	MIZATION Trategies h design strategies.	CONCEPTS / LIGHT / FEATURE LOG OPTIMIZATION Daylight Simulation Ensure indoor daylight exposure through daylight simulation strategies.			
1 point	70% of workstations are within 25 ft of glazing VLT greater than 40%	OR	Glazing area is more than 15% of regularly occupied floor area VLT greater than 40%	sDA ₃₀₀ ,50% for at least 55% regularly occupied floor area	OR	50% of daylit hours have target illuminance of 28 fc for more than 50% of individual unit area
3 points	70% of workstations are within 16 ft of glazing VLT greater than 40%	OR	Glazing area is more than 25% of regularly occupied floor area VLT greater than 40%	sDA ₃₀₀ ,50% for at least 75% of regularly occupied floor area	OR	50% of daylit hours have target illuminance of 28 fc for more than 50% of individual unit area and average illuminance 9 fc for more than 95% of individual unit area

Spectral Modeling Software Tools





- Open-source
- Radiance lighting engine
- 3 or 9 spectral bins
- Daylighting design

→Daylight spectra directly measured or derived using global horizontal CCT



Adaptive Lighting for Alertness



- Radiance lighting engine
- 81 spectral bins
- Electric lighting + daylighting design

→ Daylight spectra calculated using atmospheric parameters



5923 K

6226 K

5 PM 6153 K

Estimating EML – Open Office Model

- Golden, CO
- South facing glazing
- 90% envelope glazing area
- 45% VLT
- $sDA_{300,50\%} = 66\%$ floor area

Estimating EML – Open Office Model

- 40 Workstations
- Vertical view directions with 180° field of view
- 4 ft above floor
- Daylight only

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Open Office Model – Avg EML, All Workstations

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*Glare calculated using simplified daylight glare probability (DGPs)

Open Office Model – Avg EML, All Workstations Hrs w/ Intolerable Glare* & EML < 150 Removed

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-++-

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Open Office Model – Avg EML, All Workstations Hrs w/ Intolerable Glare* & EML < 275 Removed

	Month												
Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
	24 hou	irs							Averag	e EML (1	m-lux)		
	*Glare calcul	ated using	simplified day	ylight glare p	robability (D0	GPs)			0			1,000	+

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Open Office Model – Avg EML, 2 Rows Nearest Glazing

*Glare calculated using simplified daylight glare probability (DGPs)

*Glare calculated using simplified daylight glare probability (DGPs)

Open Office Model – Avg EML, 2 Rows Nearest Glazing Hrs w/ Intolerable Glare & EML < 275 Removed

Key Takeaways

Daylight can only go so far

It is likely that supplemental electric lighting will be needed on most projects to meet current EML recommendations

Opportunity for integrated control

Advanced daylight dimming or blind control strategies may increase daylight/EML in the space while minimizing electric energy usage

Don't forget about glare

Designing to meet EML recommendations will result in high levels of vertical illuminance, increasing the opportunity for glare

 Software is improving but data is limited Annual, diurnal spectral measurements needed to inform spectral sky models in software