

WELL 2 Building Standard

Requirements for electric lighting

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Overview- Light



△ WELL v2

Concepts and Features

10 Concepts 23 Preconditions required 95 Optimizations available

Air 4 Preconditions 10 Optimizations	Sound 1 Preconditions 5 Optimizations
Water 3 Preconditions 5 Optimizations	Materials 3 Preconditions 11 Optimizations
Nourishment 2 Preconditions 11 Optimizations	Mind 2 Preconditions 13 Optimizations
Light 2 Preconditions 6 Optimizations	Community 3 Preconditions 13 Optimizations
Movement 2 Preconditions 10 Optimizations	Innovations 0 Preconditions 5 Optimizations
Thermal Comfort 1 Preconditions 6 Optimizations	

Overview



Whole building points based system
Based on 11 subject **pre-conditions** (not negotiable)
There are 2 lighting pre-conditions

Optimisations (applied as required as part of the performance specification)
Lighting optimisations = 14 points to allow for design variances

WELL core certification	= 40 points*
WELL SILVER	= 50 points*
WELL GOLD	= 60 points*
WELL PLATINUM	= 80 points*

***Based on 1 point per concept minimum and 12 points per concept maximum**

Disclaimer

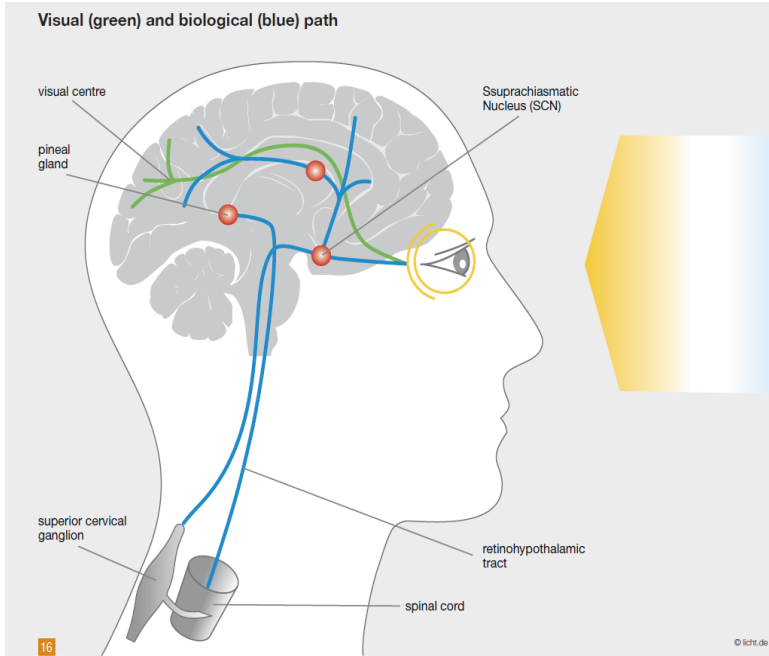
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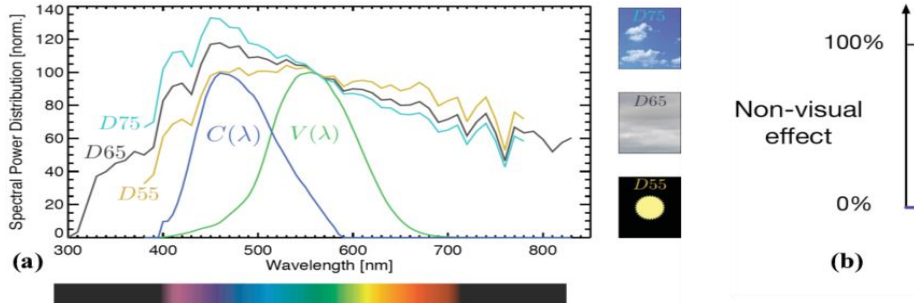
What is Melanopic Lux ? The human response



Non visual effects via ipRGCs receptors in the eyes

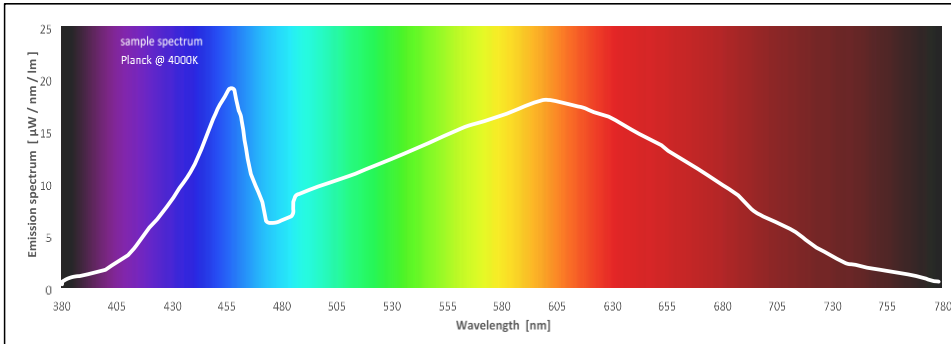
- Body temperature
- Melatonin regulation
- Sleep/wake cycle
- Cognitive function
- Attention
- Mood

What is Melanopic Lux ?- The light spectrum



Daylight spectrum report

source: CIE



LED spectrum report - 42183317 TECTON C

29 July 2019

- Melanopic lux (CA) is a sub-component found in the visible light spectrum that helps stimulate the circadian rhythm but does not improve normal vision.
- Traditional designs for interior lighting are based on photopic lux levels (illumination) (VA)
- WELL 2 refers to equivalent melanopic lux or EML in addition to photopic lux levels.
- EML can be calculated and applied to lighting designs.
- EML is measured in the vertical plane to determine the EML illumination at eye level

Section L-Lighting



PRE CONDITIONS (minimum requirement)

- L01 (pre-condition) Light Exposure & Education of users (architectural)
- L02 (pre-condition) Visual lighting design ([lighting design & specification to EN 12464-1 2011](#))

OPTIMISATIONS

- L03 Circadian lighting – based on equivalent 150-240 [melanopic lux](#) vertical/cylindrical at 1.4m (cat A or general spaces) or at 450mm above work stations for 4 hours. (+ 1-3 points)
- L04 Glare Control- Part 1- architectural but may include shading control [via lighting control system](#) (+ 2 points)
Part 2- [Luminaires](#) (+2 points)
 - 100% of light emitted above the horizontal plane
 - UGR for work stations is <19
 - Restrictions on shielding angles dependant on cd/m²

Section L- Lighting



OPTIMISATIONS con't

L05 Enhanced Daylight Access architectural (max 3 points)

L06 Visual balance (1 point) mostly architectural but supported by-

- Timing of light changes/levels are gradual over at least 30 mins **Lighting Control**
Illuminance difference between adjacent lighting zones not more than a factor of 10 **Lighting design**

Scale of illuminance (lux)

20 30 50 75 100 150 200 300 500 750 1000 1500 2000 3000 5000

L07 Electric Light Quality (max 2 points)

- **CRI or TM30 task areas CRI 90 or CRI 80 with R9 greater than 50** < CRI 80 to circulation
- **Flicker min 90Hz at all 10% increments in the 10-100% step range** as per *IEEE 1798-2015 LED*

L08 Occupant Control of Lit environment (max 2 points) **Lighting controls and free standing luminaires**

- Controls are tuneable/automated for general lighting
- Local controls for individual tastes in level, CCT and colour
- Supplementary lighting available- no additional cost, 2 x L02 designed levels and in place within 8 weeks.
- **CONCLUSION-** Compliant lighting/controls could contribute up to 24% of Well Silver, 20% of Well Gold or 15% of Well Platinum scores

How to design to the Well Standard

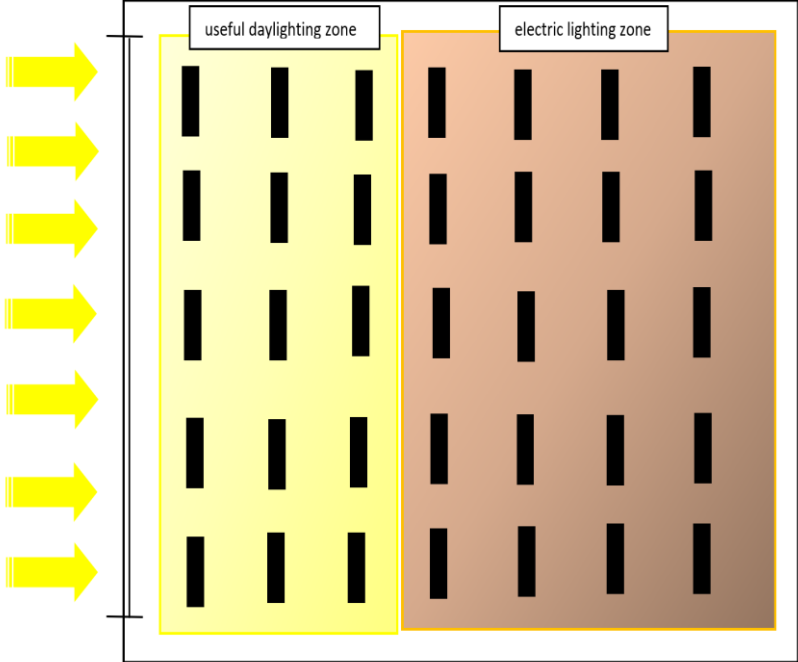


- Likely to be office/ education work stations. CAT A has a general background level pending CAT B.
- Need the EML illumination de-rating factor(s) for the preferred luminaire see EML calculator provided by WELL or manufacturers data sheets that include EML data.
- Need to ensure the luminaire proposed is min CRI 80/R9>50 or CRI 90, fixed CCT or TW.
- Dialux plot then vertical slice at WP + 450mm or 1400mm affl. 9.3m² grid for CAT A or work station positions. We can only calculate for night time conditions. Day light contribution added by the architect or lighting designer
- De-rate photopic plot by luminaire factor for EML conversion.
- Project will likely need on site verification as per Well Standard lighting verification method and a re-visit every 12 months to check lighting levels. Levels can be measured as photopic and de-rated back to EML. Melanopic light meters are rare and expensive.

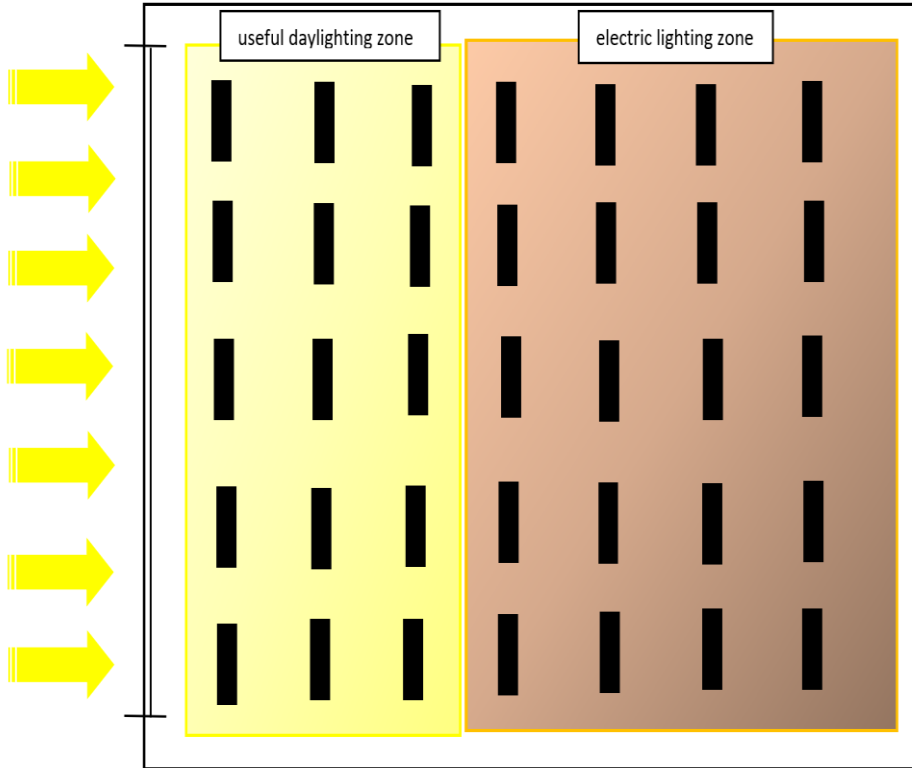
L01 & L05 Natural Light Contribution Modelling - Architectural



L01 Day Light autonomy index 30-70%



L03 Electric Lighting Zone



Electric lighting zone

Mode 1 9am-1pm

EML target as L03. CCT subject to client preference and energy target.

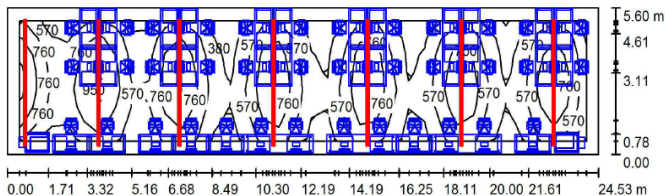
Mode 2 all other times outside mode 1 can be photopic illumination as per L02 and specified optimisations

<https://knowledge.autodesk.com/support/revit-products/getting-started/caas/simplecontent/content/daylight-analysis-bim.html>

L02- Lighting Design to BS EN 12464-1



Area 1 - Option 1B / Summary



Height of Room: 2.745 m, Mounting Height: 2.380 m, Maintenance factor: 0.80
 Values in Lux, Scale 1:176

Surface	ρ [%]	E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	$u0$
Workplane	/	610	163	1099	0.268
Floor	10	304	30	803	0.100
Ceiling	70	263	56	954	0.214
Walls (4)	50	199	32	629	/

Workplane:

Height: 0.700 m
 Grid: 35 x 7 Points
 Boundary Zone: 0.500 m

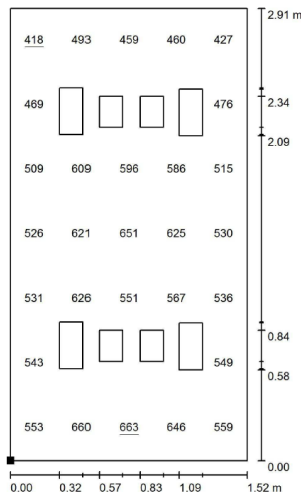
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.331, Ceiling / Working Plane: 0.360.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	28	Zumtobel 42182205 ECOOS ID LED4400-840 L1200 LDO [STD] (1.000)	4260	4260	42.0
			Total: 119280	Total: 119280	1176.0

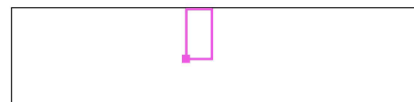
Specific connected load: $8.56 \text{ W/m}^2 = 1.41 \text{ W/m}^2/100 \text{ lx}$ (Ground area: 137.32 m^2)

Area 1 - Option 1A / Typical 4 Person Workstation / Value Chart (E, Horizontal)



Not all calculated values could be displayed.

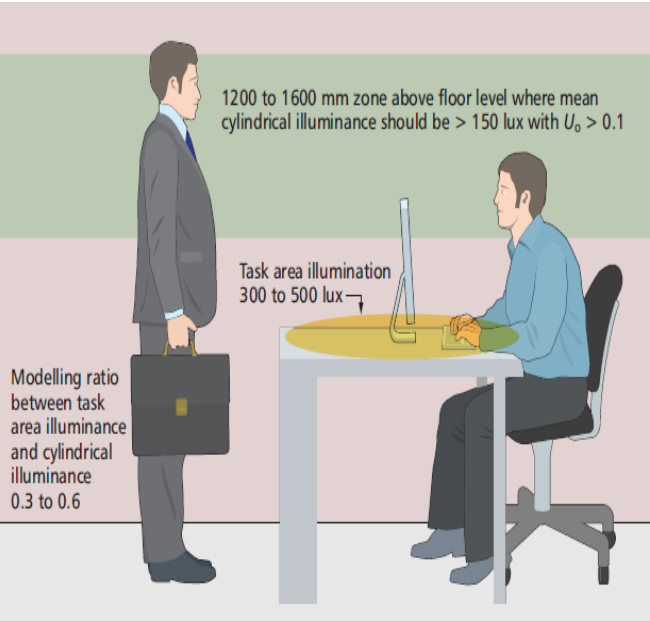
Position of surface in room:
 Marked point:
 (17.849 m, 13.753 m, 0.700 m)



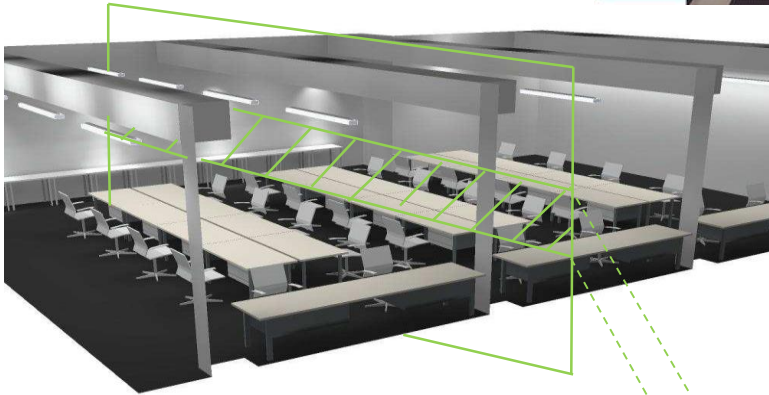
Grid: 5 x 7 Points

E_{av} [lx]	E_{min} [lx]	E_{max} [lx]	$u0$	E_{min} / E_{max}
550	418	663	0.760	0.630

L02- Lighting Design- Vertical illuminance



Source: BS EN 12464-1 & LG 7



590	675	677	<u>681</u>	676	657	670	675	669	669	619
452	530	545	550	544	536	540	540	535	523	463
296	323	337	345	339	335	333	332	324	313	297
228	235	246	251	249	247	244	244	230	221	222
213	219	230	236	236	236	230	227	215	207	<u>206</u>

0.00 2.78 m 0.00 8.14 m

LO3- Calculation Tool for EML ratio



λ (nm)	Lamp data	circadian	visual	lamp*c	lamp*v
380	0.000	0.0009	0.0000	0.0000	0
385	0.000	0.0017	0.0001	0.0000	0
390	0.000	0.0031	0.0001	0.0000	0
395	0.000	0.0059	0.0002	0.0000	0
400	0.000	0.0114	0.0004	0.0000	0
405	0.001	0.0228	0.0006	0.0000	9.3E-07
410	0.003	0.0462	0.0012	0.0001	3.2E-06
415	0.005	0.0795	0.0022	0.0004	1E-05
420	0.009	0.1372	0.0040	0.0012	3.6E-05
425	0.016	0.1871	0.0073	0.0030	0.00012
430	0.026	0.2539	0.0116	0.0067	0.0003
435	0.040	0.3207	0.0168	0.0129	0.00068
440	0.059	0.4016	0.0230	0.0238	0.00136
445	0.080	0.4740	0.0298	0.0381	0.00239
450	0.091	0.5537	0.0380	0.0505	0.00347
455	0.078	0.6297	0.0480	0.0494	0.00376
460	0.060	0.7080	0.0600	0.0427	0.00362
465	0.049	0.7852	0.0739	0.0383	0.0036
470	0.040	0.8603	0.0910	0.0344	0.00364
475	0.035	0.9177	0.1126	0.0318	0.0039
480	0.032	0.9656	0.1390	0.0312	0.00449
485	0.032	0.9906	0.1693	0.0321	0.00549
490	0.034	1.0000	0.2080	0.0345	0.00717
495	0.038	0.9920	0.2586	0.0378	0.00985
500	0.042	0.9660	0.3230	0.0409	0.01366
505	0.046	0.9223	0.4073	0.0420	0.01855
510	0.048	0.8629	0.5030	0.0416	0.02424
515	0.051	0.7852	0.6082	0.0401	0.03106
520	0.054	0.6996	0.7100	0.0377	0.03822
525	0.056	0.6094	0.7932	0.0340	0.04419

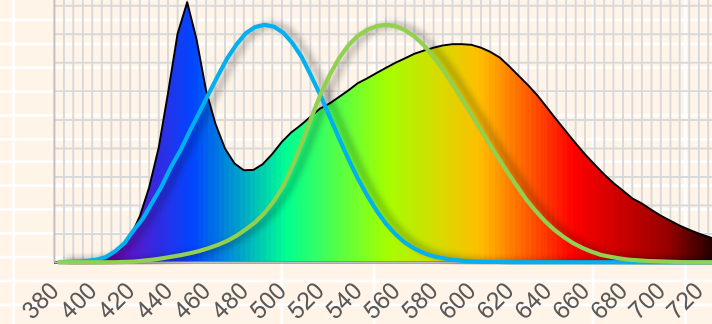
Source
Sample LED 4000 K

Melanopic Ratio
0.760

[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.



█ Lamp data
 — circadian
 — visual



L03- However.....

MELLOW LIGHT evo/inf



MLeVo AA LED4800-927-65 Q LDO SR

42185896

Melanopic LED action factors

To convert photopic (visual) evaluation parameters into melanopic (biological) evaluation parameters (according to CIE S 026 / E: 2018, DIN SPEC 5031-100)

CRI	Colour temperature	Luminaire luminous flux	MNER	MDER	MEER
-90	2700 K	4670 lm	1.04	0.48	0.53
	3000 K	4670 lm	1.05	0.55	0.61
	3500 K	4670 lm	1.04	0.65	0.72
	4000 K	4670 lm	1.02	0.72	0.80
	4500 K	4670 lm	1.00	0.78	0.87
	5000 K	4670 lm	0.99	0.84	0.92
	5700 K	4670 lm	0.97	0.90	0.96
	6500 K	4670 lm	0.96	0.96	1.00

CRI: Colour Rendering Index min.

Colour temperature: Values according to ANSI

Luminaire luminous flux: Luminaire rated luminous flux

MNER: Melanopic Natural Efficacy Ratio

≙ $m_{v, mel, nat}$ (conversion factor relative to the natural reference light, according to color rendering calculation, at equal color temperature)

MDER: Melanopic Daylight Efficacy Ratio, CIE S 026/E:2018

≙ $m_{v, mel, D65}$ (DIN SPEC 5031-100, conversion factor relative to the type of D65 light, to calculate the melanopic daylight equivalent illuminance)

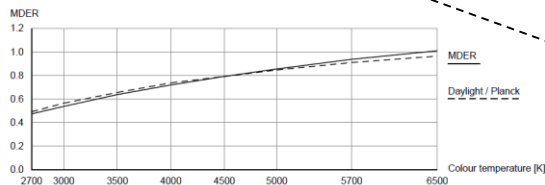
MEER: Melanopic Equal-energy Efficacy Ratio, CIE S 026/E:2018

≙ $amel, v$ (DIN SPEC 5031-100, melanopic action factor)

≙ R (equivalent Melanopic Lux Metric, Melanopic Ratio)

suitable for calculations according to WELL Building Standard v2 (L03)

Daylight / Planck: As a natural reference light source, daylight is used from a color temperature of 5000K upwards, in the area below a Planck spectrum is used.



Note for the lighting design:

See supplement on how to calculate melanopic lighting effects or contact our lighting solution planners.

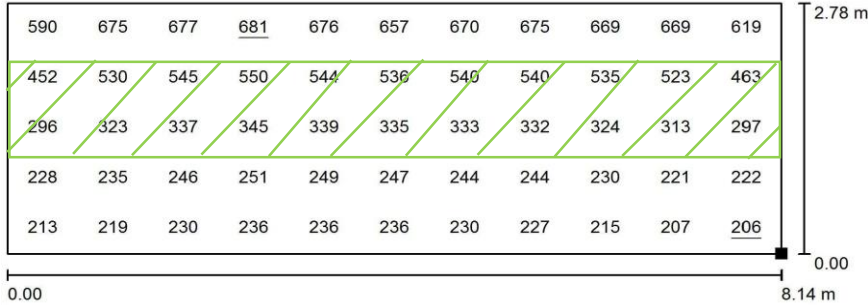
Supplement: <https://www.zumtobel.com/en/knowledge.html#lightingtechnology>

MEER
0.53
0.61
0.72
0.80
0.87
0.92
0.99
1.06

MEER: Melanopic Equal-energy Efficacy Ratio, CIE S 026/E:2018
 ≙ $amel, v$ (DIN SPEC 5031-100, melanopic action factor)
 ≙ R (equivalent Melanopic Lux Metric, Melanopic Ratio)
 suitable for calculations according to WELL Building Standard v2 (L03)



L03- EML lux levels



Multiply photopic lux levels by EML ratio or MEER value to determine EML lux levels

Example: Mellow Light CRI 90 42185896

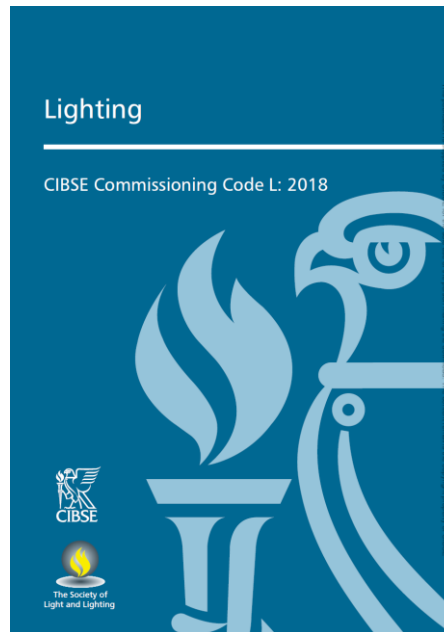
Average (photopic) = 424 lux x 0.8 = average (EML) 339 lux

Verification

WELL project implementation states that completed projects will need verifying for design compliance.

This may be carried out by a 3rd party or a lighting company and witnessed by a 3rd party.

Use design output calculations. If measuring with a photopic illumination meter, multiply vertical readings in EML zone by the designed EML ratio



The processes described in CCL are compatible with the WELL standard Verification requirements

Applications

Office

Logistics*

Data Centres*

Retail*

Education**

Hospitals

Retirement Homes



Standards Alignment

The concept of lighting for wellbeing is not new,
It is just being updated to incorporate the latest research & technology.

Best practice will be driven by 3 updated standards and further research

CIE S 026/E : 2018 System for Metrology of Optical Radiation for ipRGC Influenced Responses to Light

ISO/ WD TR 2/783 Light & Lighting - Integrative Lighting - Non Visual Effects

BS EN 12464-1 Light & Lighting of Workplaces. Indoor Work Places (2019 draft proposal for 2020/21 update)

Which will trigger a revised addition of LG 7 Lighting for Offices



Conclusion



There are 3 models for measuring/specifying the amount of light required to provide circadian stimulus.

Equivalent Melanopic Lux. *Lucas et al, University of Manchester*

(EML) Well Standard

Melanopic Daylight Equivalent Illuminance (MDEI) *DIN SPEC 67600 & DIN SPEC 5031-100*

Daylight illuminance, vertical illuminance and variable CCT at certain times of the day with 6500k as the reference CCT.

Circadian Stimulus value (CS) *Lighting Research Centre, Rensselaer Polytechnic Institute, Albany, NY*

Spectrally weighted irradiance at the cornea for acute melatonin suppression.

As of July 2019 impartial BRE/CIBSE testing has concluded that all 3 are difficult to achieve in practice but EML/MDEI easier than CS to achieve. In an office/education environment the effect is subjective/ psychological and more real world testing is required to fully confirm the medium to long term benefits.

Many thanks for your attention!