

# Lighting for Offices



Lighting for offices has traditionally been designed to meet the needs of the human visual system, focusing almost exclusively on office workers' visual performance. Lighting design that accommodates the needs of the human circadian system has been shown to improve workers' overall mood, increase alertness on the job without adverse effects on circadian entrainment, improve nighttime sleep, and reduce risks for chronic health problems that are associated with circadian system disruption. To achieve these goals, we recommend the adoption of lighting solutions that provide appropriate levels of circadian stimulus (CS) throughout the workday.

In addition to influencing the circadian system's timing, light can also exert an acute alerting effect on humans that is similar to that provided by a cup of coffee. During the day, the biological clock sends an alerting signal to the body that counteracts and balances the body's need for sleep, or "sleep drive," which increases the longer a person stays awake. When these two processes are synchronized, people can remain awake and alert for as long as 16 or 17 hours before the alerting signal switches to a sleeping signal (close to normal bedtimes) [70,71].

## Daytime work

For circadian entrainment, a lighting system should deliver a  $CS \geq 0.3$  throughout the day, or at a minimum during the first 2-3 hours of the morning. For alertness at other times of day, the system can continue to deliver a  $CS \geq 0.3$  throughout the day or occupants should use long-wavelength (red) light as supplemental lighting during the afternoon.

## Evening work

When working evenings, office workers should be mindful that their office spaces should be illuminated at levels similar to their own homes. Light levels that would be appropriate for the beginning or middle of the day must be avoided whenever possible, and whenever the work task permits. Using lower levels ( $< 100$  lux) of "warm" light no more than 2 hours prior to regular bedtimes can avoid delays to the circadian system, difficulty waking in the morning, and various sleep disturbances. A warm white 2700 K source providing 30 lux at the eye, for example, will provide a sufficiently low CS value of 0.03, which is well below a CS value of 0.1, the threshold for activation of the circadian system. Because self-luminous personal electronic devices (e.g., cell phones, tablets, computer displays, etc.) can emit excessive light, they should be turned off at least 2 hours prior to bedtime. Avoiding exposure to devices when working late in the office is every bit as important as avoiding them at home. A viable alternative would be to reduce display light levels, or cover them with orange plastic film to minimize nighttime CS exposures. Use red light when alertness is required to complete work-related tasks in the evening.

## CS schedule

Choose 0.4 CS target if:

- Furniture layout is undefined or dynamic
- CCT preference is cooler white light (5000 K - 6500 K)

Office workers- 0.4 target	
Time	CS
7:00 AM - 12:00 PM	0.4
12:00 PM - 1:00 PM	0.4 → 0.3
1:00 PM - 4:00 PM	0.3
4:00 PM - 5:00 PM	0.3 → 0.2
5:00 PM - 7:00 PM	0.2
7:00 PM - 8:00 PM	0.2 → 0.1
8:00 PM - EOB	0.1

Office workers- 0.3 target

Time	CS
7:00 AM - 4:00 PM	0.3
4:00 PM - 5:00 PM	0.3 → 0.2
5:00 PM - 7:00 PM	0.2
7:00 PM - 8:00 PM	0.2 → 0.1
8:00 PM - EOB	0.1

\*EOB = End of business day

Choose 0.3 CS target if:

- Furniture layout is defined and static
- Energy usage is a major concern and personal light devices cannot be used
- There are horizontal illuminance limits

## Additional layers of light

Office workers- Blue/Red add-on		
Time	CS	Add-on color
7:00 AM - 1:00 PM	0.4	Blue
1:00 PM - 2:00 PM	0.4 → 0.2	Transition
2:00 PM - 8:00 PM	0.2	Red
8:00 PM - 9:00 PM	0.2 → 0.1	
9:00 PM - EOB	0.1	

Choose 0.4 CS target with add-on if:

- General illumination must be extremely low for screen visibility or energy concerns; just 30 lux of blue light (peak = 470 nm) at the eye can achieve a CS of 0.4
- Promotion of alertness is desired during post-lunch dip hours



Exposure to high levels of blue light early in the day provides an acute alerting effect that, if delivered in the morning, will also promote circadian entrainment and better sleep. Receiving the same light later in the day and early evening, however, can delay circadian phase, and interfere with getting a good night's sleep.



Exposure to higher levels of longer wavelength, red light, during the “post-lunch dip” can also provide an acute alerting effect. Red light in the evening can promote alertness without suppressing melatonin production and disrupting circadian rhythms.

## References

- [70] Figueiro MG, Hunter CM, Higgins PA, Hornick TR, Jones GE, Plitnick B, Brons JA, Rea MS (2015) Tailored lighting intervention for persons with dementia and caregivers living at home. *Sleep Health* **1**, 322-330.
- [71] Rivkees SA, Mayes L, Jacobs H, Gross I (2004) Rest-activity patterns of premature infants are regulated by cycled lighting. *Pediatrics* **113**, 833-839.