Lighting Ergonomics

Lighting Ergonomics - Light Flicker

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What is light flicker?

Light flicker refers to rapid or quick, and repeated changes in the brightness of light over time – light that appears to flutter and be unsteady. It is caused when the voltage supplied to a light source changes or when the power line voltage itself fluctuates. The severity of the flicker depends on several factors such as:

- How often and regularly the voltage fluctuates.
- How much of a voltage change occurs.
- The kind of light – incandescent, fluorescent, LED (light emitting diodes), or HID (high intensity discharge lighting systems).
- The gain factor of the lamp [gain factor is a measure of how much the light intensity changes when the voltage fluctuates – (% relative change in light levels) divided by (% relative fluctuation in voltage)].
- The amount of light in the lighted area (ambient light levels).
- The design or state of repair of the lamp or lighting device.

Lamps operating on AC electric systems (alternating current) produce light flickering at a frequency of 120 Hertz (Hz, cycles per second), twice the power line frequency of 60 Hz (50 Hz in many countries outside North America). Essentially, the power is turning on and off 120 times a second (the voltage varies from +120 volts to -120 volts, 60 times or cycles a second and is at zero volts twice in one cycle).

Can you actually see lights flicker?

It depends on the frequency of the flicker. People can see lights flashing on and off up to about 50 flashes per second (50 Hz) – they are most sensitive to time-varying illumination in the 10-25 Hz range. The actual critical flicker frequency increases as the light intensity increases up to a maximum value, after which it starts to decrease. When light is flickering at a frequency greater than 50 or so Hertz, most people can no longer distinguish between the individual flickers. At this frequency – the critical flicker frequency or flicker fusion threshold – the flashes appear to fuse into a steady, continuous source of light. This situation happens because the response to the light stimulus lasts longer than the flash itself.

Most people cannot notice the flicker in fluorescent lights that have a flicker rate of 120 cycles per second (or 120 Hz). Flicker with LED lights may be more noticeable due to the fact that LED lights flicker between less than 10% and 100%, whereas fluorescent lights dim to about 35% and back to 100%).

The light flicker may be detected by its stroboscopic effect. When objects move or rotate rapidly, they may be lit at or about the same position during each cycle or rotation. This makes objects look as if they are moving more slowly than their actual speeds – they may even appear stationary if the object is moving at the same rate as the flicker frequency (or a multiple of it). This fact is the principle behind a strobe light but it is not the desired effect in general lighting. In fact, it could be a safety hazard if someone mistakenly thought that some equipment was stationary or was moving slowly.

Are there any health effects associated with light flicker?

Health effects may include blurred vision, eye strain, fatigue, headaches, nausea, or reduced visual performance for visual tasks. Visual performance may include difficulty reading, not seeing the rotation of machinery, and being distracted. Epileptic seizures may also occur. Some individuals may be photosensitive or experience photophobia where light, especially bright light, can cause discomfort and pain.

What kind of things can cause light flicker or dimming?

Voltage changes can be caused by faulty equipment, faulty bulbs, or when electrical equipment drawing heavy currents are turned on or when being used (e.g., resistance welding machines; motors in refrigerators, air conditioners; arc furnaces; medical imaging machines (x-ray, CAT scan, MRI); motors subject to variable loads; large capacity photocopiers). Resistance welding machines that repeat welding at a rate of one or more per second can cause repetitive voltage fluctuations and may result in a noticeable light flicker.

Voltage fluctuations are usually small and do not have adverse effects on electrical equipment. However, in offices, for example, voltage fluctuations of just a few tenths of one percent can produce very annoying flickers in the lighting, especially if they are regular and repetitive in the 5-15 Hz range.

What can be done to reduce or eliminate light flicker?

To correct flicker:

- Replace bulbs on a scheduled basis. Old bulbs tend to flicker more and they are not as bright.
- Ensure that all parts of the light fixture, especially the ballast, are functioning properly.
- Discuss issues with your lighting manufacturer or supplier. Lighting technology can vary, and options may be available.

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