Lighting Ergonomics – Light Flicker Fact Sheets



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).

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 (actually 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 a 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 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%, where as 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?

Although humans cannot see fluorescent lights flicker, the sensory system in some individuals can somehow detect the flicker. Ever since fluorescent lighting was introduced in workplaces, there have been complaints about headaches, eye strain and general eye discomfort. These complaints have been associated with the light flicker from fluorescent lights. When compared to regular fluorescent lights with magnetic ballasts, the use of high frequency electronic ballasts (20,000 Hz or higher) in fluorescent lights resulted in more than a 50% drop in complaints of eye strain and headaches. There tended to be fewer complaints of headaches among workers on higher floors compared to those closer to ground level; that is, workers exposed to more natural light experienced fewer health effects. [Fluorescent lighting, headaches and eye-strain. A. J. Wilkins, I. Nimmo-Smith, I., A. Slater & L. Bedocs. Lighting Research and Technology, 1989. Vol. 21, 11-18]

SCHEER (the Scientific Committee on Health, Environmental and Emerging Risks) in Europe released an opinion paper which states:

“LED lighting can produce a stroboscopic effect, depending on the degree of modulation. The use of modulated LED lighting in domestic and other non-industrial environments where awareness is likely to be low is of a concern. Although no published case studies were identified, there are claims that a small number of people are very sensitive to temporal light modulation at about 100 Hz, triggering symptoms such as headaches, migraine and general malaise.”

From: SCHEER (Scientific Committee on Health, Environmental and Emerging Risks), Opinion on Potential risks to human health of Light Emitting Diodes (LEDs), 6 June 2018.

WHAT KIND OF THINGS CAN CAUSE LIGHT FLICKER OR DIMMING?

Voltage changes can be caused by dimmer switches 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 repeats welding at a rate of one or more per second can cause repetitive voltage fluctuations and may result in a noticeable light flicker.

Usually voltage fluctuations are 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 KIND OF LIGHTING IS LIKELY TO CAUSE A FLICKER PROBLEM?

Flicker is usually a potential problem only with lighting that requires the use of ballasts, like fluorescent lights. Incandescent lights usually do not cause a flicker problem since the light filaments generally do not cool quickly enough (and make the light dimmer) during the “off” time as the voltage changes in the AC power line.

The type of ballast, which controls the electrical supply to fluorescent lights, affects the amount of flicker. Magnetic ballasts change the voltage supplied to the fluorescent lamps but do not alter the frequency – the power line frequency of 60 Hz.

The ultraviolet (UV) light produced inside the fluorescent light tube also fluctuates 120 times per second. The phosphorescence (the fluorescent light) resulting from the UV shining on the phosphor coatings inside the light tube is sufficiently stable (i.e., lasts long enough) to even out the variations in the fluorescent light output.

WHAT CAN BE DONE TO REDUCE OR ELIMINATE LIGHT FLICKER?

Some types of ballasts can reduce flicker considerably. Energy-efficient electronic ballasts take the 60 Hz supplied power and convert it to a much higher frequency (20,000 – 60,000 Hz). The resulting flicker frequency (twice the supplied power frequency, 40 -120 kHz) is so high that the human eye cannot detect any fluctuation in the light intensity – essentially flicker-free. An added benefit is that electronic ballasts produce less hum than that emitted by other kinds of ballasts.

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.
- When replacements are needed, upgrade to fluorescent lighting that uses electronic ballasts.
- Discuss issues with your lighting manufacturer or supplier. Lighting technology can vary and options may be available.

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