Soft Lights Foundation

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January 8, 2022

BY EMAIL

Kay Fitzpatrick, Senior Research Engineer
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Re: Rectangular Rapid Flashing Beacons

Dear Kay Fitzpatrick,

LED electromagnetic radiation devices emit non-uniform electromagnetic radiation that is exceedingly intense in the middle of the chip. While human tolerance is approximately 50,000 nits of peak uniform luminance, today's LED chips can have a peak non-uniform luminance exceeding 100,000,000 nits.[1]

The Emergency Responder Safety Institute study titled "*Will You Stop for Me? Roadway Design and Traffic Control Device Influences on Drivers Yielding to Pedestrians in a Crosswalk with a Rectangular Rapid-Flashing Beacon*"[2] found that the wide range of yield rate (19% to 98%) is more likely due to factors other than the RRFB itself. A recent study titled, ""*Effects of Emergency Vehicle Lighting Characteristics on Driver Perception and Behavior: Study Report*"[3] concludes that high intensity lights are no more visible than lower intensity lights. Both studies noted that these flashing light systems "capture" driver attention, which is obviously dangerous since driver attention must be allowed to be free to locate all possible obstacles and hazards in the scene. Neither study included the differences in peak luminance values of the LED devices and the impacts of such excessive peak luminance values on human biology and psychology.

The RRFB study failed to address these issues.

1) Peak luminance of the emitter. How do different luminance values affect drivers?
2) Effects on driver psychology. Do the RRFB's cause mental anguish or road rage?
3) Multiple RRFBs. For example, in Florence, Oregon on Highway 101, three or four RRFBs can be functioning at the same time within approximately one mile. How does the presence of multiple flashing lights impact drivers?

[1] https://www.laserfocusworld.com/test-measurement/research/article/16555223/nonlaser-light-sources-highluminance-leds-target-emerging-automotive-lighting-applications
[2] https://static.tti.tamu.edu/tti.tamu.edu/documents/TTI-CTS-0010.pdf
[3] https://www.respondersafety.com/Download.aspx?DownloadId=f31a5f73-7b95-44c7-bd25-1e4cdfce5229

4) Eye safety. Considering that eye damage is cumulative, what are the short term and long-term impacts on eye health from RRFBs?
5) Distraction. When the scene has multiple distractors such as a crossing pedestrian, loose dog, bicyclist on the side, vehicle turning left in front of the driver, LED billboards, etc., do RRFBs improve driver vision or decrease driver vision?
6) Humans evolved to use light reflected from an object to create vision. The concept of shining high intensity spatially anisotropic light directly into the human eye is a new concept. What are the overall effects on human health, psychological health, and eye health from this action?
7) What is the effect of RRFBs on those in Risk Group 3, such as those with epilepsy, migraines, autism, bipolar disorder, PTSD, and other neurologically divergent persons?

The focus of this letter is on the dangers of LED flashing lights which have a dangerous peak radiance and turn on and off instantly. These LED flashing lights are being used on RRFBs, stop signs, yield signs, police cars, ambulances, utility trucks, tow trucks, and fire engines. The non-uniform radiation and intense peak radiance triggers seizures, causes migraines, interferes with human nerve functioning, reduces vision, increases agitation, and endangers the lives of the public and first responders.

The left side of Figure 1 shows a spherical emitter that sends light in all directions in space. Because of the curvature of the emitter, the light rays do not overlap, and the radiation is spatially, spectrally, and temporally uniform. Every single point on the sphere is the same as any other point. On the other hand, the right side of Figure 1 shows a flat surface emitter such as an LED, which has a middle and edges. This flat surface creates a situation where the middle of the chip has different energy than the edges of the chip. LEDs send light only in the forward direction and the light rays are confined to an 'escape angle' which is determined by the physical characteristics of the chip. Thus, there are overlapping rays, with the most overlap being in the center of the chip, and the least overlap being on the edges. The result is that every point in space has different spatial, spectral, and temporal properties.

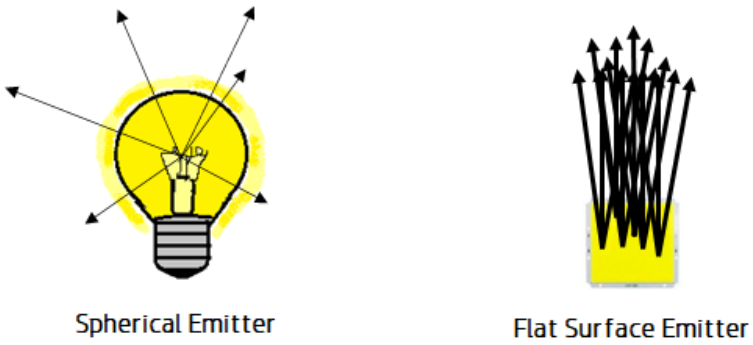


Figure 1 - Spherical vs. Flat Surface Emitter

Figure 2 shows the uniform spatial energy from candles, incandescent and High-Pressure Sodium versus the non-uniform spatial energy from an LED. The intense peak of energy will cause eye damage and will overload the nerve signals to the brain because the information is not uniform.

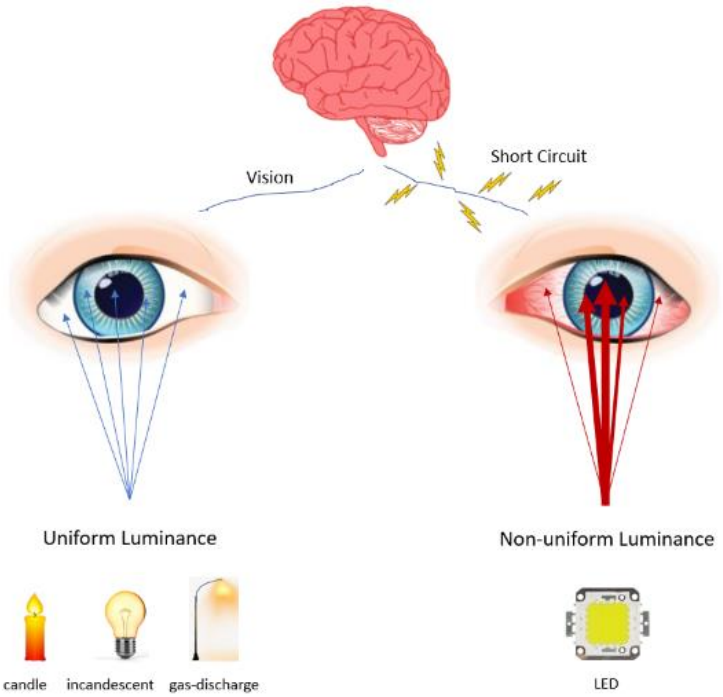


Figure 2 - Spatially Uniform v. Non-Uniform Radiation

Figure 3 is a diagram showing the categorization of radiation and shows that *light* and *illumination* are spatially isotropic radiation in the human visible portion of the electromagnetic spectrum. Electromagnetic radiation emitted by LEDs do meet the regulatory meaning of or comply with standards for the use of light as illumination.

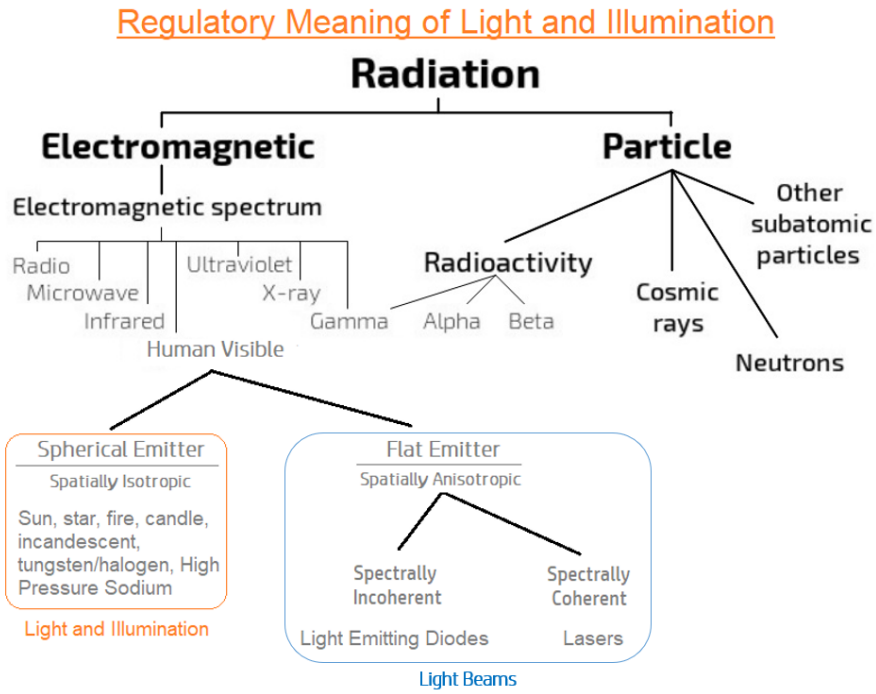
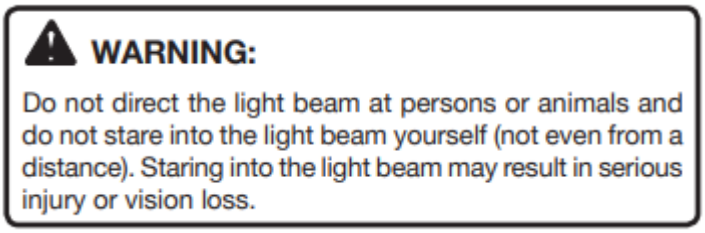


Figure 3 - Radiation Types

As an example of how dangerous LED electromagnetic radiation is, the operator's manual for the Ryobi P705 Flashlight includes the following: "WARNING: Do not direct the light beam at persons or animals and do not stare into the beam yourself (not even from a distance) Staring into the light beam may result in serious injury or vision loss."



The warning also refers to children, who along with infants are an identified high-risk population vulnerable to LED-exposure harm. Babies often lack an adult's automatic, self-protective aversion response to bright or intense light, and will stare directly at the source. If the manufacturer of an LED flashlight provides a warning that shining an LED light into a person's eye is dangerous, then this implies that Rectangular Rapid Flashing Beacons are purposely causing eye damage. This creates a liability for any institution that uses RRFBs.

The first video example below shows how incandescent hazard lights work. They give a slow, general, soft warning and let people know that the vehicle is in an unusual situation without detracting from the task of driving or walking.

Non-LED Hazard Lights: https://youtu.be/DHJZTb7qXQo

Figure 4 - Non-LED Hazard Lights

The remaining videos show the misuse of technology, where flashing LED radiation devices do not carefully warn, but rather assault people, violating their civil rights, damaging their eyes, interfering with the functioning of their nerves, and endangering their lives.

Utility Truck: https://youtu.be/ma0hGwHivO4

Figure 5 – Utility Truck

Flashing Stop Sign: https://youtu.be/dLv9bqMFaXY

Figure 6 - Flashing Stop Sign

Highway Patrol: https://youtu.be/bhEkxtKbtks

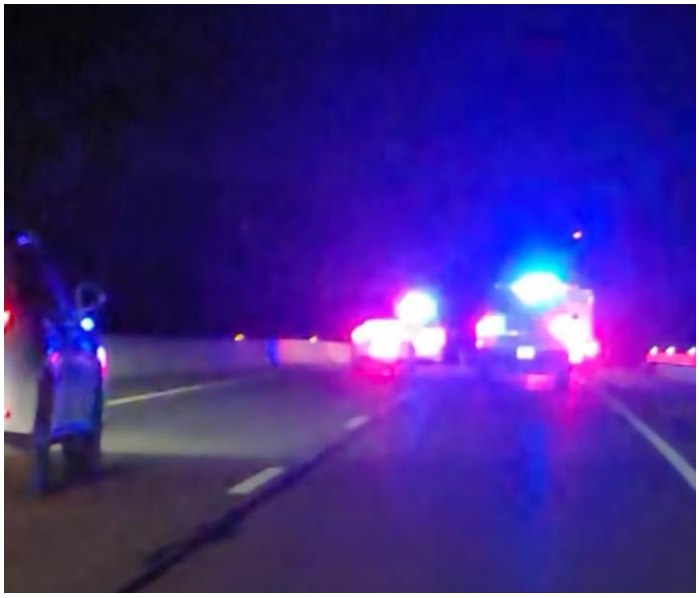


Figure 7 - Highway Patrol

Rectangular Rapid Flashing Beacon: https://youtu.be/KBltx0Argag

Figure 8 - RRFB

Fire Truck: https://youtu.be/910_J5xhrTk

Figure 9 - Fire Truck

Tow Truck: https://youtu.be/cJKgMtXJ-lE

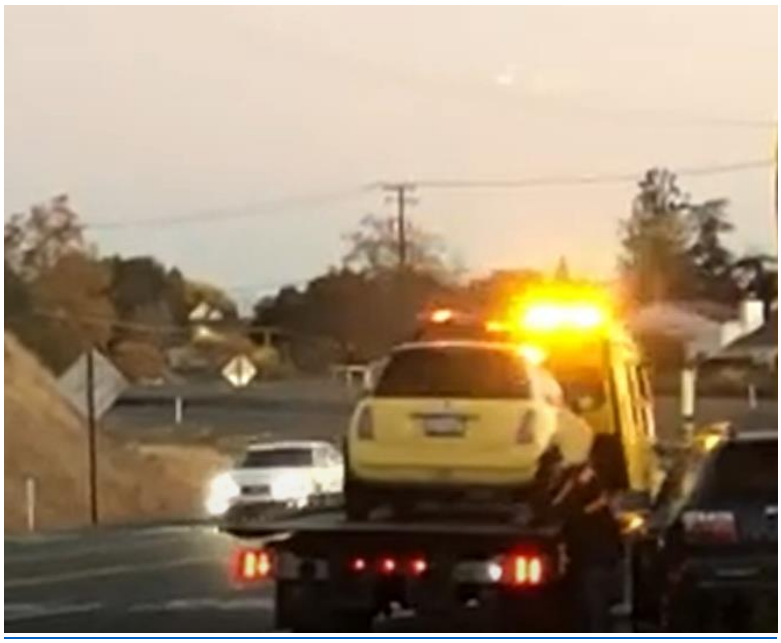


Figure 10 - Tow Truck

Ambulance: https://youtu.be/S6-wZDtTMfA

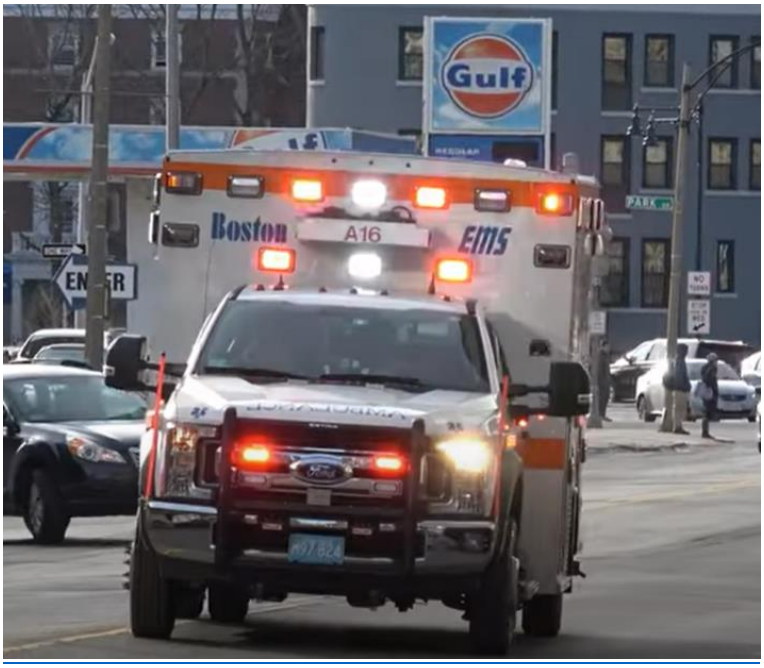


Figure 11 - Ambulance

Utility Truck: https://youtu.be/0MLDA6too1Q

Figure 12 - Utility Truck

Figure 13 - Incandescent vs. LED Flashing LightsFigure 13 is a diagram showing why the spatial distribution of LED radiation is to toxic and dangerous. The peak luminance of an LED can be hundreds of thousands or even hundreds of millions of nits, far exceeding human thresholds, and the non-uniform shape interferes with the human nervous system.

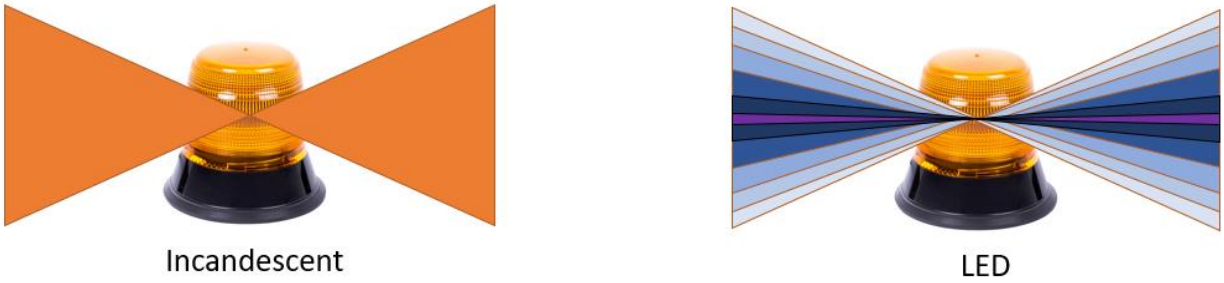


Figure 13 - Incandescent vs. LED Flashing Lights

In addition to the spatial characteristics of LED radiation, the spectral and temporal characteristics also make LED radiation dangerous. LEDs turn on and off immediately, giving the brain no time to adapt to change. An LED can also have a peak of 450nm blue wavelength that causes glare and eye damage.

The FHWA currently has no regulations for the quantity of LED flashing devices in a geographic location, their flash rate, peak radiance, or protection for eyes, vision, or neurology and the FHWA has made no effort to ensure that LED flashing lights do not violate the Americans with Disabilities Act.

Both human drivers and Artificial Intelligence drivers rely on sensors to receive input from the world about them and a communication channel to send that input to a processing center. LED flashing lights interfere with this system, degrading vision, and increasing the likelihood of vehicle crashes, injury, and death.

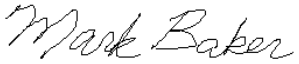
The result of exposure to LED radiation is immediate sickness in the form of headaches, nausea, eye pain, loss of balance, migraines, panic response, altered vision, epileptic seizures, disorientation, and other neurological disturbances. Each of these symptoms is being verifiably reported by an increasing number of individuals and constitute medical evidence of LED-induced harm. LED visible radiation exposure is causing catastrophic physical harm, subjecting at-risk individuals to illness and injury, and plunging formerly healthy, independent people into crisis levels of stress, hopelessness, psychological trauma, and persistent thoughts of suicide.

LED radiation is discriminatory because it interferes with human nerves and disrupts major life functions such as seeing, thinking, and concentrating for people with disabilities, such as those with epilepsy, autism, PTSD, migraines, bipolar disorder, and others. Electromagnetic LED radiation prevents safe access to public services such as roads, sidewalks, and government facilities. Use of LED radiation devices violates the federal Americans with Disabilities Act.

The key point from our own observations and research is that these high intensity LED flashing lights, now installed on signs and emergency vehicles everywhere, has made everyone less safe, they are

discriminatory, there are far too many of these devices, and they must be eliminated from our roadways. We must return to using very few spatially isotropic devices with slow, low-to-high, smooth flashing patterns, or no flashing at all. LED light beams exceed human senses.

Sincerely,



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