Soft Lights Foundation

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BY EMAIL

Stephen Ridella
Director, Office of Defects Investigation
National Highway Transportation Administration
1200 New Jersey Ave. SE
Washington, DC 20590
stephen.ridella@dot.gov

Re: Spatially Anisotropic Visible-Radiation Devices

Dear Stephen Ridella,

The Soft Lights Foundation has researched and analyzed the use of Light Emitting Diodes in vehicle headlights, daytime running lights, taillights, brake lights, turn signals, dashboard lights, interior lights, as well as flashing lights on police cars, fire trucks, ambulances, tow trucks and utility trucks. We have determined that LED radiation devices used in or on vehicles are either illegal or discriminatory or hazardous and we therefore consider these LED devices to be a defect of the vehicle.

The National Highway Transportation Safety Administration publishes FMVSS-108 which regulates vehicle headlights and other lighting devices.[1] The word "light" is used approximately 208 times in the FMVSS-108 regulation but is never defined. We must therefore first address the ambiguity of the definition of the word "light". The definition from Britannica is "*Electromagnetic radiation that can be detected by the human eye*".[2] According to information in Wikipedia, "light" can refer to any wavelength of electromagnetic radiation.[3] Therefore, to be more precise, if we are speaking of only the light detected by the human eye, we should use the term "visible light". FMVSS-108 was originally written in 1967 for the purpose of regulating illumination devices on vehicles. Therefore, it makes most sense that the word "light" in FMVSS-108 refers to "visible light" as a constraint, and does not refer to x-rays or microwaves, which are also part of the same electromagnetic spectrum.

In addition, FMVSS-108 does not specifically address the uniformity of the radiation emitted by the lighting source. Since FMVSS-108 was written in 1967, when laser beams and light emitting diodes were just being invented, we can infer that another constraint of FMVSS-108 is that the radiation emitted by the light source be spatially uniform. Indeed, FMVSS-108 also contains numerous references to "luminous intensity", but contains only one reference to "luminance", and that one reference is

[1] https://www.govinfo.gov/content/pkg/CFR-2004-title49-vol5/xml/CFR-2004-title49-vol5-sec571-108.xml
[2] https://www.britannica.com/science/light
[3] https://en.wikipedia.org/wiki/Light

unclear. For spatially isotropic sources such as a tungsten filament, there are many assumptions that can be made about the density of the light and how it spreads out from the source. For example, the luminous intensity can be measured at any spatial position (excluding lensing), and the results will be the same. FMVSS-108 contains no restrictions on the luminance or radiance of the visible light, so we infer that the luminance or radiance must be within some range of comfort or tolerance level for humans.

Lasers and LEDs are spatially anisotropic, meaning that the radiation emission is not uniform. Because the radiation emits from a flat-chip source, rather than from a curved sourced, the spatial properties of the light are significantly more complex than spatially isotropic radiation sources.[4] Due to the small size of an LED chip, the spatial changes are at tiny scales, perhaps in the nano-, pico-, or femto-meter range. It is not possible to use a simple light meter at 100 feet from the vehicle to measure such tiny changes in the spatial distribution of the light shape. In addition, the peak luminance can be exceedingly high. As of 2018, LED chip makers had reached 100,000,000 nits of peak luminance[5] for this spatially anisotropic radiation, whereas human comfort level for just spatially isotropic visible light is around 300 nits.

The conclusion is that FMVSS-108 applies only to *spatially isotropic radiation in the visible portion of the electromagnetic spectrum*. Any use of spatially anisotropic visible radiation sources would automatically not comply with FMVSS-108, as a different set of regulations would need to be written for spatially anisotropic visible radiation such as LEDs and lasers that includes maximums on peak luminance and peak radiance to protect the human eye, as well as restrictions on spectral properties such as limits on the amount of 450nm wavelength radiation, and restrictions on temporal properties such as sub-sensory flicker caused by diodes or pulse width modulation.

Figure 1 is a diagram showing the categorization of radiation. As we can see in the chart, tungsten lamps are spatially isotropic radiation sources. LEDs, on the other hand, emit spatially anisotropic radiation. Tungsten/halogen lamps can comply with FMVSS-108. LEDs cannot comply with FMVSS-108 because it is not a type of radiation covered by FMVSS-108.

[4] https://ieeexplore.ieee.org/document/8879542

[5] https://www.laserfocusworld.com/test-measurement/research/article/16555223/nonlaser-light-sources-highluminance-leds-target-emerging-automotive-lighting-applications

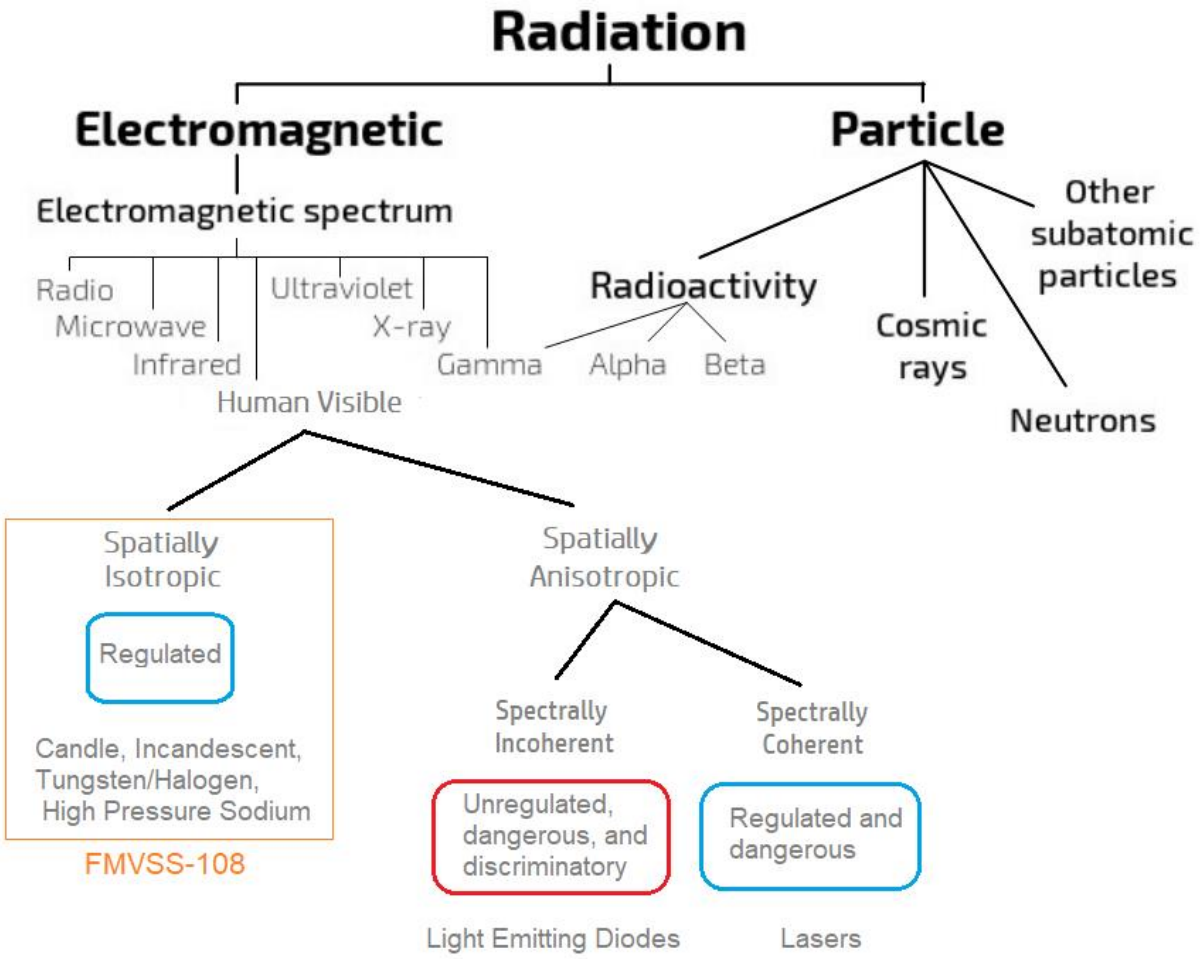


Figure 1 - Radiation Types

The auto makers use a self-certification process. NHTSA allows the auto makers to certify that their headlights comply with FMVSS-108, but NHTSA typically does not verify the veracity of the compliance statements. This system has led us to a situation where the auto makers have been self-certifying LED radiation devices as being compliant with FMVSS-108, even though that is not possible. NHTSA has so far not investigated this situation of non-compliance. The result of this non-compliance is demonstrated in Figure 2. This photo was taken in October 2021 and is representative of the glare and danger presented by directed energy LED headlights.

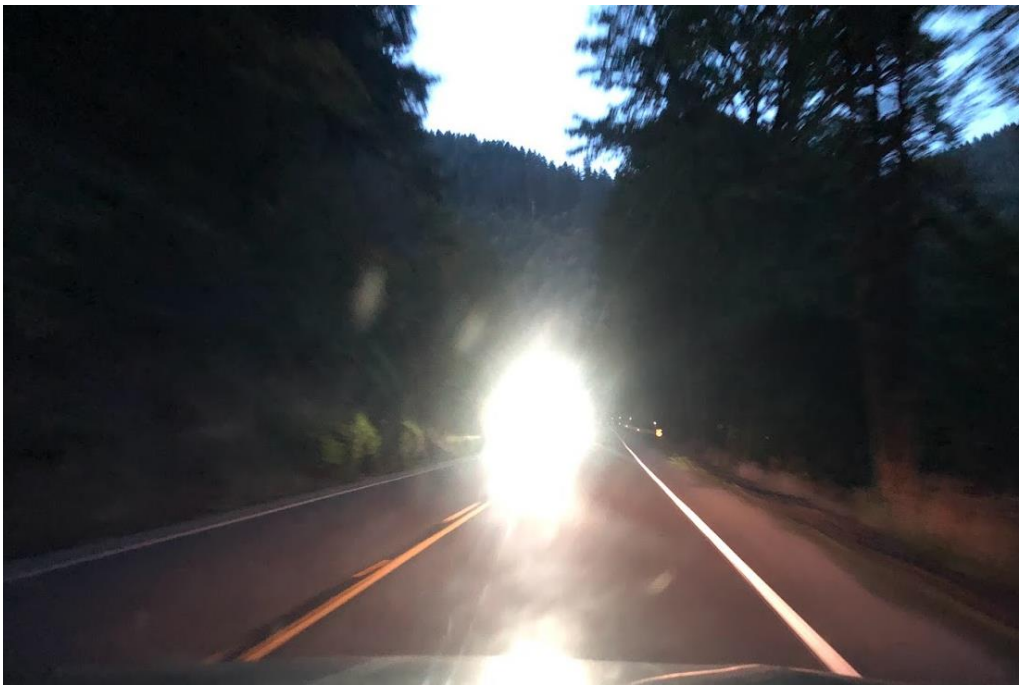


Figure 2 - LED Headlights

The auto industry has invalidly self-certified LED headlights, Daytime Running Lights, and other LED radiation devices either willfully or through negligence. We surmise that the engineers who do the measurements during the self-certification process used measuring devices and software that was not designed for spatially anisotropic radiation sources and was not of sufficient precision to properly calculate the luminous intensity at the femtometer scale. If valid measurement techniques had been used, the measurements would have shown that the LED headlights exceed FMVSS-108 limits for luminous intensity.

Figure 3 is a photo of a Cadillac with non-compliant LED lights.[6] As can be seen in the photo, the LED radiation is intense and distracting. What cannot be seen in the photo is the likely sub-sensory flicker. Spatially anisotropic radiation interferes with the proper functioning of the human nervous system and poses a danger to drivers or pedestrians coming towards the vehicle.

[6] https://gmauthority.com/blog/2021/07/cadillac-ct5-discount-offers-0-9-apr-plus-500-off-in-july-2021/

Figure 3 - Cadillac

To our knowledge, there are no ocular exposure standards for LEDs. In his 2009 presentation, Senior Engineer Michael Shulman of Underwriters Laboratories wrote, "Currently, neither the U.S. nor Canada have mandatory standards or regulations for ocular exposure to LEDs emitting incoherent visible light."[7] In the research article, titled Light Emitting Diode Induced Retinal Damage[8] the authors state, "*Excessive LED light exposure presents a potential hazard to retinal function.*" In other research, those in Risk Group 3 (those with epilepsy, autism, migraines, photophobia, etc.) are often purposely ignored during the research, invalidating results that might have shown that LEDs are safe. Because the luminance and radiance of LEDs can be exceedingly dense, millions of vehicles are already on the road today that are causing eye damage, psychological trauma, seizures, migraines, loss of vision, distraction, vehicle crashes, and thoughts of suicide.

As an example of how dangerous LED radiation is, consider this warning shown in Figure 4 from the company Gear Light. It should be immediately clear that if it is dangerous to look into a small LED flashlight, then a powerful LED vehicle headlight would be even more dangerous.

[7] http://www.softlights.org/wp-content/uploads/2021/10/MichaelShulman_LEDFireElectricalSafety.pdf
[8] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5313540/

Figure 4 - LED Flashlight

There are several significant federal laws that protect civil rights and prohibit discrimination. These laws include the 14th Amendment of the US Constitution which guarantees the right to liberty[9], the Enforcement Act of 1871 which makes government liable for deprivation of civil liberties[10], the Rehabilitation Act of 1973 which addresses the notion of equal access for all[11], and the Americans with Disabilities Act prohibits discrimination against persons with disabilities, including anything that prevents seeing, thinking, or concentrating.[12] LED radiation violates civil liberties by interfering with the human nervous system, preventing people from seeing, thinking, concentrating, and communicating. LED radiation devices violate these federal laws.

Because LED radiation devices do not comply with NHTSA FMVSS-108, and because they are dangerous, and because they are discriminatory, LED radiation devices constitute a defect in the safe operation of the vehicle, and therefore must be investigated. Due to the ongoing dangers posed by these devices already on the road, we believe that vehicles with LED headlights and DRLs must be recalled.

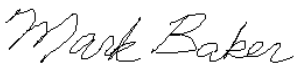
Beyond removing the LED radiation devices, we believe that NHTSA should rethink its approach to regulating radiation. Semi-autonomous and self-driving vehicles are using multiple radiation devices to detect the world around them. If these radiation devices can detect obstacles, then there is no need for high-intensity visible radiation from LEDs. A tiny amount of light on the front of the vehicle to make the car visible at night is all that is needed. In addition, all automakers will now be including Automated Emergency Braking in new vehicles, meaning that that software can prevent the vehicle outrunning the sensors and should be able to prevent vehicle crashes better than human operators on their own.

[9] https://www.constituteproject.org/constitution/United_States_of_America_1992
[10] http://www.antibiaslaw.com/list/enforcement-act-of-1871#n2953
[11] https://www.eeoc.gov/statutes/rehabilitation-act-1973
[12] https://www.law.cornell.edu/uscode/text/42/12102

NHTSA must research the hazards of LED radiation on human eyes and human nervous systems. It is already known that LED radiation is toxic, even at low levels, especially for LED-reactive persons. The car makers likely need to switch to advanced tungsten/halogen or incandescent lighting technologies which are spatially uniform to be compliant with FMVSS-108 and to prevent harm and discrimination. Correlated Color Temperatures of the spatially isotropic visible radiation should be 2700 Kelvin or less to reduce distraction, discrimination, and eye damage.

We request that NHTSA take corrective action to solve the issues described above.

Sincerely,



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