November 11, 2021

To:

City Attorney
City of San Jose, California
cao.main@sanjoseca.gov

Re: Rebuttal to Zeiger Engineering Report on LED Billboards

Dear City of San Jose,

This letter is a rebuttal to the engineering report by Zeiger Engineers regarding the proposed LED billboards in San Jose. We assert that this engineering report is both heavily biased towards the LED billboard industry and seriously flawed technically, including the incorrect use of mathematics. Zeiger Engineers has conflated isotropic radiation from sources such as an incandescent lamp, and anisotropic radiation such as from LEDs, thus invalidating the entirety of the report.

Figure 1 is a photo taken by the Soft Lights Foundation on November 6th, 2021 in Yakima, Washington. As is obvious from the photo, the LED radiation is exceedingly intense and is endangering the eye safety, physical safety and mental safety of pedestrians, drivers of vehicles, and even pilots of aircraft.

Figure 1 – LED Billboard in Yakima, WA

Zeiger Engineers states that LED billboards emit an approximate maximum of 9,000 nits, but the report then uses invalid arguments and incorrect math to convince the reader that this 9,000 nit

spatially anisotropic radiation is somehow perfectly safe and compliant with safety standards. We rebut those arguments.

Figure 2 is a diagram showing the categorization of radiation. As we can see in the chart, candles, incandescent light bulbs, and High-Pressure Sodium lamps are all spatially isotropic radiation sources. LEDs, on the other hand, emit spatially anisotropic radiation.

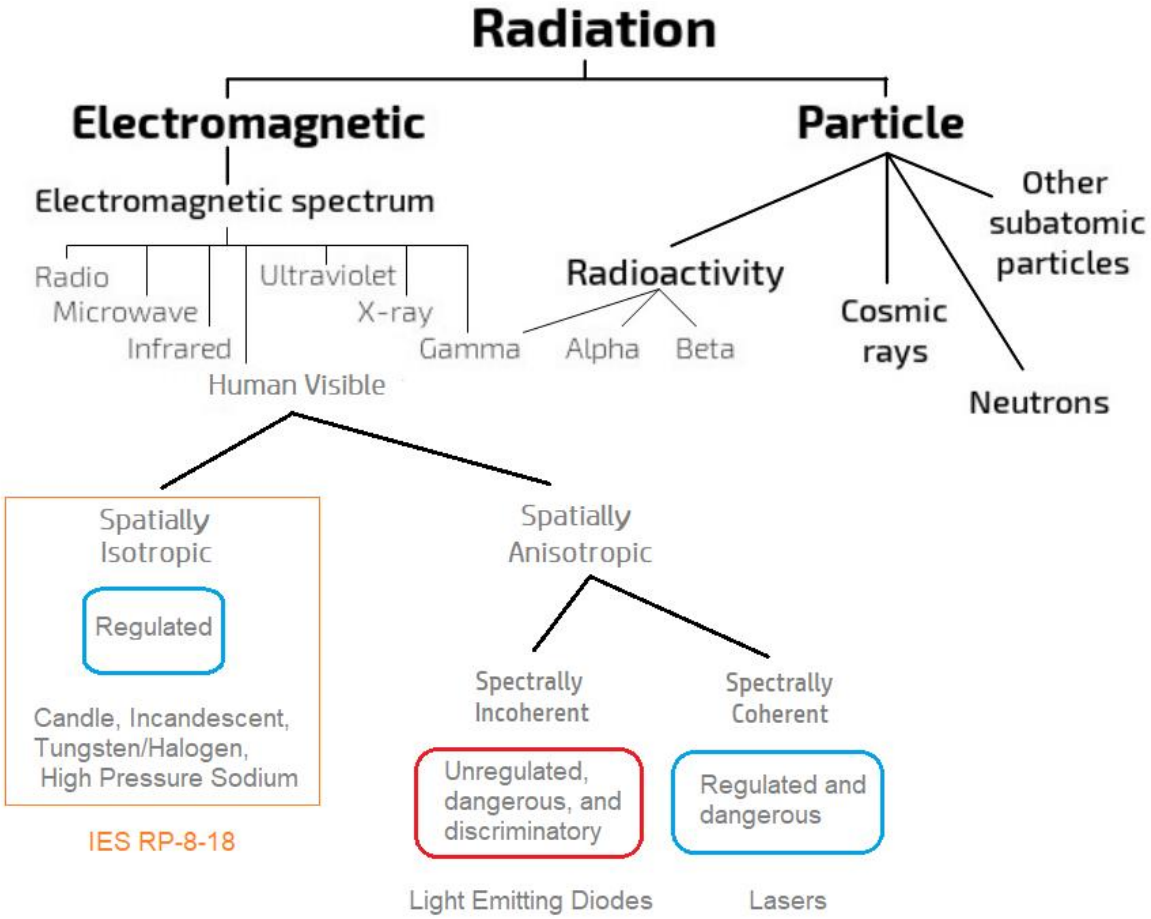

Figure 2 - Radiation Types

The Illuminating Engineering Society Recommended Practice for Design and Maintenance for Roadway Parking Facility Lighting (IES RP-8-18) is the de-facto standard for outdoor lighting for streets and parking lots. The references to "light" in IES RP-8-18 are for *spatially isotropic radiation in the visible portion of the electromagnetic spectrum*. The word "light" in IES RP-8-18 does not refer to microwaves, laser beams, or spatially anisotropic, spectrally incoherent radiation such as LEDs.

LEDs do not comply with existing standards, they emit dangerous radiation, discriminate against persons with light sensitivity disabilities and have unregulated spatial, temporal, and spectral characteristics. LED radiation has been shown to cause pain, sickness, eye damage, seizures, migraines, psychological trauma, vehicle accidents, loss of liberty, thoughts of suicide and likely loss of life.

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."[1] In the research article, titled Light Emitting Diode Induced Retinal Damage[2] 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.

In the paragraphs below, we will address specific statements in the Zeiger Engineers report. The quotes are in the same order as they are written in the report.

Quote: **"Project Design will also produce very little glare and potential for pilot distraction in the landing approach from the North (Runways 12L/12R) or South (Runways 30L/30R) due to the light control features on the billboards."**

Zeiger Engineers makes substantial effort to note how these LED billboards will have special features to prevent the LED radiation from reaching the eyes of pilots. In other words, Zeiger Engineers and Clear Channel concede that the toxic radiation from LEDs is so harmful to human eyes and human vision that they are introducing special controls to keep this LED radiation out of the eyes of pilots. The implication is that Clear Channel and Zeiger Engineers believe that the eyes and nervous systems of drivers on the freeway do not merit the same concerns and that shining hazardous spatially anisotropic radiation into the eyes of drivers is perfectly within their rights as a corporation.

Quote: **"The billboards will control unwanted light (trespass or spill light) toward nearby airport operations, airport control tower, and Guadalupe River and riparian habitat."**

All LED billboard radiation is unwanted. 93% of the public oppose being subjected to toxic LED radiation. The primary entity that desires the toxic radiation from LED billboards is Clear Channel in their pursuit of profits. As per the Zeiger report, significant engineering effort is being made to control the LED radiation so that is directed only into the eyes of drivers on the freeway, and not into the eyes of pilots or into the sky. The very idea of purposely directing harmful radiation into the eyes of the public is a clear violation of civil rights and leaves San Jose liable for all claims of eye damage, vehicle crashes, emotional trauma and civil rights violations.

Quote: **"However, to operate at 100 percent white color, it would require turning off the ambient light sensor and disabling dimming control of the face as well. Normal advertising images are of course not "white", and the resulting "colored" brightness is greatly less than white as when the LEDs are operating much more efficiently."**

We have seen many occurrences of LED billboards displaying 100 percent white. Frequently, this event occurs due to a technician error, setting the controller to display 100% white during routine maintenance. The results of operator error such as this are devastating, especially for a pilot attempting to land a plane with 300 passengers on board or drivers attempting to drive safely on a freeway. Figure 3 shows an LED billboard displaying the same 100% white that Zeiger Engineers contends will never happen.

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

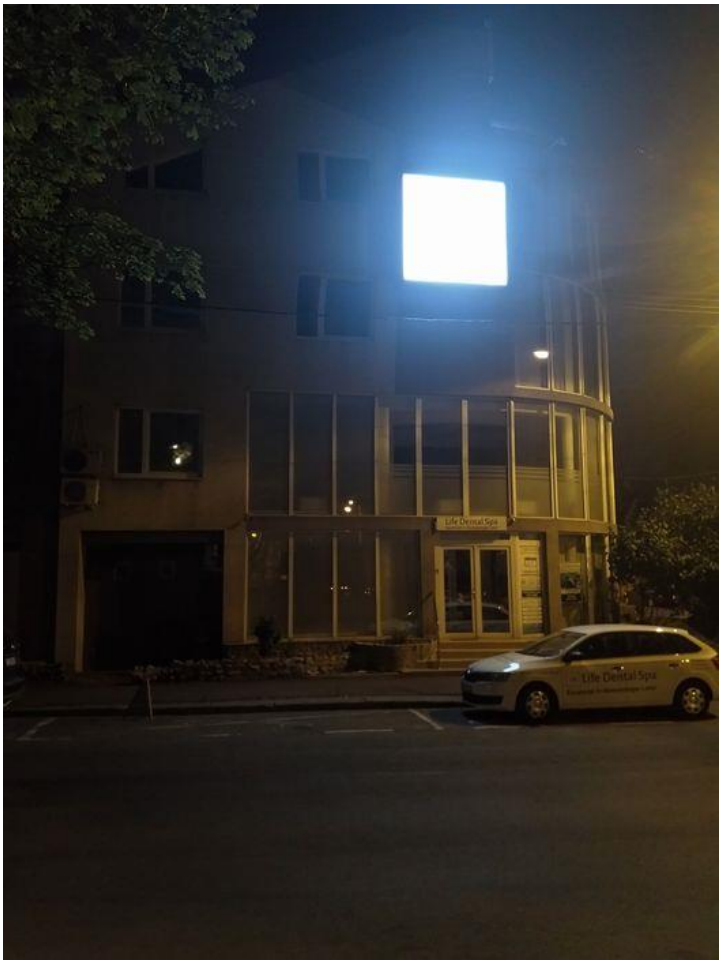

Figure 3 - LED Billboard Light

Quote: **"Due to the upper shielding on the LED modules providing an 18 degree cutoff, planes within 1-mile of the billboards would need to be below 1,700 feet altitude to first observe the display, and at that distance the illumination would be less than 0.0012 footcandle (0.012 lux)."**

The concept of "illumination" from an LED billboard is an inappropriate measurement unit when discussing eye safety and pilot vision. We note that the critical flaw in the Zeiger analysis is ignoring the luminance and radiance of the LED radiation from the billboard, which is unaffected by distance. In addition, the Zeiger report uses incorrect mathematical calculations, erroneously attempting to convert a density measurement into an area measurement.

"Luminance" is the density of the LED light. The full 9,000 nits of the LED billboard will be stabbing the pilot in the eye just as the pilot is attempting to land the plane. The Federal Aviation Administration currently regulates the radiance from LED lasers and thus it is a federal crime to shine a laser at an airplane. LED radiation is just as dangerous, and yet the FAA has no regulations for spatially isotropic, spectrally incoherent radiation. It is up to the City of San Jose to protect pilots from hazardous radiation from LEDs.

Figure 4 shows an LED billboard in front of a church. This photo was taken by one of our members, who provided a description of how this LED radiation affect her. *"Total freak out this morning. Beautiful morning so let my dog out the front yard for her morning constitution. When she went to the sidewalk and turned towards the church I followed only to be blasted full on and lost my sight, meaning My eyes got this over exposure in a flash. I got frantic went to my side yard only to be even more sensitive to the church's LED lights I couldn't see the ground or make much of anything. I know where my house is so I went back to get an umbrella to shield my eyes so I could find my dog. She is home and I am still sight fuzzy and mentally and emotionally drained."*

Figure 4 - LED Billboard at Church

Quote: **"The above illuminations are much less than illumination of a full Moon, which typically provides only about 0.005 footcandle (0.05lux) –0.01 footcandle (0.1 lux) illumination."**

A comparison of spatially anisotropic radiation from LEDs to spatially isotropic radiation from the sun and then reflected off the moon is inappropriate. LEDs are a directed energy source and do not provide uniform illuminance. There is no comparison between moonlight and light energy from LEDs, as they are different types of radiation.

Quote: **"The conclusion is that billboards will provide no more potential for pilot distraction as compared to other commonly found illumination sources, such as moon light, parking lot illumination, automobile headlights, freeway signage, building illumination, etc."**

This is a false conclusion, as LED billboards are not "illumination sources." LEDs emit highly directional, spatially anisotropic radiation that has been shown to cause eye damage, interference with

the human nervous system, and loss of awareness that endangers the lives of pilots, airline passengers, drivers, and the public.

Quote: **"Subsequently, the IES "Lighting Handbook 10th Edition (2011) (the "NA" was dropped) was published, in a completely rewritten format, but it lacks all mention of lighting of outdoor advertising. The recommendations of this publication were based on a report commissioned by the American Outdoor Advertisers Association. It has become something of a national model code for installation of billboards."**

We note that that, rather than using standards from the medical profession or from an agency such as the Environmental Protection Agency, Zeiger Engineers chose to use "recommendations" from the American Outdoor Advertisers Association. Mr. Zeiger further states that these recommendations are "something of a national model code for installation of billboards." It is unacceptable for a supposedly unbiased engineering report to rely on the industry's own recommendations for LED billboards which do not adequately address protection of human eyes, human psychological health, civil rights, and the special needs of people with disabilities. The Zeiger Engineers report is therefore heavily biased towards the industry.

Quote: **"Nighttime surface brightness of <u>conventional</u> billboards have been surveyed in studies conducted in Arizona (2009), New York (2008) and other cities. Those surveys provided results that show a luminance range from <100nits to <150nits."**

This is an important data point. Conventional billboards use spatially isotropic lamps to illuminate the billboard, with the result being a uniform luminance of 150 nits or less hitting the eye. The maximum comfort level for humans is around 300 nits of uniform luminance, with a maximum tolerance level of 50,000 nits. Therefore, a **conventional** billboard is not a significant health or safety hazard, just a visual blight.

Mr. Zeiger, however, then uses invalid calculations to mystically prove that the 9,000 nit spatially anisotropic, direct energy luminance from an LED billboard is safe. 9,000 nits far exceed human comfort level and is approaching the absolute maximum tolerance level of human beings. In addition, since the radiation from the LEDs is spatially anisotropic, this type of radiation has much more severe impacts on the human nervous system than spatially isotropic radiation. Therefore, 9,000 nits of LED radiation cause far more harm than 9,000 nits of radiation from an incandescent light source.

LED chip makers were already creating chips that emit more than 100,000,000 nits as of 2018, so while 9,000 nits may be the maximum for LED billboards today, it is likely that they will emit far more intense radiation in the near future. LED billboards pose an eye hazard and psychological health hazard due to the intense spatially anisotropic radiation.

Quote: **"The value of <0.3 footcandle is relatively low but can be measured with a handheld photometer."**

This is a false statement as it would be applied to LED billboards. A handheld photometer is used to measure the illuminance from a spatially isotropic source. The software in the photometer is coded with the assumption that the light source emits radiation uniformly. For LED directed energy radiation, it makes no sense to attempt to measure the illuminance, because the radiation is focused and directed and non-uniform. The key measurement unit for an LED billboard is the luminance or

radiance, which is the density of the radiation and is measured in a laboratory by the manufacturer. The key safety parameter is the intense 9,000 nits of spatially anisotropic radiation emitted by an LED billboard. The Zeiger Engineering report invalidly attempts to convert the 9,000-nit density measurement into a footcandle area measurement. This conversion would require knowing the luminance at every point in space, with a precision in the nanometer, picometer or femtometer range and then integrating across the area in question. The simple formulas used by Zeiger Engineers are not valid for spatially anisotropic radiation.

Quote: **"The industry commonly uses approximately an 8 second duration time between static messages."**

Here again we see the deference to the industry, rather than to the medical research. The intense radiation and the messaging on the billboard are purposely designed to capture attention and make an impact on a person's thoughts. An LED billboard violates the goals of the Vision Zero program by distracting drivers. Persons with autism can be highly focused and a person with even mild autism will be highly susceptible to this attention-grabbing effort. Thus, LED billboards also violate the Americans with Disabilities Act because they put persons with autism at high risk of injury or death. As noted in the Zeiger report, California does not have a safety standard for LED billboards, and thus the City of San Jose would be liable for any injuries caused by the LED radiation and the projected images.

The Soft Lights Foundation manages two Facebook groups, Ban Blinding LEDs, and Soft Lights. Th requirement to join the Ban Blinding LEDs group is to answer the following question, "Which problem is worse, LED headlights or LED flashing lights on police cars?" A response we received on November 11, 2021, was "headlights & billboards are the worst." While most responses are either LED headlights or LED flashing lights, it is not uncommon for respondents to share their hatred of LED billboards. As stated earlier in this rebuttal, the main beneficiary of the emission of this toxic LED radiation is Clear Channel and the public suffers the consequences of reduced safety, damage to health and degraded quality of life.

The fact that LEDs are unregulated and lack standards, cause sickness and eye damage, interfere with the human nervous system, are hazardous, and discriminate against people with light sensitivity disabilities will make San Jose and Clear Channel liable for the harm and discrimination they cause if LED billboards are installed.

Sincerely,

Mark Baker

Mark Baker
President
Soft Lights Foundation
www.softlights.org
mbaker@softlights.org
9450 SW Gemini Drive PMB 44671
Beaverton, OR 97008

Mark Baker has a Bachelor of Science degree in Electrical Engineering from the University of California at Santa Barbara. He is the President of the Soft Lights Foundation.