BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF MINNESOTA

In the matter of the Petition for the Regulation of Light Emitting Diode Streetlights	Docket No. _____
	Petitioner: Soft Lights Foundation
	Date: July 11, 2022

Petition to Require FDA Approval of LED Streetlights

I. INTRODUCTION

The US Food and Drug Administration has not approved Light Emitting Diode products and has not developed regulations for LEDs. LED light has been shown to be toxic, dangerous, and discriminatory. LEDs emit a directed beam of non-uniform energy and is thus a low-quality light. LEDs are not energy efficient because they do not provide the same quality of light as previous technologies.

II. STATEMENT OF FACTS

A. Regulation of Electromagnetic Radiation

In 1968, Congress passed the Radiation Control for Health and Safety Act which directed the Food and Drug Administration to regulate electronic products and the electromagnetic radiation emitted by those products, including visible

light. The FDA issued Title 21, Part I, Subchapter J, Part 1040 in the Code of Federal Regulations which is titled *Performance Standards for Light-Emitting Products*. The FDA has issued 21 CFR Part 1040.10 Laser products., Part 1040.20 Sunlamp products and ultraviolet lamps intended for use in sunlamp products., and Part 1040.30 High-intensity mercury vapor discharge lamps.

In 2018, the FDA posted the statement on the FDA's website, "*LEDs (Light Emitting Diodes) are different from laser diodes and are not subject to the Federal laser product performance standard.*"[1] This statement does not clarify whether LEDs have never been regulated by the FDA, or if the FDA had been previously regulating LEDs under Part 1040.10 but has now stopped regulating LEDs within Part 1040.10. In either case, this lack of regulation of LEDs violates Congress' mandate in the 1968 Radiation Control for Health and Safety Act to regulate electromagnetic radiation.

LEDs were invented in the 1960s, so FDA regulation of Light Emitting Diodes should have occurred long ago. As we can see, however, Part 1040 Performance Standards for Light-Emitting Products is missing Subpart 1040.40 Light Emitting Diode products.

The significance of these statements is that any utility company that sells, installs, or operates LED streetlights is doing so without FDA approval. The FDA has not published studies on the health impacts of LED light and has not

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[1] https://www.fda.gov/radiation-emitting-products/home-business-and-entertainment-products/laser-products-and-instruments

published regulations to protect the health and welfare of the public. The installation and operation of unapproved, unregulated LED streetlights endangers public health and safety.

B. Light Emitting Diodes

There are two types of light sources: point sources and surface sources.

Point source: A point source emits light from a curved surface which results in spatially uniform energy, and which can be modeled as a mathematical point. Brightness is measured with luminous intensity in candela. Examples include the sun, a candle, an incandescent light bulb, fluorescent, and High-Pressure Sodium.

Surface source: A surface source emits light from a non-curved, flat surface which results in spatially non-uniform energy, and which creates a 3D Lambertian mathematical shape. Brightness is measured with luminance in nits (candela per square meter). An example is a Light Emitting Diode.

Cellular organisms and viruses have evolved with the uniform energy of point source light. The introduction of non-uniform energy from surface source devices has created new type of light. For humans and other biological systems, this surface source LED light is a low-quality light because of its spatial non-uniformity, piecewise spectral power distribution, and square wave flicker. The diagram below shows a comparison of the spatial, spectral, and temporal properties of point source versus surface source light.

Incandescent vs. Light Emitting Diode (LED)

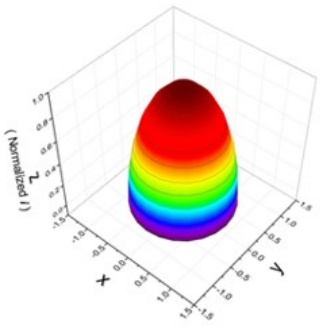
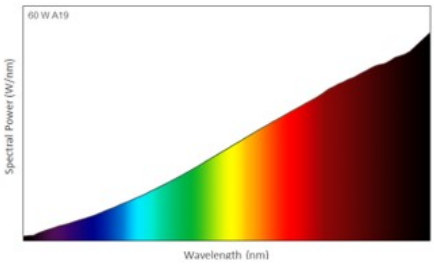
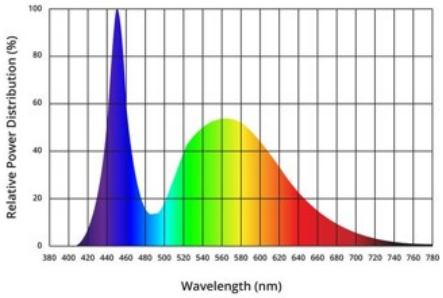
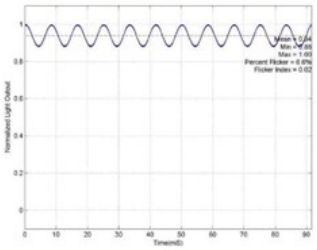
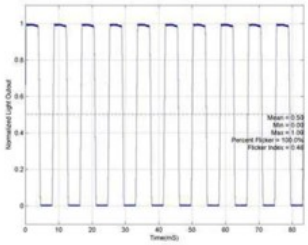
	High Quality Light Incandescent	Low Quality Light LED
Spatial		
	Uniform Luminance	Non-Uniform Luminance
Spectral		
	Low Blue Continuously Increasing	Blue Spike Piecewise
Temporal		
	Analog Sine Wave	Digital Square Wave

Figure 1 - Incandescent vs. LED

The Institute of Electrical and Electronics Engineers has published a peer-reviewed article by Dr. Nisa Khan that details the calculus mathematics used to describe the Lambertian shape of a flat-surface source.[2] Figure 2 from the IEEE article shows how light from a flat surface LED chip does not produce spatially uniform energy. This view is a 2D cross-section of 3D space.

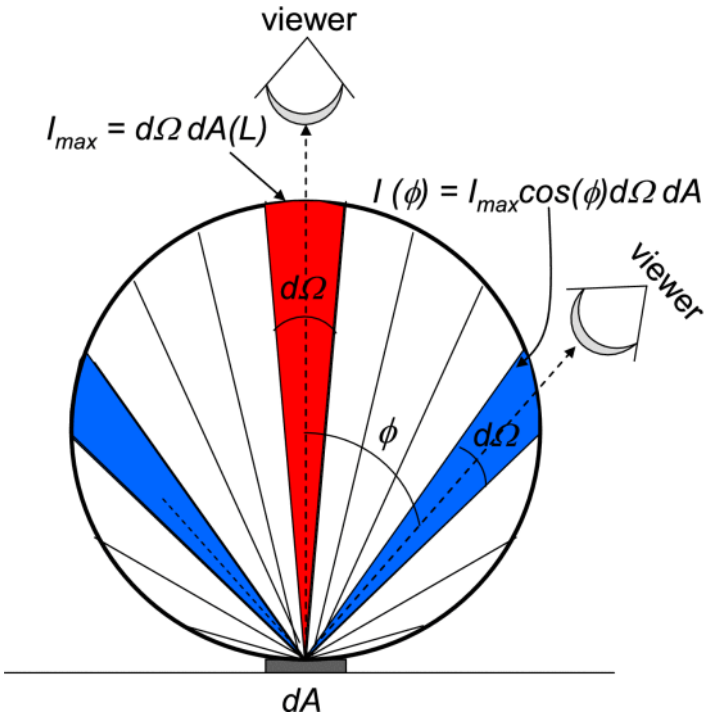


Figure 2 - Lambert's Cosine Law

This mathematical proof that LED light is spatially non-uniform is of utmost importance for the installation and operation of LED products. LED light has different energies and characteristics at every point in 3D space which

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

means that previous formulas, calculations, and regulations that assumed uniform luminance cannot be used with LED products.

C. Health, Safety, and Comfort

The low quality of LED light has been shown to have significant negative impacts on human health, safety, and comfort, including causing epileptic seizures, migraines, panic attacks, nausea, loss of balance, reduced visual perception, anxiety, anger, agitation, and eye injury.

1. Neurological Health, Safety, and Comfort

The FDA has not set standards to protect all members of the public, including those who are especially sensitive to LED light. It may be that LED light is so toxic that it cannot be used for the purpose of illumination. Just because there are already hundreds of millions of LED sources already in the environment does not justify continuing to allow harm to members of the public who are sensitive to LED light.

The study Daily blue-light exposure shortens lifespan and causes brain neurodegeneration in Drosophila was published on October 17, 2019.[3] The study concluded that "*blue light may cause brain degeneration as well as*

[3] https://www.nature.com/articles/s41514-019-0038-6

retinal damage and reduce the lifespan."[4] This is extremely significant as many LED products emit excessive amounts of blue wavelength light.

There is a lack of formal, supervised study of the impacts of the spatially non-uniform energy of LED light on humans. However, there is significant documented evidence via personal stories of serious negative reactions to LED light that cannot be explained by the square wave flicker or blue wavelength light alone. LED light is very dense and yet within that density, the energy is non-uniform. Exactly how this effects our nervous system has not been formally studied in detail, and yet we already know the consequences from the telling of personal experiences.

MarieAnn Cherry testified to the New York State Public Service Commission on May 16, 2022.[5] Ms. Cherry opened her testimony by saying, "*I have epilepsy and migralepsy. I cannot neurologically tolerate any LED exposure, and I am thrown instantly into violent seizures from the briefest strike of LED light*." Ms. Cherry does not experience these seizures when exposed to incandescent or High-Pressure Sodium light. The difference is the spatially non-uniform energy from LEDs that trigger Ms. Cherry's seizures. These LED lights are currently used in public streetlights, preventing Ms. Cherry from using the public roads when these LED

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[4] https://www.news-medical.net/news/20191018/Blue-light-and-fruit-flies-a-warning-for-humans.aspx
[5] https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=21-02623&CaseSearch=Search

streetlights are turned on. The FDA has not regulated LED products so that people like Ms. Cherry are protected from life-threatening seizures. This means that the FDA has not set health, safety, and comfort requirements for spatial uniformity, peak luminance and peak radiance, spectral power distribution, and square wave flicker.

Elaine Dennehy testified to the Irish Parliament on February 3, 2022.[6] Ms. Dennehy opened her testimony by saying, "*I thank the committee very much for this opportunity. I also hope that this can help, in many ways, the others who are suffering around the world from light emitting diode, LED, sensitivity and artificial light sensitivity. I have been made ill from LEDs since 2007. It is more than a sensitivity; it is a disability. I am disabled by my environment, like so many others, and excluded from society. This is also an accessibility issue*." The fact that the use of LED light excludes Ms. Dennehy from society is a serious concern. Utility companies must understand the toxicity of spatially non-uniform LED light and its impacts on human nerves and consider these factors in the installation and operation of LED products.

Additional References:

a. NYSPSC Case Number 21-02623[7]

b. Soft Lights Foundation Documented Stories of LED Harm[8]

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[6] https://www.oireachtas.ie/en/debates/debate/joint_committee_on_disability_matters/2022-02-03/2/
[7] https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=21-02623&CaseSearch=Search
[8] http://www.softlights.org/stories/

c. LightAware Charity Documented Stories of LED Harm[9]

d. Soft Lights Foundation Collection of Research Articles[10]

2. Eye Health, Safety, and Comfort

The energy from LEDs is measured both with luminance and radiance. The FDA has not set maximum safety standards using either metric. The FDA has not set standards for preventing eye damage or discomfort.

The company Fireflier published the article What is Photobiological Safety Standard? in April 2021[11]. The article concludes, "*the risks posed by these new sources of light are also rooted in their intrinsic characteristics: high optical output in a small package (producing a high radiance level) associated with significant blue light emission. The combination of these two factors can potentially increase the risk of photochemical damage of the retina, in comparison with the incandescent lamp and the fluorescent lamp*." FDA regulation of LED light is a necessity.

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**

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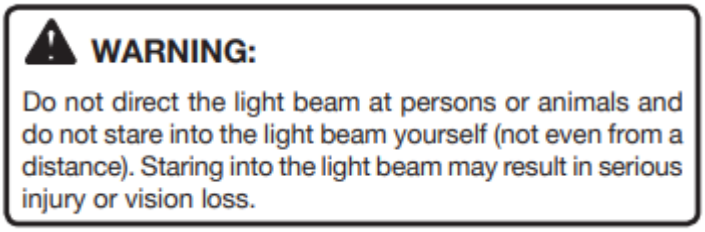
[9] https://lightaware.org/about/individual-stories/
[10] https://www.softlights.org/resources/
[11] https://fireflier.com/what-is-photobiological-safety-standard/

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. The parenthetical "(not even from a distance)" indicates a high level of danger.



Ryobi's decision to include "not even from a distance" is significant. LEDs emit very dense light that can travel long distances with very little dispersion, so Ryobi is correct about the dangers. Utility companies that sell, install, or operate LED streetlights that are known to be dangerous and have no FDA approval and no FDA regulations are liable for the injuries caused by LED streetlights.

D. Existing Standards for Illumination

Existing standards for illumination are based on point source light. These standards assume that the light is spatially uniform. An example is the Illuminating Engineering Society RP-8-18 Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting was written for point source light such as High-Pressure Sodium. Because LEDs emit spatially non-

uniform light, utility companies cannot use standards such as IES RP-8-18 for LED streetlights. A new standard must be written that accounts for the spatially non-uniform light.

Cree Lighting is the first company in the industry to admit that the industry has been measuring LED light incorrectly.[12] Cree states, "*Not one of the existing metrics takes into account the non-uniform emitting surface of a LED luminaire.*" This statement is very important for utility companies to understand. Cree is stating what no utility company has so far admitted, which is that LED light is spatially non-uniform and that there are no measurement standards that are taking this spatial non-uniformity into account. Cree also writes, "*We also bring a call for urgency to this work. Without a speedy agreement on metrics for measuring LED intensity, photometry, and LED spacing, we will be installing millions of LED luminaires for street lighting purposes that are not suitable for use, could even be described as dangerous, and that will be costly to replace*."

Existing devices that measure light in far-field cannot be used to measure surface light due to lack of precision and lack of firmware and software designed to process spatially non-uniform light.

E. Energy Efficiency Claim

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[12] https://online.flippingbook.com/view/702884488/

The definition of **energy efficiency is providing the same quality of service using less energy**. This means that when LED light is compared against High-Pressure Sodium light, the light quality must be equivalent in order to state whether LED is more energy efficient than High-Pressure Sodium. Since LED light is spatially non-uniform, has a piecewise spectral power distribution shape, and has square wave flicker, the light quality of LED is much lower than the light quality of High-Pressure Sodium. Therefore, the claim that LEDs are more energy efficient than High-Pressure Sodium cannot be made because the two sources are not providing the same quality of service. LED light is simply a low-quality light.

In general, the utility companies have falsely equated luminous efficacy with energy efficiency. When two lighting products emit the same quality of light, then luminous efficacy is equivalent to energy efficiency. For example, for two LED products, one with a luminous efficacy of 60 lumens per watt and the other at 100 lumens per watt, the 100 lumens/watt LED is more energy efficient. However, for two lighting products that have different output qualities, such as a comparison between High-Pressure Sodium and an LED, luminous efficacy does not equate to energy efficiency. Utility companies cannot truthfully claim that LED streetlights are energy efficient when compared to HPS because the two products provide different quality of service and therefore no energy efficiency comparison can be made.

Figure 3 shows LED streetlights on the left and HPS streetlights on the right. The photo shows the excessive and dangerous glare, the toxic blue/purple

wavelengths, the zebra pattern on the ground from the non-uniform luminance and the exceedingly high peak luminance.

Figure 3 - LED vs. HPS Streetlights

F. Conclusion

Light Emitting Diodes emit an entirely different type of light than incandescent because the light is emitted from a flat surface, thus creating non-uniform luminance. In addition, LEDs have a piecewise spectral power distribution and square wave flicker. The quality of LED light is much lower than the quality of High-Pressure Sodium light. The low quality of LED light causes serious negative health effects, including seizures, migraines, and emotional trauma, as well as a high risk of eye injury. LED devices are not energy efficient because they don't produce the same quality of light as HPS.

In just the past two decades, LEDs have proliferated across the world in almost unimaginably large numbers, almost entirely without regulation. This has led to very serious negative consequences for the health, safety, comfort, and civil rights of the public.

Congress has mandated that the FDA regulate electromagnetic radiation from electronic products, including visible light. Therefore, utility companies must either petition the FDA or wait for the FDA to issue CFR 21 Part 1040.40 LED products which will regulate spatial uniformity, peak luminance and peak radiance, spectral power distribution, and square wave flicker to ensure the health, safety, comfort, and civil rights of the public, especially those who are LED light-disabled.

III. UTILITY COMPANY REBUTTALS

We anticipate that the utility companies will attempt to rebut the facts. In this section we provide responses to their anticipated rebuttals.

A. Health Studies

A utility company may respond that they are unaware of any formal peer reviewed studies that show negative impacts on human health from LED lights. The counter to this argument is that the utility companies have installed LED products without waiting for the FDA to study the health effects of LED light. The FDA has not published studies on how spatially non-uniform LED light

affects the neurological system. The FDA has never stated that LED light is safe.

In addition, there are many studies which show that the blue wavelength light from LEDs is unsafe and that the square wave flicker from LEDs is unsafe. Many of these studies are available on the Soft Lights Foundation website.[13]

Also, because LEDs have been released into society without waiting for the peer reviewed studies, we have all now become subjects in a giant real-life experiment. The personal stories of harm from LED light now form the basis of a study. Many documented stories of harm can be found on the Soft Lights Foundation website.[14]

B. Illuminating Engineering Society

A utility company may claim that the IES is studying the health effects of LED light and is collaborating with the American Medical Association. This claim is untrue. The IES is making no effort that we are aware of to study the health effects of LED light and the AMA stopped investigating LED light after publication of their 2016 report on the harms of blue wavelength light.[15]

The IES also falsely claims that LEDs are point sources and that LED light has the same characteristics as High-Pressure Sodium. The IES has failed to

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[13] https://www.softlights.org/resources/
[14] http://www.softlights.org/stories/
[15] https://www.ama-assn.org/sites/ama-assn.org/files/corp/media-browser/public/about-ama/councils/Council%20Reports/council-on-science-public-health/a16-csaph2.pdf

create a version of IES RP-8-18 that accounts for the spatial non-uniformity of LED light. The IES has no standards that can be used for the photometric layout of LED streetlights.

C. Industry Standards

A utility company may claim that they are simply using industry standard equipment and that LEDs are what is available. The counter to this argument is that utility companies are part of the industry, and it is their own decision to switch to LEDs. The decision to switch to LED was a financial decision for utility company which brought in new revenue. The claim that the utility company is essentially forced to use LED streetlights because LEDs are what is available is unsupported. As soon as the utility companies inform their suppliers that they need High-Pressure Sodium or Low-Pressure Sodium streetlights, the supplier will provide.

D. Light Quality

A utility company may claim that light quality is only subjective and cannot be quantified. This is an untrue claim.

Spatially, light can be quantified as uniform or non-uniform and the luminance in 3D space can be graphed. The higher the degree of uniformity, the higher the quality.

Spectrally, light can be quantified in terms of whether the energy distribution is the same across all wavelengths, or if the energy is smoothly

increasing from low blue to high red, or if the energy distribution has peaks and valleys. Blue wavelength light is the most toxic in a nighttime environment, so the more blue wavelength energy, the lower the quality of the light.

Temporally, sign wave flicker is higher quality than square wave flicker.

E. Energy Efficiency

A utility company may claim that LED streetlights are necessary for saving energy. This is an untrue claim. High-Pressure Sodium streetlights are already efficient. Replacing a 100-watt HPS with a 50-watt HPS would be a 50% energy savings without sacrificing safety and without introducing the toxicity of LED light. Switching to Low-Pressure Sodium would save even more energy.

Figure 4 is a luminous efficacy comparison of different lamp types. Notice that LEDs are the only lamp type shown in the chart that emits non-uniform luminance. Also notice that LEDs are similar in luminous efficacy to High-Pressure Sodium. Not shown on the chart is Low-Pressure Sodium which has a luminous efficacy approaching 200 lumens per watt, which is better than LEDs.[16]

[16] https://ieeexplore.ieee.org/abstract/document/605090

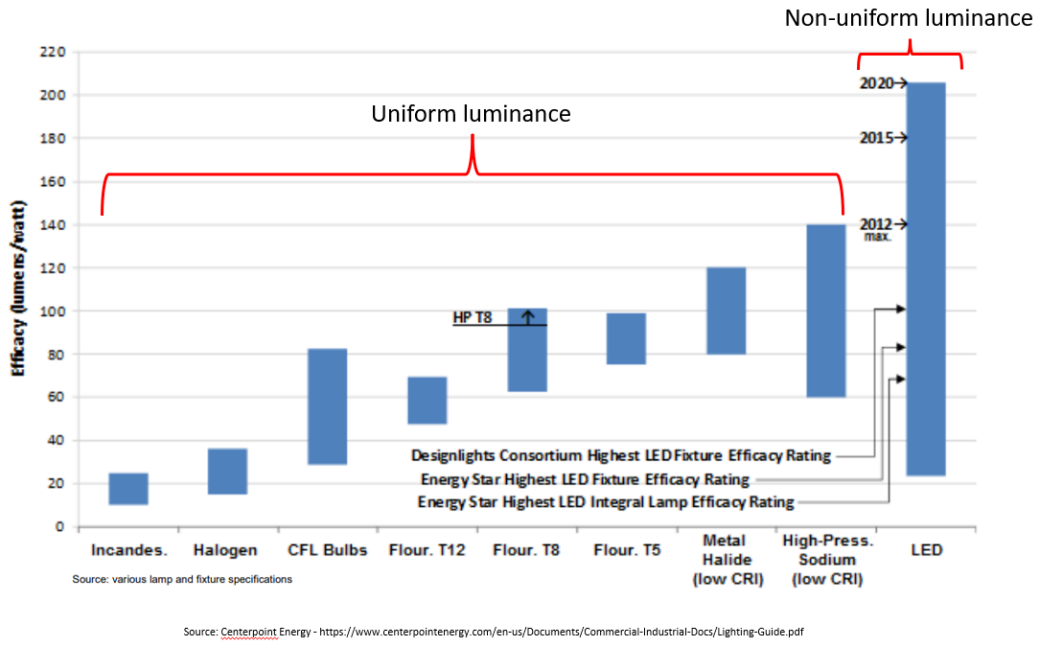

Figure 4 - Energy Efficiency Comparison

Nevada Revised Statutes 704.7833.1 defines an Energy Efficiency Program as "*a program designed, intended or used to improve energy efficiency by reducing the energy consumption by a retail customer of an electric utility*." While not explicitly stated, the reduced energy consumption cannot be obtained via reduced quality of service. The utility company may not switch from HPS to LED and truthfully claim that such a switch is part of energy efficiency program.

F. Color Rendering

A utility company may claim that LED streetlights provide superior color rendering. This is a claim that only serves to distract from the actual issues. At night, the key concern is contrast. Rod cells in the eye are 7 times more efficient than cone cells at converting light to signals, although with a loss of

color determination. However, at night it is psychologically disturbing to see green grass when the surrounding environment is not illuminated by sunlight.

CRI is useful for indoor lighting, during daytime hours, when the goal is to emulate sunlight, such as in a classroom or office setting. However, at night when streetlights are in use, using high CRI lighting is counterproductive and unwanted.

IV. REGULATORY AUTHORITY

The Minnesota Statutes Chapters 216-217 provides authority to the Minnesota Public Utilities Commission to regulate the actions of the utility companies.

216B.08 Duties of Commission

The commission is hereby vested with the powers, rights, functions, and jurisdiction to regulate in accordance with the provisions of Laws 1974, chapter 429 every public utility as defined herein. The exercise of such powers, rights, functions, and jurisdiction is prescribed as a duty of the commission. The commission is authorized to make rules in furtherance of the purposes of Laws 1974, chapter 429.

216B.09 STANDARDS; CLASSIFICATIONS; RULES; PRACTICES

Subdivision 1.**Commission authority, generally.**

The commission, on its own motion or upon complaint and after reasonable notice and hearing, may ascertain and fix just and reasonable standards, classifications, rules, or

practices to be observed and followed by any or all public utilities with respect to the service to be furnished.

As described in chapters 216B.08 and 216B.09, the Minnesota PUC is directed to supervise and regulate the utility companies and to develop rules to protect the public. The Minnesota PUC therefore has authority to regulate the quality of light emitted by streetlights to ensure the protection of the public health and welfare.

V. RELIEF

The Soft Lights Foundation respectfully requests the Minnesota Public Utilities Commission to take the following actions:

A. Require Minnesota utility companies to wait for FDA approval and regulation of LED products prior to the sale or installation of any LED streetlight.

B. Direct Minnesota utility companies to inform consumers via their website that:

   i. LEDs have not been approved by the FDA and that the FDA has not developed regulations for LEDs;

   ii. LED light is a low-quality light, not an energy efficient light;

   iii. LED light has been shown to cause significant negative health effects.

/s/ Mark Baker
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