Soft Lights Foundation

Light should guide us, not blind us.

June 25, 2026

Jillian LeDuc, ADA Coordinator, Davis, California
jleduc@cityofdavis.org

Ken Hiatt, City Manager, Woodland, California
ken.hiatt@cityofwoodland.gov

Peter Ibrahim, ADA Coordinator, West Sacramento, California
ada@cityofwestsacramento.org

ADA Coordinator, Winters, California
cityclerk@cityofwinters.org

ADA Coordinator, Yolo County California
Risk.Mgmt@YoloCounty.gov

Re: Notice of Gross Negligence Exposure, ADA Request for Accommodation – Auxiliary Vehicle Lamps

Dear ADA Coordinator, City Manager, City Attorney, County Administrator, and County Counsel:

I submit this letter in two capacities: (1) as an individual Yolo County resident with a photosensitive disability who is personally affected by the high-intensity flashing lights described below, and who may bring a pro se ADA Title II action if these issues are not resolved; and (2) as President of the Soft Lights Foundation, a nonprofit organization advocating for responsible lighting practices and equitable access to public spaces for photosensitive individuals. Both capacities are material to the obligations addressed here. This letter creates a written record for purposes of the Americans with Disabilities Act (ADA), 42 U.S.C. § 12101 et seq., 28 C.F.R. Part 35, and applicable federal motor vehicle safety law.

I. Self-Evaluation Obligation: 28 C.F.R. § 35.105

Title II of the ADA, and its implementing regulation at 28 C.F.R. § 35.105, require every public entity to evaluate its services, policies, and practices to identify and remedy those that do not meet the requirements of Part 35. This obligation extends to electronic product radiation emitted by equipment the public entity operates or deploys in public-contact settings — including Rectangular Rapid Flashing Beacons (RRFBs) installed at pedestrian crossings, and auxiliary vehicle lights mounted on law enforcement, fire, emergency-

management, and utility vehicles that operate in public rights-of-way.

Your jurisdiction's self-evaluation must address:

(a) The photobiological and neurological effects of high-intensity static and flashing lamps on individuals with photosensitive conditions, including but not limited to migraine disorder, photosensitive epilepsy, traumatic brain injury, autism spectrum disorder, and post-concussion syndrome;

(b) Whether current use of Light Emitting Diode (LED) configurations such as RRFBs and auxiliary vehicle lamps deter or exclude members of the disability community from full and equal access to public streets, sidewalks, and rights-of-way; and

(c) Whether any written self-evaluation exists that addresses light and sound signaling systems, and whether that evaluation has been reviewed and updated within the period required by 28 C.F.R. § 35.105(c).

(d) Whether your jurisdiction's communications programs — including emergency alert lighting, pedestrian crossing signals, and traffic management systems — comply with the ADA effective communication requirement at 28 C.F.R. § 35.160, which requires public entities to take appropriate steps to ensure that communications with individuals with disabilities are as effective as communications with non-disabled individuals; and

(e) Whether your jurisdiction's use of high-intensity flashing LED devices in pedestrian crossings and adjacent to sidewalks creates barriers to full and equal access to the pedestrian path of travel — including sidewalks, crosswalks, and pedestrian facilities — in violation of 28 C.F.R. § 35.150 (program access) and the path-of-travel obligations that apply when a public entity undertakes alterations to facilities used by the public.

If your jurisdiction has not conducted such an evaluation, or if an existing evaluation does not address electronic product radiation from RRFBs or auxiliary vehicle lamps, I request that you initiate one promptly and provide written confirmation of the timeline for completion.

II. Photometric Evidence: Peer-Reviewed Research Establishes That Rapid Flashing Devices Cause Unbearable Glare to a Segment of the Public, Including Me

Attached as Exhibit A is a copy of Robertson and Fitzpatrick, "Investigating a Relationship between Luminous Intensity, Optical Power, and the Discomfort Glare of Rapid Flashing Traffic Control Devices" (Texas A&M Transportation Institute, prepared for the TRB 2014 Meeting, rev. July 27, 2013) (hereafter "Robertson"). This study was prepared for FHWA-sponsored research on Rectangular Rapid Flashing Beacons and is directly relevant to the LED flashing devices your jurisdiction operates at pedestrian crossings. Its findings extend, by analogy, to the high-intensity LED auxiliary lamps on your fleet vehicles, which operate at comparable or higher luminous intensities and at closer range to pedestrians.

The Robertson study tested 71 participants — men and women, younger and older — who rated the brightness of rapid flashing LED beacons at various controller settings as "comfortable," "irritating," or "unbearable." The study defined "unbearable" as glare so intense that the participant wants to avoid looking at the device. Key findings include:

(a) Even at the lowest controller setting — the minimum luminous intensity tested —

approximately one percent of participants rated the device as "unbearable." This means that even lights operated at minimum required intensity cause unbearable discomfort glare to a measurable segment of the public under controlled conditions.

(b) At the highest controller setting (controller level 6, the maximum brightness tested), nearly 50 percent of all participants rated the device as unbearable — and the probability of rating a light as unbearable was approximately 13 times greater at night than during daytime conditions.

(c) The study authors recommended that transportation agencies focus on meeting minimum luminous intensity requirements and avoid devices with the highest intensities possible. The authors further recommended that the profession consider setting maximum luminous intensities for rapid flashing devices — an indication that the profession already recognizes unconstrained intensity poses a public harm.

(d) The discomfort glare associated with rapid flashing beacons is not limited to RRFBs. Auxiliary vehicle lamps — police light bars, fire apparatus warning lights, and utility vehicle strobe systems — operate using the same rapid-flash LED technology at comparable or greater luminous intensities, and they are typically encountered at closer range than a pedestrian beacon. The Robertson findings therefore establish, at a minimum, that flashing LED auxiliary vehicle lamps operating above minimum intensity levels cause unbearable glare to a statistically significant portion of the public, and that portion grows substantially at night and at shorter distances.

I fall within the population for whom flashing LED devices at even minimum intensity cause unbearable glare. The Robertson data confirm that this is not an idiosyncratic sensitivity; it is a documented, measurable phenomenon affecting a segment of every population exposed to these devices. The ADA's individualized-accommodation framework exists precisely for circumstances like this, where a facially neutral practice causes discriminatory exclusion for a subset of individuals with disabilities. Receipt of this letter, with the Robertson study attached, constitutes actual notice that your jurisdiction's current practices cause unbearable light-induced discomfort to members of the public with photosensitive disabilities — and that your self-evaluation under 28 C.F.R. § 35.105 must address this documented impact.

III. Request for Individualized, Fact-Specific Reasonable-Accommodation Determination

I am an individual with photosensitive disability. I am adversely affected by RRFBs and the flashing auxiliary lights used on vehicles operated by your jurisdiction. I formally request that your jurisdiction conduct an individualized, fact-specific investigation to determine what constitutes a reasonable accommodation for me in connection with the use of auxiliary flashing lights by your employees and contractors operating within public rights-of-way.

This request is grounded in 28 C.F.R. § 35.130(b)(7), which requires public entities to make reasonable modifications to policies, practices, or procedures to avoid discrimination on the basis of disability, unless the entity can demonstrate that doing so would fundamentally alter the nature of the service or activity. The investigation must be fact-specific and individualized — a blanket policy denying all accommodation without any individualized inquiry does not satisfy this standard.

Please designate an ADA coordinator or comparable official to contact me within thirty (30) days of receipt of this letter.

IV. FMVSS 108 Steady-Burning Requirement and Final Agency Action

Federal Motor Vehicle Safety Standard 108, codified at 49 C.F.R. § 571.108, governs lamps, reflective devices, and associated equipment on motor vehicles. Section S6.2.1 of FMVSS 108 provides that no auxiliary lamp may impair the effectiveness of any lamp required by the standard. Auxiliary flashing lamps that override or compete with required signal lamps violate this provision.

NHTSA's Chief Counsel issued interpretive letters dated June 27, 2024 (Exhibit B), and December 13, 2024 (Exhibit C), confirming that the steady-burning requirement applicable to federally mandated lamps constitutes a long-standing agency interpretation. These letters reflect NHTSA's authoritative, definitive position that auxiliary vehicle lamps installed in a manner that causes required lamps to flash, pulse, or otherwise deviate from their steady-burning function are noncompliant with FMVSS 108.

On May 18, 2026, the United States Court of Appeals for the Eighth Circuit held, in a 2-1 decision in the Brake Plus litigation, that NHTSA's informal interpretive letters — issued after a multi-year investigation by an official with delegated interpretive authority — constitute final agency action reviewable under the Administrative Procedure Act. The court applied the two-part test of *Bennett v. Spear*, 520 U.S. 154 (1997), and concluded that letters applying NHTSA's authoritative interpretation to specific products and conduct, and concluding that those products 'cannot be installed for their intended use on motor vehicles consistent with Federal law,' satisfy both prongs of that test.

The practical legal consequence is significant: your jurisdiction has been on constructive — and now actual — notice that auxiliary flashing lamps that cause required vehicle lamps to deviate from their steady-burning function violate federal law. Continued use of such configurations after notice of this final agency action constitutes **gross negligence**. A public entity that operates noncompliant auxiliary lighting systems after receiving actual notice of the applicable federal standard cannot characterize its continued practice as a good-faith policy choice. It is an unreasonable departure from the standard of care, and it exposes your jurisdiction and your risk pool, YCPARMIA, to substantial liability.

V. RRFBs - Proposed Compliance Solution

The use of an RRFB is an optional choice by your jurisdiction. There are many alternatives to RRFBs, including the yellow slow-glowing, non-LED lamps used in traditional red/yellow/green street signals and the narrowing of streets with pedestrian islands at pedestrian crossings.

VI. Vehicle Lamps - Proposed Two-Step Compliance Solution

I recognize that operational lighting systems serve legitimate public-safety purposes, and I am not asking your jurisdiction to eliminate auxiliary vehicle lamps. I am offering a practical, low-cost compliance path that addresses the federal regulatory violation and the

ADA accommodation issue simultaneously.

Step 1 — Steady-Burning Mode: Program all auxiliary lamp control modules to operate in steady-burning mode only, eliminating any flashing, strobing, or pulsing function. Modern programmable light-bar and auxiliary-lamp controllers can be reconfigured by software or firmware update with minimal cost and no hardware replacement. This single step brings your fleet into compliance with FMVSS 108 § S6.2.1 as interpreted by NHTSA's June 27, 2024, and December 13, 2024 letters, and as confirmed by the Eighth Circuit's May 18, 2026 ruling.

Step 2 — Intensity Calibration: Program auxiliary lamp modules to operate at an intensity level no greater than that of standard incandescent brake lights — the baseline intensity that FMVSS 108 contemplates for federally required signal lamps. This step ensures that auxiliary lamps do not impair the effectiveness of the required lamps under 49 C.F.R. § 571.108(S6.2.1), and it substantially reduces the photobiological impact on photosensitive individuals, including me.

Together, these two programming changes — steady-burning mode and calibrated intensity — can be implemented with minimal operational impact. Vehicles would retain full auxiliary lighting capability in steady-burning mode and would continue to be visually distinct and identifiable to other drivers. The safety rationale for auxiliary lights is preserved; the federal regulatory violation and the discriminatory impact on persons with photosensitive disabilities are remedied.

VII. Requested Response

I request a written response within thirty (30) days addressing each of the following:

1. Whether your jurisdiction agrees to conduct or update a self-evaluation under 28 C.F.R. § 35.105 addressing: (a) electronic product radiation from RRFBs and auxiliary vehicle lamps; (b) effective communication obligations under 28 C.F.R. § 35.160 as applied to light-based signaling systems; and (c) whether RRFBs and auxiliary vehicle lamp configurations create barriers along the pedestrian path of travel in violation of 28 C.F.R. §§ 35.150 and 35.151, and if so, the expected timeline for completion and remediation;

2. Your jurisdiction's position on the FMVSS 108 compliance issue described in Section IV, including any steps taken or planned to bring auxiliary vehicle lamps into compliance with the steady-burning requirement;

3. Whether your jurisdiction will discontinue the use of RRFBs as described in Section V, or alternatively, take steps to reduce their luminous intensity to the minimum level required by SAE Standard J595 for Class 1 optical warning devices, consistent with the Robertson study's finding that even minimum-intensity devices cause unbearable glare for approximately one percent of the population; and

4. Whether your jurisdiction is willing to implement the two-step programming solution described in Section VI, and if not, the specific operational or legal basis for declining; and

5. The name and contact information of the ADA Title II coordinator designated to respond to this letter and to initiate the individualized interactive process requested in Section III.

Failure to respond within thirty days will be treated as a denial, and I will evaluate all available administrative and legal remedies, including complaints to the United States

Department of Justice Civil Rights Division, the U.S. Department of Transportation Office of Civil Rights, and litigation.

I am committed to a cooperative resolution and am available to discuss any of the matters raised in this letter. Please do not hesitate to contact me at the information above.

Respectfully submitted,

/s/ Mark Baker
President, Soft Lights Foundation
mbaker@softlights.org

/s/ Mark Baker
Individual, Yolo County Resident
mbaker@moonlightadvocacy.org

Enclosure: Exhibit A — Robertson and Fitzpatrick, "Investigating a Relationship between Luminous Intensity, Optical Power, and the Discomfort Glare of Rapid Flashing Traffic Control Devices" (Texas A&M Transportation Institute, rev. July 27, 2013)

Exhibit B — Interpretation ID: NCC-231121-001 Autoliv (Veoneer) Spotlight Interpretation 1 – June 27, 2024

Exhibit C - Interpretation ID: NCC-241023-001TSEI-TIMA Letter of Interpretation 571.108 Flashing Amber Lights 12-13-2024.signed. – December 13, 2024

EXHIBIT A

Investigating a Relationship between Luminous Intensity, Optical Power, and the Discomfort Glare of Rapid Flashing Traffic Control Devices.

By

James Robertson
(Corresponding author)
Graduate Assistant Research
Texas A&M Transportation Institute, 3135 TAMU
College Station, TX 77843-3135
phone: 979/845-9896, fax: 979/845-6006
email: J-Robertson@tamu.edu

and

Kay Fitzpatrick, Ph.D., P.E.
Senior Research Engineer
Texas A&M Transportation Institute, 3135 TAMU
College Station, TX 77843-3135
phone: 979/845-7321, fax: 979/845-6006
email: K-Fitzpatrick@tamu.edu

For the TRB 2014 Meeting

Revision date: July 27, 2013
Total Words: 7,326 [4,076 Words, 7 Tables & 6 Figures (3,250)]

ABSTRACT

Since providing interim approval for the option use of Rectangular Rapid Flashing Beacons (RRFBs), the Federal Highway Administration (FHWA) has issued six official interpretations to clarify the proper use, brightness, and flash pattern of the device. This paper clarifies photometric terminology associated with rapid flashing beacons and uses this terminology to document a relationship between the luminous intensity, the optical power, and the discomfort glare of rapid flashing beacons. As an initial investigation, this paper finds that as luminous intensity and optical power increase, the odds of an observe indicating the device has unbearable brightness (discomfort glare) increases. Additionally, the data show that the odds of an observer indicating the brightness is unbearable are 13 times lower during daytime conditions than during nighttime conditions. These results suggest transportation agencies should focus on meeting minimum luminous intensity requirements and put less emphasis on obtaining devices with the highest luminous intensity possible. Additionally, these results suggest the profession should consider setting maximum luminous intensities for rapid flashing traffic control devices.

INTRODUCTION

In 2008, the Federal Highway Administration (FHWA) provided interim approval for the optional use of rectangular rapid flashing beacons (RRFBs) (*1*) based upon their effectiveness in a Florida study (*2*). As of September 2012, FHWA has released six official interpretations concerning the interim approval of Rectangular Rapid Flashing Beacons; they are:

- 4-376 (I) on overhead mounting of RRFBs, December 9, 2009 (*3*).
- 4(09)-5 (I) on using RRFBs with the W11-15 sign, August 12, 2010 (*4*).
- 4(09)-17 (I) on RRFB light intensity, January 9, 2012 (*5*).
- 4(09)-21 (I) on clarification of RRFB flashing pattern, June 13, 2012 (*6*).
- 4(09)-22 (I) on flashing pattern for existing RRFBs, August 8, 2012 (*7*).
- 4(09)-24 (I) on daytime dimming of RRFB, September 27, 2012 (*8*).

Official interpretation number 4-376 (I) allows agencies to mount an RRFB over the roadway with a W11-2 or S1-1 sign. Official interpretation number 4(09)-5 (I) allows agencies to use an RRFB with the W11-15 shared use trail crossing sign. While these first two official interpretations address the use of RRFBs, the next four official interpretations address the operation of RRFBs; and the focus of this paper is on the four most recent official interpretations.

Official interpretation number 4(09)-17 (I) clarifies that the light intensity of an RRFB shall meet the minimum intensity requirements for a yellow Class 1 optical warning device as defined within the Society of Automotive Engineers (SAE) standard J595, as opposed to the minimum intensity requirements for yellow Class 2 and yellow Class 3 optical warning devices (*9*). The requirements for a yellow Class 2 and yellow Class 3 device are approximately 75 percent and 90 percent less than the requirements for a yellow Class 1 optical warning device. And, official interpretation states, “The reduced light intensity of such installations has been noticeable and,

anecdotally, jurisdictions are seeing far lower rates of driver yielding at such locations than was achieved at the original RRFB experimentation locations."

Official interpretation number 4(09)-21 (I) clarifies the flash pattern of the RRFB after researchers measured the light output of the original RRFB experimentation locations with an oscilloscope. In general, the pattern changed from two flashes from the left beacon followed by three flashes on the right beacon to two flashes on the left beacon and five flashes on the right beacon. Related to official interpretation number 4(09)-21 (I) is official interpretation number 4(09)-22 (I) which indicated agencies are not required to change the flash pattern of devices installed prior to the release of official interpretation number 4(09)-21 (I), which means official interpretation number 4(09)-21 only applies to new deployments.

Official interpretation number 4(09)-24 states "that it is not acceptable to dim the RRFB signal indications during daytime conditions and that the light output from the RRFB signal indications must meet the SAE J595 requirements for peak luminous intensity (candelas) for Class 1 at all times during daylight hours."

The multiple clarifications needed for the RRFB reflect the development process for a new device. To aid in this development process, it may benefit the profession to document appropriate terminology for discussing the use of the terms associated with measuring the brightness and flash pattern of rapid flashing beacons. And, with the use of such a novel flash pattern, the profession may need to move beyond common photometric measurements such as intensity (candela) and consider alternative measures such as optical power (candela-seconds / minute). Ultimately, the choice of photometric measurement depends on the measurements correlation with the devices performance. As an initial investigation, this paper documents a relationship between intensity, optical power, and discomfort glare using rapid flashing beacons.

OBJECTIVES

The objectives of this paper are to:

1. Clarify the photometric terminology associated with the evaluation of rapid flashing beacons.
2. Document how FHWA official interpretations have changed the operation of the yellow rectangular rapid flashing beacon being used with Pedestrian or School Crossing signs.
3. Demonstrate the use of optical power as a measurement of brightness and an alternative to intensity.
4. Define a relationship between intensity, optical power, and discomfort glare using rapid flashing 8-inch circular beacons and LED-embedded signs.

PHOTOMETRIC TERMINOLOGY

Often, the profession and the public use the terms intensity and brightness interchangeably. While this has limited effect on every day conversations, doing so within the transportation profession can lead to confusion and mistakes. Formal definitions of intensity, brightness, and other photometric measurement terms are shown in Table 1. Visual examples of these definitions, shown on oscilloscope readings, are provided in Figure 1.

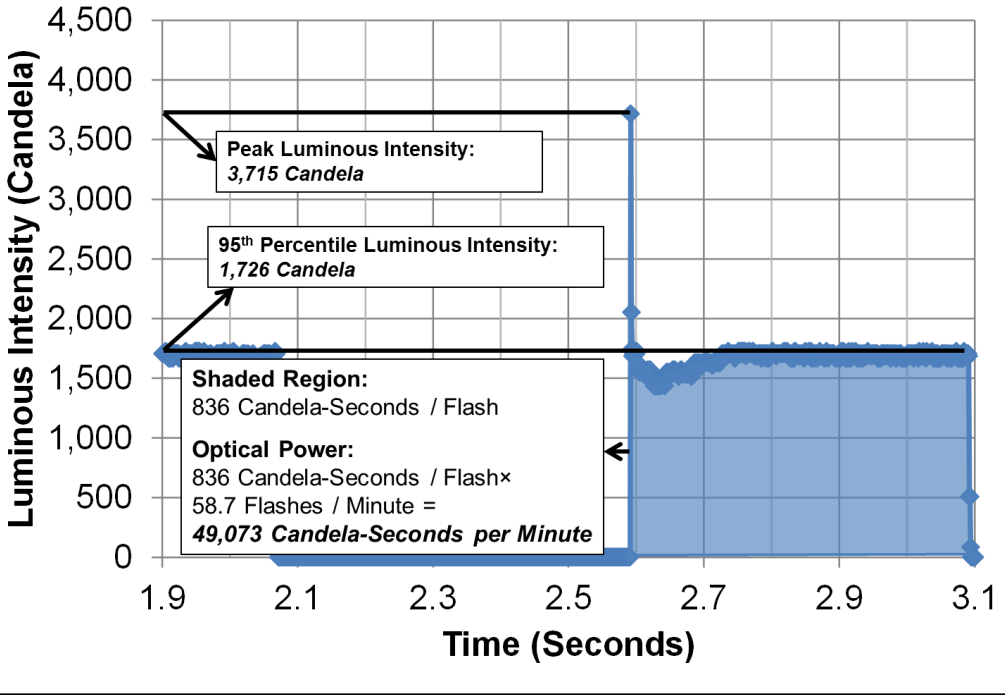
Table 1. Photometric Terminology.

Term	Definition
Brightness	"Brightness is a sensation associated with luminance, but apparent brightness is influenced also by contrast, adaptation, and other factors besides the physical energy in the stimulus." (*10*, pg. 285)
Luminous Intensity (Candela)	"The luminous flux per unit solid angle in a given direction expressed in candela (cd)." (*11*, pg. 1)
Optical Power (candela-seconds/minute)	"The integration of the luminous intensity of the flashing light source for a time of 60 seconds." (*9*, pg. 3)
Light Pulse	"A single, visually continuous emission of optical energy. High frequency modulation is permitted." (*9*, pg. 3)
Flash	"A flash is a light pulse or a train of light pulses, where a dark interval of at least 160 ms separates the light pulse or the last pulse of the train of light pulses from the next pulse or the first pulse of the next train of light pulses." (*9*, pg. 3)

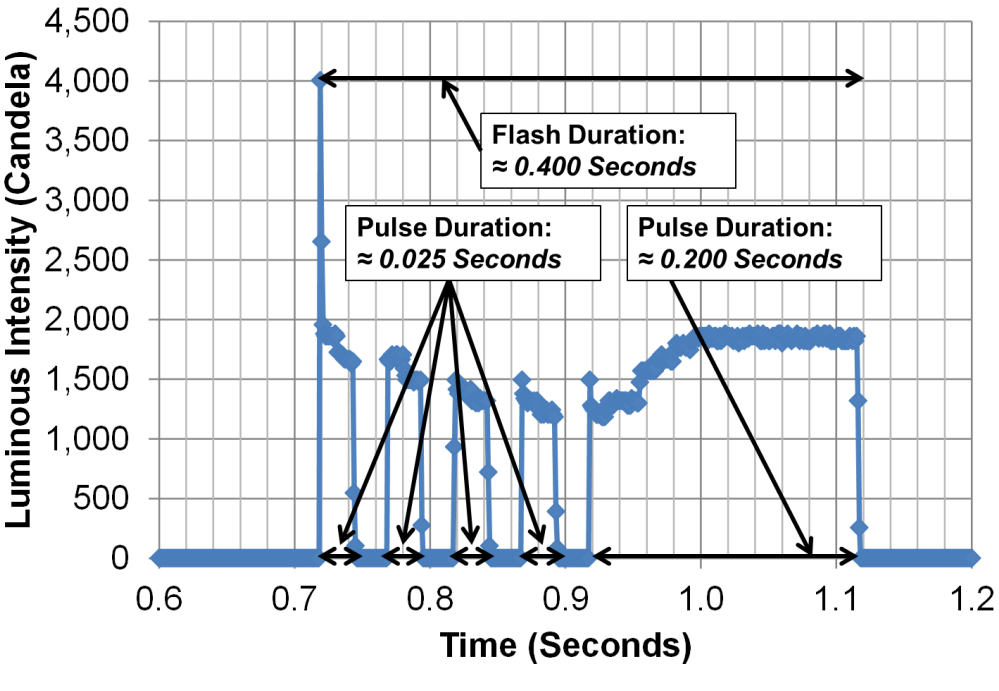
In addition to the interchanging of the terms intensity and brightness, professionals and the public occasionally use the term flash when discussing light pulses, as defined by SAE in Table 1. For example, the initial RRFB interim approval reads (*1*):

> *The flash rate of each individual yellow indication, as applied over the full on-off sequence of a flashing period of the indication, shall not be between 5 and 30 flashes per second, to avoid frequencies that might cause seizures.*

However, using SAE's definition, what is described as "flashes" are actually light pulses. The reason for this is the dark interval between each light interval is less than 160 milliseconds, which is the minimum dark period between light pulses before they are defined as flashes (1 second evenly divided into 5 light intervals and 5 dark intervals results in each interval having a length of 100 milliseconds, which is less than 160 milliseconds). This indicates it might be appropriate to change the interim approval to read, "the pulse rate of each individual yellow indication, … , shall not be between 5 and 30 light pulses per second, to avoid frequencies that might cause seizures."



a. Luminous Intensity and Optical Power Calculations.



b. Flash and Pulse Duration Calculations.

Figure 1. Photometric Calculation Examples.

THE EFFECT OF FHWA OFFICIAL INTERPRETATIONS ON RRFB OPERATIONS

While there are six official interpretations, this paper focuses on the third, fourth, fifth, and sixth because these official interpretations made modifications to the flash pattern and brightness of the device. The purpose of this section of the paper is to document how RRFBs should be operating in the field using the information within the official interpretations and the definitions provided in Table 1.

Official Interpretation 4(09)-17 (I) on RRFB Light Intensity

In official interpretation 4(09)-17 (I), FHWA clarified that RRFBs must meet the minimum luminous intensity requirements for a Class 1 Optical Warning Device. What this means is the luminous intensity of the device must meet or exceed the values shown in Table 2. Each cell within Table 2 represents a test point; the center test point (the horizontal and vertical angles equal zero degrees) represents the face of the device being perpendicular to the direction of the photometer in both the horizontal and vertical direction (in Table 2, the minimum luminous intensity for this test point is 600 candela). The other test points represent the light source rotated away from a perpendicular angle in increments of 5 degrees from a total of 20 degrees left to 20 degrees right on the horizontal axis and 10 degrees up and 10 degrees down on the vertical axis. The reason for testing at these different angles is to make sure the device is visible to drivers viewing the device from angles that are no perpendicular, for example when viewing the device from a different lane or when going through a horizontal or vertical curve.

Table 2. Class 1 Optical Warning Device Minimum Luminous Intensities (Candela) (*9*).

Vertical Angle (Up and Down)	Horizontal Angle (Left and Right)						
	L: 20	L: 10	L: 5	H: 0	R: 5	R: 10	R: 20
U: 10	-	-	40	100	40	-	-
U: 5	40	100	200	300	200	100	40
V: 0	60	150	400	600	400	150	60
D: 5	40	100	200	300	200	100	40
D: 10	-	-	40	100	40	-	-

Official Interpretation 4(09)-21 (I) on Clarification of RRFB Flashing Pattern

In official interpretation 4(09)-21 (I), FHWA modified the flash pattern of RRFBs from a device with two flashes on the left beacon and three flashes on the right beacon to the specific pattern shown in Table 3. When the 2008 Interim Approval was issued, FHWA was under the impression that the RRFB used a 2/3 pattern. After measuring the devices using an oscilloscope, it was determine that the RRFBs in the Florida study used a pattern consisting of two slow pulses on the left and four rapid pulses on the right followed by a long pulse. An oscilloscope reading of this flash pattern is shown in Figure 2.

A unique aspect of this flash pattern, which may cause confusion concerning the device, is that most human observers only sees two light pulses from the left beacon and three light pulses from

the right beacon, despite there being five light pulses from the right beacon. This occurs because the four 25 millisecond light pulses are too short for the human visual system to process as separate light pulses; therefore, the human visual system compensates and perceives these four light pulses as two light pulses and a third longer light pulse.

Table 3. RRFB Flash Pattern Following Official Interpretation 4(09)-17 (I).

Time Increment (milliseconds)	Left Beacon	Right Beacon
124	**On**	Off
76	Off	Off
124	**On**	Off
76	Off	Off
25	Off	**On**
25	Off	Off
25	Off	**On**
25	Off	Off
25	Off	**On**
25	Off	Off
25	Off	**On**
25	Off	Off
200	Off	**On**
800	**Total**	

Official Interpretation 4(09)-22 (I) on Flashing Pattern for Existing RRFBs

In official interpretation 4(09)-22 (I), FHWA informed agencies that they did not have to change the flash pattern of devices installed prior to the release of official interpretation 4(09)-17 (I), which established the pattern provided in Table 3 and illustrated in Figure 2.

Official Interpretation 4(09)-24 (I) on Dimming of RRFBs during Daytime Hours

In official interpretation 4(09)-24 (I), FHWA informed agencies it is not appropriate to dim RRFBs during daytime conditions and that the light output must meet SAE J595 requirements for minimum peak luminous intensity for class 1 optical warning devices at all times during daylight hours.

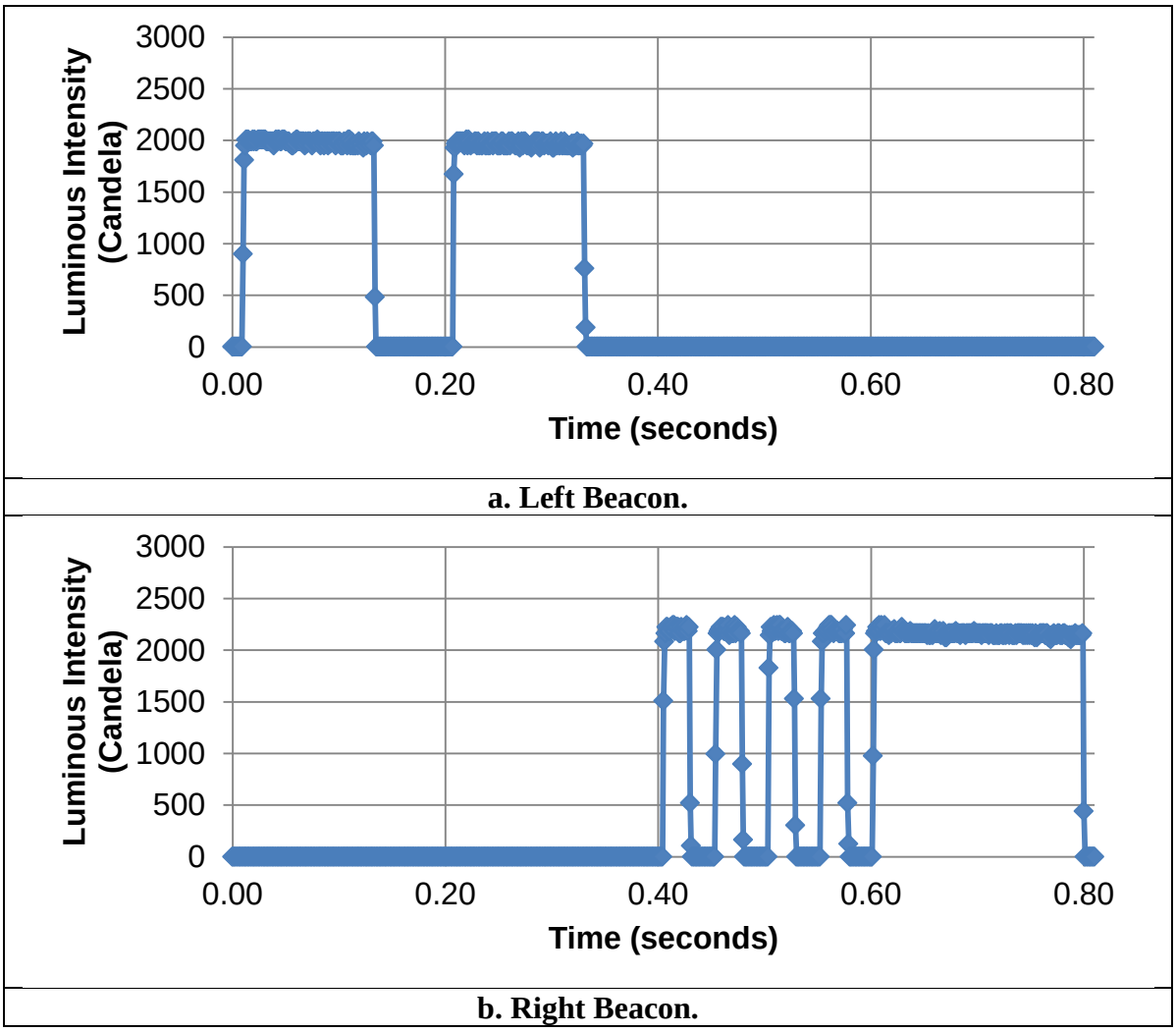


Figure 2. RRFB Flash Pattern, Post Official Interpretation 4(09)-17 (I).

EVALUATION OF POTENTIAL RELATIONSHIPS

After a closed course driving study investigating sign legibility and object detection around traffic control devices with rapid flashing beacons, researchers asked participants to evaluate the discomfort glare of a LED embedded sign and circular 8-inch beacons (*12*). The total time for a participant to complete the driving study and the discomfort glare evaluation was between 80 and 90 minutes, with the discomfort glare study taking approximately 10 minutes.

There were 71 participants in this study. Of the 71 participants, 37 participants were men and 34 participants were women, 35 participants were less than 55 years old and 36 participants were 55 years old or greater. This study took place in the summer of 2012 at Texas A&M University's Riverside Campus and was approved by the Texas A&M University Institutional Review Board.

Data Collection

The setup for the discomfort glare study is shown in Figure 3. At the beginning of the discomfort glare study, researchers asked the participants to park 250 ft away from sign 1 (the first two orange barrels, as shown in Figure 3). After the participant parked the vehicle, researchers turned on the beacon and asked the participant to indicate if the brightness of the light was comfortable, irritating, or unbearable, defined as:

- Comfortable – where the glare is not annoying and the signal is easy to look at.
- Irritating – where the glare is uncomfortable, however the participant is still able to look at it without the urge to look away.
- Unbearable – where the glare is so intense that the participant wants to avoid looking at it.

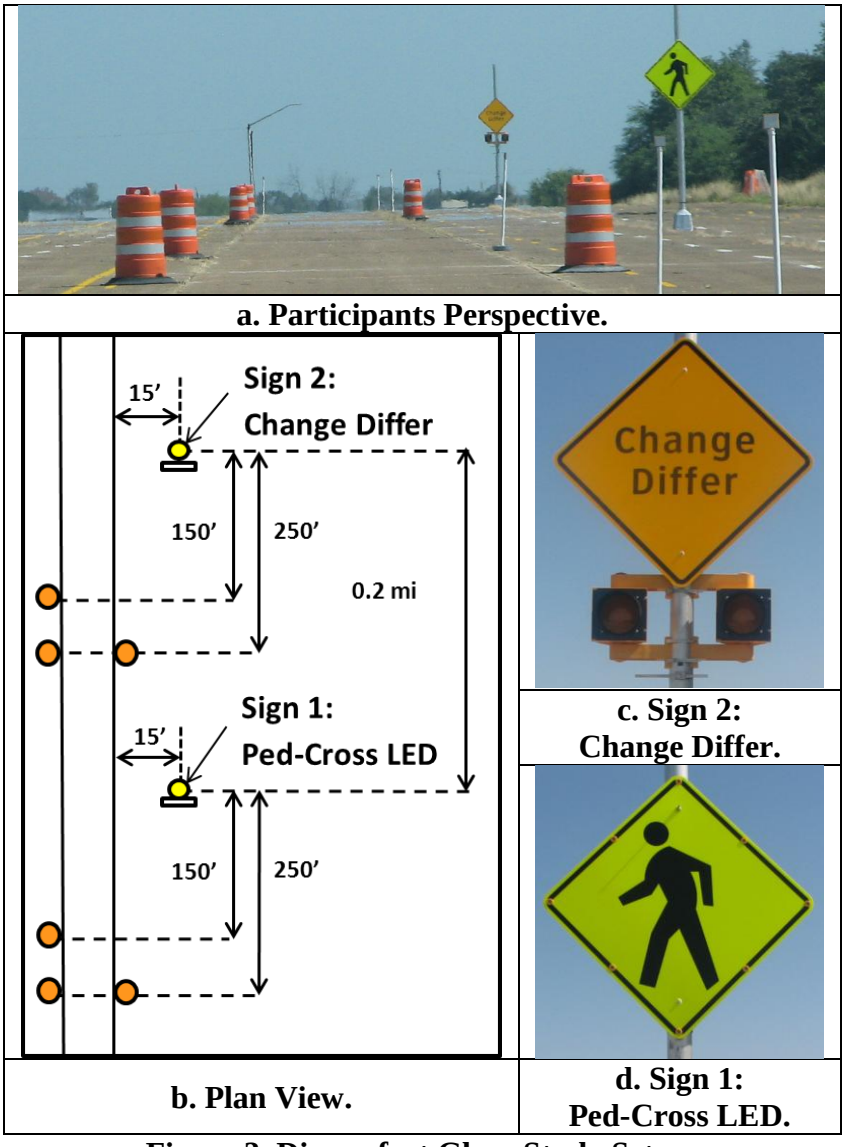


Figure 3. Discomfort Glare Study Setup.

After the participant rated the first controller setting, a technician increased the controller setting to level two. This process continued until the participant indicated the brightness was unbearable or the technician reached sixth controller setting (the highest setting for the device).

Once the participant indicated the brightness was unbearable or the technician reached level six, the researcher asked the participant to move to the next position. In order, the positions were:

- LED Embedded Sign, 250 ft.
- LED Embedded Sign, 150 ft.
- 8-inch Circular Beacons, 250 ft.
- 8-inch Circular Beacons, 150 ft.

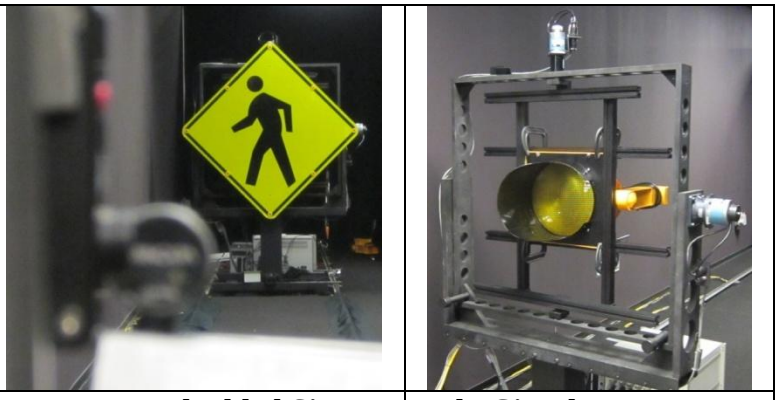
This order remained the same for every participant, which is a limitation of this study.

Flash Pattern of Study Devices

The 8-inch circular beacons operated using the same pattern as a rectangular rapid flashing beacon, which is the pattern shown in Figure 2. The LED embedded sign operated using the flash pattern shown in Figure 2 b, which is the flash pattern for the right beacon in an RRFB assembly.

Intensity and Optical Power of Study Devices

At the conclusion of the closed course study, researchers tested the photometric of the devices within the Texas A&M Transportation Institute Visibility Laboratory. Images of the devices mounted on the goniometer within the Visibility Laboratory's photometric range are provided in Figure 4.



a. LED Embedded Sign.	b. Circular Beacon.

Figure 4. Study Beacons and LED Embedded Sign Mounted On Goniometer.

For the purpose of this study, researchers only documented the luminous intensity and optical power of each device at a vertical angle of zero and horizontal angle of zero, which is the center test point of SAE standard J595, shown in Table 2. The 95th percentile luminous intensity and optical power of the devices for the six controller settings are provided in Table 4. Researchers chose 95th percentile luminous intensity instead of the peak luminous intensity because of the

spike in luminous intensity at the beginning of the flash (shown in Figure 1 a) not being representative of the flashes overall intensity.

Statistical Analysis

To evaluate participant's ratings of discomfort glare, researchers used the statistics program R to develop cumulative logistic regression models. Cumulative logistic regression models are a method for calculating the probability of a response less than or equal to a specific value for ordinal data; the discomfort ratings in this study (comfortable, irritating, and unbearable) are an example of ordinal data. The basic form of the Cumulative Logit models in this study is (*13*):

$$\text{Logit}(P(I\_ciu \leq j)) = \alpha_j + \beta_i X_i \qquad \textbf{Equation 1}$$

where,

- Logit(p) = odds(p) = ln(p) – ln(1-p).
- p = P(I_ciu ≤ j).
- ln = the natural log function.
- P(I_ciu ≤ j) = probability of the brightness being unbearable.
- α_j = intercept value (for comfortable j = 1, for irritating j = 2).
- β_i = i^{th} parameter value.
- X_i = i^{th} variable.

Table 4. Discomfort Glare Study Device Brightness Measurement.

Device	Controller Setting	95th Percentile Luminous Intensity (cd)	Optical Power (cd-sec / min)
LED Embedded Sign	1	707	13,215
	2	1,320	25,318
	3	1,880	36,590
	4	2,199	46,375
	5	2,517	54,523
	6	2,848	59,518
8-inch Circular Beacons	1	284	8,867
	2	427	15,077
	3	581	21,028
	4	713	26,370
	5	838	32,315
	6	1,036	37,489

For variables taking only two values, exp (β_i) is the odds ratio, which is the probability of event A occurring divided by the probability of event B occurring. Mathematically, the odds ratio is:

Odds ratio = $[P_a/(1-P_a)] / [P_b/(1-P_b)]$ **Equation 2**

where,

P_a = probability of event A occurring.

P_b = probability of event B occurring.

The variables considered for inclusion in the cumulative logistic regression models are shown in Table 5.

Model Selection

To select statistically significant cumulative logistic regression models, researchers used the Akaike's information Criterion (AIC) to assess the value of adding a parameter to the model. First, researchers tested the two measures of brightness to see which parameter had the lowest AIC. For the collected data, researchers found that the AIC for optical power (3,131) was less than the AIC for luminous intensity (3,398). Next, researchers tested the non-brightness measures for inclusion in the model adding one parameter at a time and keeping the parameter with the lowest AIC when the new parameter resulted in a statistically significant improvement. For this study, researchers did not investigate the inclusion of cross terms.

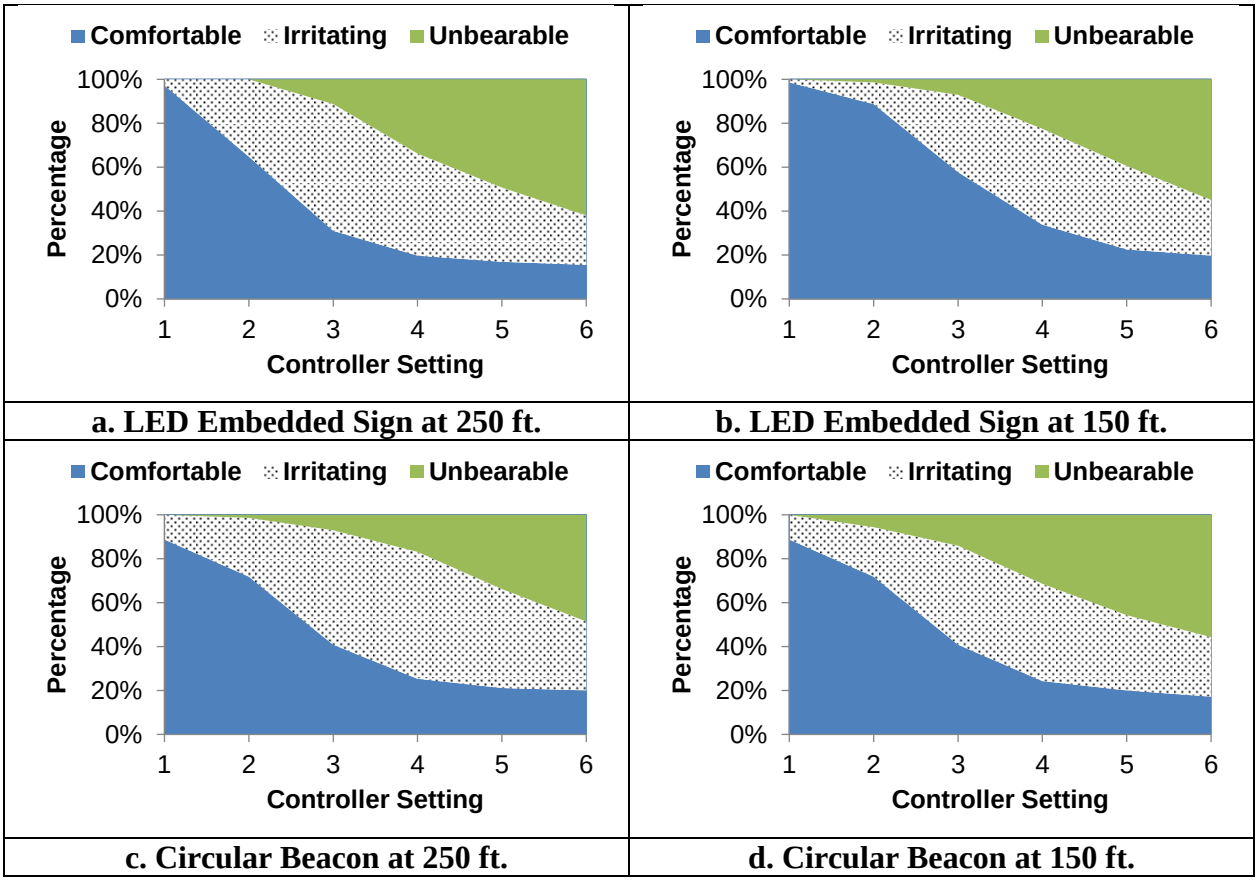
Table 5. Discomfort Glare Variable Names and Descriptions.

Variable Name	Description
CIU_I	Indicates if the participant felt the device was comfortable, irritating, or unbearable to look at for a given combination of variables; equals 1 if comfortable, 2 if irritating, and 3 if unbearable
INT_One	95^{th} percentile intensity measured at a vertical angle of zero and a horizontal angle of zero
OP_One	Optical power measured at a vertical angle of zero and a horizontal angle of zero
M_Num	Measurement number representing the order measurements were taken (0 = 250 ft for Sign 1, 1 = 150 ft for Sign 1, 2 = 250 ft for Sign 2, 3 = 250 ft for Sign 2)
Older_I	Indicator value for age of participant; equals 1 for participants 55 years or older, 0 otherwise
Dist_I	Indicator value for distance from assembly where measurements were taken; 1 if 250 ft, 0 otherwise
Device_I	Indicator value for device where measurements were taken; 1 if Sign 1, 0 if Sign 2
Day_I	Indicator value for day or night; 1 if Day, 0 if Night

RESULTS

Raw Data

Raw data for the discomfort glare study are shown in Figure 5. The raw data show that the percentage of participants that indicate the brightness of the light is comfortable decreases as the luminous intensity increases and the percentage of participants that indicate the brightness is unbearable increases as luminous intensity increases. Additionally, almost 50 percent of all participants feel the discomfort glare is unbearable at controller setting number 6.



a. LED Embedded Sign at 250 ft. | b. LED Embedded Sign at 150 ft.

c. Circular Beacon at 250 ft. | d. Circular Beacon at 150 ft.

Figure 5. Raw Data for Discomfort Glare Ratings.

Selected Cumulative Logistic Regression Models

The parameter estimates, standard error, odds ratio, and 95 percent confidence interval for the odds ratio for the selected Cumulative Logit Regression Models are provided in Table 6 and Table 7. The models show that as the intensity or optical power increases, the odds of a participant indicating the brightness is unbearable increases. An interesting result of this study is the odds of a participant indicating the brightness of a light is unbearable are around 13 times lower during the day than at night (from Table 7). An atypical finding of this study is that older

participants are 1.4 times less likely to indicate the brightness is unbearable than younger participants.

Table 6. Cumulative Logit Model with Intensity as a Measure of Brightness (AIC = 2,448).

Parameter	Estimate	Standard Error	95 % Confidence Interval[1]		
			Lower Bounds	Odds Ratio[2]	Upper Bounds
Intercept (j = 1)	5.5347	0.3490	-	-	-
Intercept (j = 2)	7.9764	0.3819	-	-	-
INT_One[3]	-0.003781	0.0001693	-	-	-
Day_I = 1	2.4113	0.1238	8.7465	11.1484	14.2100
M_Num = 2	0.8889	0.1689	1.7469	2.4325	3.3870
M_Num = 3	-4.7285	0.2840	0.0051	0.0088	0.0154
M_Num = 4	-5.0237	0.2871	0.0037	0.0066	0.0116
Older_I = 1	0.3205	0.1085	1.1139	1.3778	1.7043

Italics indicates less than 95 percent confidence

[1] If the odds ratio confidence interval includes the value 1.000, the difference is not statistically significant with 95 percent confidence.

[2] For M_Num = z, the odds ratio is odds(M_Num = z)/odds(M_Num = 1).

[3] It's not appropriate to interpret the parameter estimate of INT_One as an odds ratio because it is a continuous.

Table 7. Cumulative Logit Model with Optical Power as a Measure of Brightness (AIC = 2,352).

Parameter	Estimate	Standard Error	95 % Confidence Interval[1]		
			Lower Bounds	Odds Ratio[2]	Upper Bounds
Intercept (j = 1)	4.0117	0.2602	-	-	-
Intercept (j = 2)	6.6042	0.2984	-	-	-
OP_One[3]	-0.0001534	0.000006193	-	-	-
Day_I = 1	2.5577	0.1287	10.0287	12.9061	16.6091
M_Num = 2	0.8730	0.1661	1.7288	2.3941	3.3153
M_Num = 3	-2.1270	0.1875	0.0825	0.1192	0.1721
M_Num = 4	-2.4520	0.1903	0.0593	0.0861	0.1251
Older_I = 1	0.3313	0.1105	1.1216	1.3928	1.7296

Italics indicates less than 95 percent confidence

[1] If the odds ratio confidence interval includes the value 1.000, the difference is not statistically significant with 95 percent confidence.

[2] For M_Num = z, the odds ratio is odds(M_Num = z)/odds(M_Num = 1).

[3] It's not appropriate to interpret the parameter estimate of OP_One as an odds ratio because it is a continuous variable.

Prediction Equations

To quantify a relationship between luminous intensity, optical power, and discomfort glare, researchers developed prediction equations using the cumulative logistic regression models in Table 6 and Table 7. These equations predict the probability of someone indicating a light emission is unbearable based upon the data collected in this study. The prediction equations are:

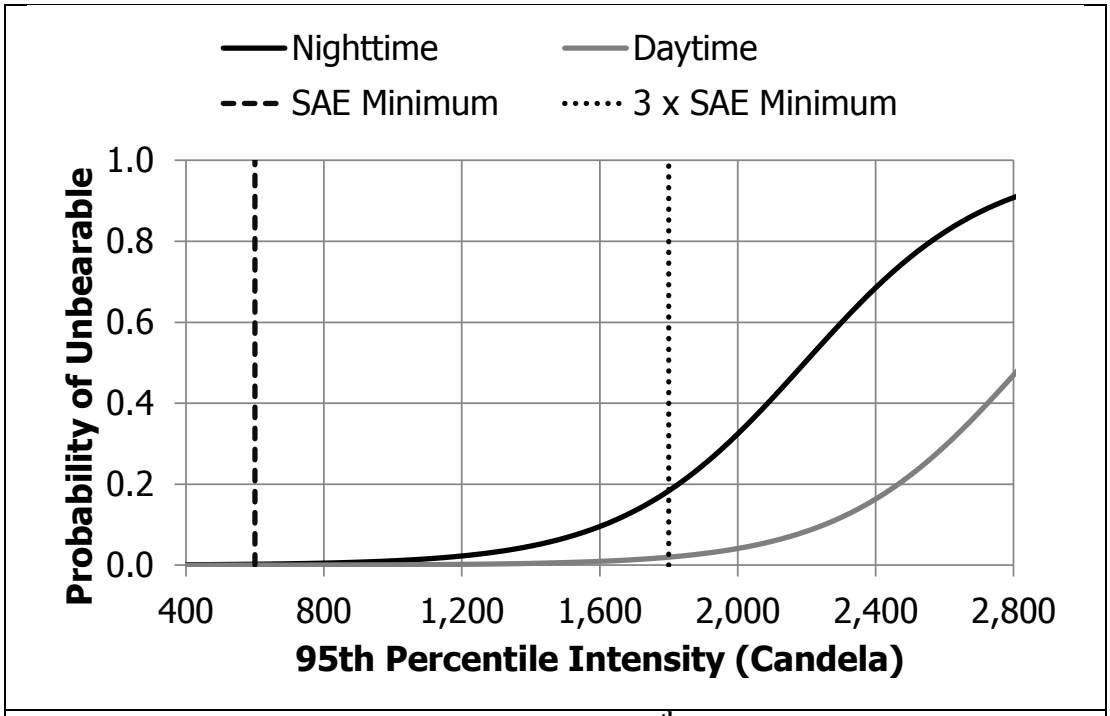
$$p(I\_ciu = 3)INT = 1 / [1 + \exp(7.9764 - 0.003781 \times INT\_One + 2.4113 \times Day\_I + 0.3205 \times Age\_I + fM\_Num(INT))] \quad \textbf{Equation 3}$$

$$p(I\_ciu = 3)OP = 1 / [1 + \exp(6.6042 - 0.0001534 \times OP\_one + 2.5577 \times Day\_I + 0.3313 \times Age\_I + fM\_Num(OP))] \quad \textbf{Equation 4}$$

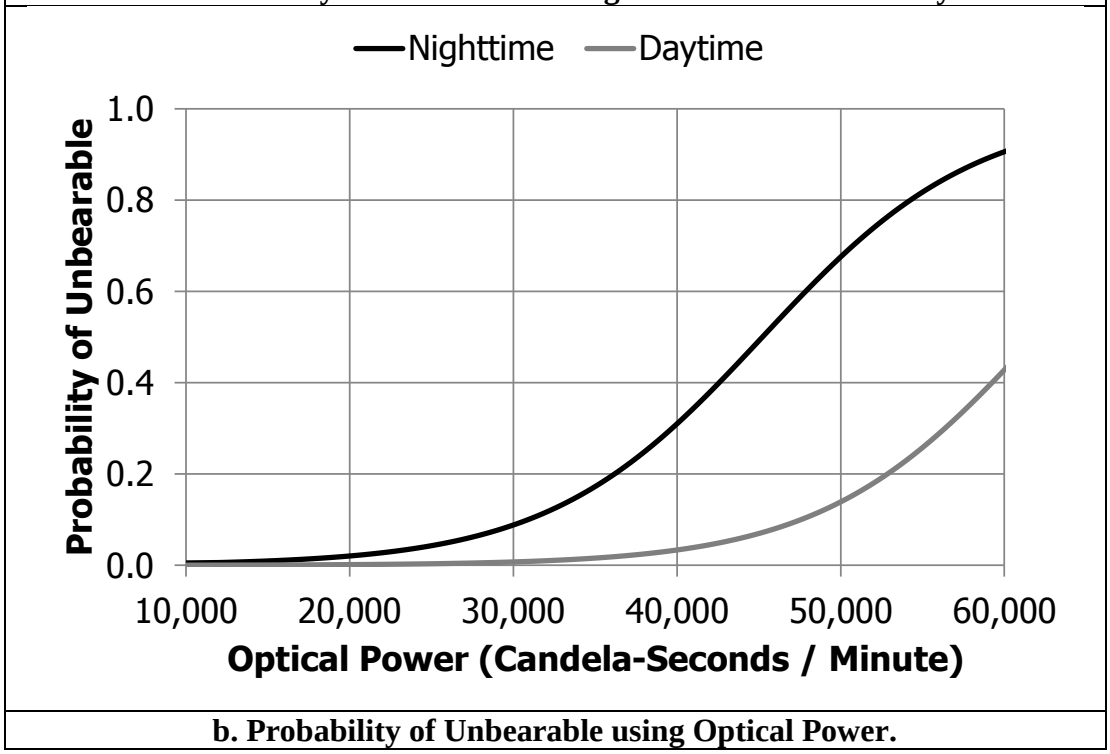
where,

- p(I_ciu = 3)OP = Probability of participant indicating the light level is unbearable with optical power as the measure of brightness.
- p(I_ciu = 3)INT = Probability of participant indicating the light level is unbearable with 95th percentile intensity as the measure of brightness.
- exp( ) = Exponential function.
- OP_one = Optical power of the device measured at a vertical and horizontal angle of zero.
- INT_one = 95th percentile intensity of the device measured at a vertical and horizontal angle of zero.
- Day_I = Indicator variable for daytime; equals 1 if daytime and 0 if nighttime.
- Age_I = Indicator variable for age group; equals 1 if 55 years or older, 0 otherwise.
- fM_Num(OP) = Factor associated with the measurement number (M_Num); equals 0 if M_Num = 1, 0.8730 if M_Num = 2, -2.1270 if M_Num = 3, and -2.4520 if M_Num = 4.
- fM_Num(INT) = Factor associated with the measurement number (M_Num); equals 0 if M_Num = 1, 0.8889 if M_Num = 2, -4.7285 if M_Num = 3, and -5.0237 if M_Num = 4.

Using these prediction equations, researchers produced the curves shown in Figure 6. These curves show the probability of an older driver (55 years or more) indicating the discomfort glare of LED embedded sign is unbearable using the flash pattern from the right beacon of an RRFB. In addition to the discomfort glare curves, researchers also indicate the SAE minimum luminous intensity for the center test point and three times the SAE minimum luminous intensity for the center test point. The Institute of Transportation Engineers specifies a maximum luminous intensity of three times the minimum luminous intensity for LED traffic signal heads (*11*).



a. Probability of Unbearable using 95th Percentile Intensity.



b. Probability of Unbearable using Optical Power.

Figure 6. Probability of a LED Embedded Sign Being Unbearable to Older Drivers from 250 Feet.

DISCUSSION AND RECOMMENDATIONS

The data presented in this paper show that as the luminous intensity and optical power of device increases, the probability of an observer indicating the discomfort glare is unbearable increases. These finding suggest agencies should place more emphasis on meeting the SAE minimum luminous intensity and put less emphasis on obtaining devices that have the highest luminous intensities possible. This is evidenced by the probability of an observer indicating the brightness of the device is unbearable is less than one percent at the SAE minimum luminous intensity, the Florida study that used devices meeting this minimum requirement, and FHWA's anecdotal evidence that sites with lower intensities have lower compliance (*2, 5*).

Additionally, these data show that the odds of an observer indicating a device is unbearable bright are 13 times greater at night, which has two implications for the profession. One implication is that the profession should consider setting maximum luminous intensities and optical powers for these devices. A reason for this is that as discomfort glare increases, observers are more likely to look away from the source of the discomfort. If the source of the discomfort is near a pedestrian crossing location, looking away from that location may cause a driver to miss a pedestrian trying to cross the street, which has implications for a pedestrian's safety if they are trying to cross the street at this location. A maximum intensity worth considering is three times the minimum intensity, which the Institute of Transportation Engineers uses within their LED signal head purchasing specifications (*11*).

The other implication for the nighttime findings is a potential value in using devices that dim during nighttime conditions. Such devices would allow the device to command driver's attention during the day through greater luminous intensity while avoiding the discomfort glare associated with the same intensity during the evening hours. Additionally, these results may suggest having different specifications for devices operating during nighttime conditions than the specifications used for devices operating during daytime conditions.

ACKNOWLEDGMENTS

The Federal Highway Administration (FHWA) sponsored this research as part of the "Evaluation of Pedestrians Safety Engineering Countermeasures at Urban and Suburban Midblock Crossing Locations" project. The project is under the direction of Ann Do of FHWA. The research was performed at the Texas A&M Transportation Institute (TTI). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or polices of FHWA. Several TTI employees assisted the authors with collecting data, especially Laura Higgins, Christine Yager, and Jeff Miles. We also value the comments provided by reviewers of draft versions of this material and members of the National Committee of Uniform Traffic Control Device.

1 REFERENCES

1 Furst, A. (2008). "MUTCD- Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)." U.S. Department of Transportation Federal Highway Administration Memorandum, July 16, Washington, D.C.

2 Houten, R. and J.E. Malenfant (2008). An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL. Center for Education and Research in Safety, Kalamazoo, MI. http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgrpt/stpetersburgrpt.pdf

3 Pisano, P. (2009). R-376(I) – RRFB Overhead Mounting. U.S. Department of Transportation Federal Highway Administration Memorandum, December 9, Washington, D.C.

4 Kehrili, M. (2010). 4(09)-5(I) – RRFB Use with W11-15 Sign. U.S. Department of Transportation Federal Highway Administration Memorandum, August 12, Washington, D.C.

5 Kehril, M. (2012). 4(09)-17 (I) – RRFB Light Intensity. U.S. Department of Transportation Federal Highway Administration Memorandum, January 9, Washington, D.C.

6 Kehrili, M. (2012). 4(09)-21 (I) – Clarification of RRFB Flashing Pattern. U.S. Department of Transportation Federal Highway Administration Memorandum, June 13, Washington, D.C.

7 Kehrli, M. (2012). 4(09)-22 (I) – Flashing Pattern for Existing RRFBs. U.S. Department of Transportation Federal Highway Administration Memorandum, August 8, Washington, D.C.

8 Kehrli, M. (2012). 4(09)-24(I) – dimming of RRFBs during Daytime Hours. U.S. Department of Transportation Federal Highway Administration Memorandum, September 27, Washington, D.C.

9 SAE International (2005). Surface Vehicle Recommended Practice. SAE Standard J595, January 2005.

10 Huchingson, R. (1981). New Horizons for Human Factors in Design. McGraw-Hill Book Company, New York, NY.

11 Institute of Transportation Engineers (ITE) (2005). Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement. Performance Specification of the Institute of Transportation Engineers, Washington, D.C.

12 Fitzpatrick, K. J. Robertson, and R. Avelar. Closed-Course Study to Identify Driver Detection of Traffic Control Devices and Objects. Draft Technical Memorandum. Federal Highway Administration. 2013.

13 Agresti, A. (2007) An Introduction to Categorical Data Analysis Second Edition. Wiley Series in Probability and Statistics, John Wiley & Sons, Inc., Hoboken, New Jersey.

EXHIBIT B

← SEARCH INTERPRETATIONS

Interpretation ID: NCC-231121-001 Autoliv (Veoneer) Spotlight Interpretation 1

June 27, 2024

Richard Seoane

VP Operations and Business Development

Thermal Product Area

Veoneer

420 South Fairview Avenue Goleta, CA 93117

Dear Mr. Seoane:

This responds to your request dated October 10, 2016, concerning the application of Federal Motor Vehicle Safety Standard ("FMVSS") No. 108, Lamps, reflective devices, and associated equipment, to a lighting system you describe in your letter. As I explain below, based on your description of the system we agree that it is supplemental lighting, but disagree with your assertion that it would not impair the effectiveness of any of the required lighting equipment.

In responding to this request, the National Highway Traffic Safety Administration (NHTSA) notes that the contents of this letter do not have the force and effect of law and are not meant to bind the public in any way. This letter is only intended to provide clarity regarding existing requirements under the law at the time of signature.

Description of the Marking Light and the Request for Interpretation

In your letter, you request an interpretation of FMVSS No. 108 as applied to an auxiliary light designed to prevent nighttime crashes (the Marking Light). As you describe it, the Marking Light consists of two auxiliary spotlights operated independently of the headlighting system. The spotlights are mounted symmetrically about the vertical centerline of the vehicle, below the headlamps, and pointed down at a fixed angle. The Marking Light operates independently of the upper and lower beam headlamps to produce a narrow, white-light beam pointed down to highlight the path to an object (such as a pedestrian) in or near the forward roadway so that the driver can see it. The Marking Light is activated and controlled by Autoliv's Night Vision System, which has an infrared camera that detects

pedestrian, bicyclist, and animal hazards up to 100 meters in front of the vehicle. The Night Vision System alerts the driver with in-vehicle

visual (e.g., head-up display icon and/or dash icon) and audible signals indicating activation of the Marking Light and directs the Marking Light to illuminate the path over the ground to the hazard to visually alert the driver of the presence and location of the hazard. The system does not engage vehicle steering or brakes. The Marking Light cannot be activated manually by the driver or continuously operated; it is activated only by the night vision system when a hazard is detected to assist the driver in seeing the hazard but does not assist the driver in seeing the roadway. You state that the Marking Light is disabled in the presence of oncoming and preceding traffic so that it does not glare drivers on a wet or shiny roadway.

You explain your position that the Marking Light is a supplemental lamp, not a required lamp such as a headlamp. You then make a variety of different arguments (and provide data) to support your view that the Marking Light does not impair the effectiveness of any of the required lighting. We summarize these arguments in more detail where relevant in the discussion below.

Applicable Requirements

FMVSS No. 108, which is codified at 49 C.F.R. § 571.108, sets requirements for vehicle lighting. The standard requires a variety of types of lighting, depending on vehicle type and size, and specifies requirements for these required lighting elements. The standard also sets requirements (referred to as “if equipped” requirements) for some non-mandatory lighting devices, such as daytime running lamps.

Lighting devices that FMVSS No. 108 does not require or regulate as “if equipped” lighting devices are considered supplemental (or auxiliary) lighting devices. Supplemental lighting is generally permitted as long as it does not impair the effectiveness of any of the lighting equipment required by the standard. See FMVSS No. 108 S6.2.1 (also referred to as the “impairment” provision).

FMVSS No. 108 applies only to original equipment and lighting equipment manufactured to replace original lighting equipment required by FMVSS No. 108. The standard does not directly apply to supplemental lighting devices sold in the aftermarket. Instead, supplemental lighting offered as an aftermarket accessory is subject to the “make inoperative” prohibition (49 U.S.C. § 301222), which prohibits certain specified commercial entities (such as dealers or repair shops) from taking a vehicle out of compliance with an FMVSS. In applying the “make inoperative” prohibition to aftermarket accessory lighting, NHTSA typically asks whether the accessory lighting would impair the effectiveness of any required lighting. Generally, if an item of accessory lighting would not be permitted as original equipment, commercial entities will not be permitted to install the lighting as an aftermarket accessory for a vehicle in use.

While the vehicle manufacturer has the legal responsibility under the National Traffic and Motor Vehicle Safety Act (Safety Act) to certify that the vehicle complies with FMVSS No. 108 and all other applicable FMVSS, as a practical matter, vehicle manufacturers generally insist that equipment

manufacturers provide assurance that their products meet federal standards. The judgment of impairment is one made, in the first instance, by the person installing the device. That decision, however, may be questioned by NHTSA if it appears clearly erroneous.

Page 3
Richard Seoane

Discussion

The threshold issue presented by your request is whether the Marking Light is part of the required headlighting system and thus subject to the requirements applicable to headlighting systems, or supplemental lighting that is regulated by FMVSS No. 108's impairment provision. We agree with you that the Marking Light would be considered supplemental lighting.

FMVSS No. 108 requires vehicles to be equipped with one of several permissible headlighting systems.1 Headlighting systems are comprised of headlamps and associated hardware. The purpose of headlamps is primarily to provide forward illumination.2 In determining whether lighting equipment that provides forward illumination is part of the required headlighting system or supplemental lighting, NHTSA looks at several factors. These factors have included, among other things: (1) where the lamp directs its light; (2) whether it uses a headlamp replaceable light source to emit a beam that provides significantly more light flux than supplemental cornering lamps or fog lamps; (3) whether the lamp is intended to be used regularly, or is limited to more narrow driving conditions and situations; or (4) whether there is a manual on/off switch.3

None of our previous interpretations appear to have addressed a frontal lighting concept precisely like the Marking Light. We agree with you, based on the information you have provided us, that it is supplemental lighting because it is not intended to be used regularly, but is instead a narrow beam that is activated only when there is a hazard forward of the vehicle such as a pedestrian or animal near the roadway.

Because the Marking Light would be considered supplemental lighting, it is permitted as long as it does not impair the effectiveness of any lighting equipment required by the standard. In its previous interpretation letters, NHTSA has identified a number of different ways that a supplemental lamp could impair the effectiveness of the required lighting.4

With respect to the Marking Light, there are two types of impairment that are potentially relevant. One is the potential to confuse other drivers arising from the Marking Light's color, location, or activation pattern.5 The other potentially relevant type of impairment is the potential for glare to other road users due to the intensity of the Marking Light. We address each of these potential types of impairment below.

1 FMVSS No. 108 Table I-a; S10.
2 FMVSS No. 108 S4 ("Headlamp means a lighting device providing an upper and/or a lower beam used for providing illumination forward of the vehicle.").
3 See Letter from Jacqueline Glassman, Chief Counsel, to [Redacted] (Jan. 21, 2004). Prior to the 2004 interpretation letter, NHTSA issued several interpretations concerning auxiliary driving beams in which the agency treated those lamps as supplemental lighting without expressly considering the

issue. See, e.g., Letter from Erika Z. Jones, Chief Counsel, to P. Soardo, Instituto Elettrotecnico Nazionale (May 22, 1987). If the lamps in question in those earlier interpretations would be considered supplemental lighting under the factors set forth in the 2004 interpretation, they may be consistent with that later interpretation. There is not, however, sufficient information about the lighting systems at issue in those earlier interpretation letters to allow application of the factors from the 2004 interpretation. In any case, the 2004 interpretation has been, to date, NHTSA's view of the issue.
4 See, e.g., Letter from Jonathan Morrison, Chief Counsel, to Paul Schaye, Pedestrian Safety Solutions (Sept. 9, 2019).
5 See id.

Color and Location

The impairment provision prohibits auxiliary lamp colors that are likely to confuse other road users.6 For auxiliary lamps located on the front of the vehicle, colors that could cause confusion include red (which could be confused with a tail lamp), green (which could be confused with a traffic signal), and blue (which could be confused with a law enforcement vehicle).7

You state that because the Marking Light is white, it cannot be confused with a turn signal and would not conflict with the emergency (hazard) lamps or parking lamps.

We agree that because the Marking Light is white and mounted below the headlamps, it would not likely be confused with the front turn signal (which is amber8) and would not conflict with the vehicle hazard warning (which consists of all required turn signal lamps flashing simultaneously9) or the parking lamps (which must be white or amber10). I therefore agree that the color and location of the Marking Light would not cause confusion with the vehicle's signal lamps.

Activation Pattern

FMVSS No. 108 requires that all auxiliary lamps be steady burning except for auxiliary lamps that supplement required lamps that flash, such as turn signals.11 This requirement means that the lamp must be steady burning when activated, not that it is prohibited from being activated or deactivated automatically.12 However, the (de)activation of the lamp cannot be so frequent or random that the lamp would distract or confuse other road users. For example, a lamp that activates and deactivates on an extremely short time interval due to sensitivity to slight changes in conditions would not be considered steady-burning.13 NHTSA has also interpreted the steady-

6 Id.
7 Id.
8 FMVSS No. 108 Table I-a.
9 Id. S6.6.2; S4 (definition of vehicle hazard warning signal flasher).
10 Id. Table I-a.
11 See, e.g., Letter from Jonathan Morrison, Chief Counsel, to Paul Schaye, Pedestrian Safety Solutions (Sept. 9, 2019); Letter from Anthony Cooke, Chief Counsel, to Kerry Legg, New Flyer, Inc. (Feb. 21, 2008). Before 2007, FMVSS No. 108 included an explicit requirement that, with certain

exceptions (e.g., turn signal lamps), all lamps on a vehicle, including auxiliary lamps, must be steady burning. In 2007, NHTSA implemented an administrative rewrite of FMVSS No. 108 which, among other things, converted the blanket "steady burning" requirement (and its exceptions) into individual activation requirements for each type of required lamp. See 72 FR 68234 (Dec. 4, 2007). Although the reorganized rule no longer includes a blanket "steady burning" requirement, NHTSA stated in the preamble to the reorganized rule that its "rewrite of FMVSS No. 108 is considered administrative in nature because the standard's existing requirements and obligations are not being increased, decreased, or substantively modified." Id. Moreover, NHTSA continues to believe that flashing auxiliary lamps would impair the effectiveness of required lamps by distracting or confusing other road users.
12 See Letter from Jonathan Morrison, Chief Counsel, to Paul Schaye, Pedestrian Safety Solutions (Sept. 9, 2019).
13 See id.

burning requirement to mean that headlamp intensity may modulate, but only if the changes in intensity are not detectable by the human eye.14

You state that the Marking Light is steady burning in that it does not flash (cycle on and off). You state that the Marking Light is activated when the night vision system identifies a pedestrian, bicyclist, or large animal in or near the forward roadway as a hazard. When the object is no longer deemed a hazard, the night vision system switches off the Marking Light. We also understand that the intensity of the Marking Light does not modulate.

We agree that, based on the facts represented to us in your letter, the Marking Light is steady burning and would therefore not violate the impairment provision in this respect. This conclusion assumes that the Marking Light does not activate and deactivate frequently (which could confuse or distract other road users) or change intensity while activated in a way that is detectable to the human eye.

Brightness (Photometric Intensity)

Supplemental lighting can also impair the effectiveness of the required lighting if it is so intense that it glares other road users15 or, relatedly, masks any of the required signal lighting.16 As a point of reference, we note that FMVSS No. 108 specifies two upper beam (or high beam) maxima, at H-V and 4D-V.17 The magnitude of the specified maxima depends on the type of upper beam system; for the purposes of this letter, we will compare the Marking Light to the highest specified maxima at each test point, which are 75,000 candela (cd) at H-V and 12,000 cd

14 See, e.g., Letter from Stephen Wood, Acting Chief Counsel, to Kiminori Hyodo, Koito Manufacturing Co., Ltd. (Nov. 5, 2005); Letter from John Womack, Acting Chief Counsel, NHTSA, to Joe De Sousa (Mar. 10, 1994) (stating, in the context of a modulating motorcycle headlamp, that "there is no failure to conform if the modulating light from the lamp is perceived to be a steady beam").
15 See, e.g., Letter from John Womack, Acting Chief Counsel, to Yoshiaki Matsui, Stanley Elec. Co., Ltd. (Sept. 20, 1995) (fog lamp supplementing lower beam) ("Finally, as a cautionary note, we believe that Stanley should evaluate the glare potential of the headlamp when the fog lamp and lower beam

are operating simultaneously, as it is important to safety that oncoming drivers not be distracted or discomforted in the operation of their vehicles."). Cf. Letter from Jacqueline Glassman, Chief Counsel, to Rusty Riggin, Willow Development (Aug. 2, 2002) (explaining that a supplemental rear cornering lamp could violate the impairment provision if it was so intense that it "create[d] distracting glare").
16 See, e.g., Letter from Jonathan Morrison, Chief Counsel, to Paul Schaye, Pedestrian Safety Solutions (Sept. 9, 2019) ("NHTSA has in the past stated that auxiliary lamps that were so bright as to 'mask' adjacent required turning signal lamps would be prohibited due to impairment."); Letter From Samuel Dubbin, Chief Counsel, to Richard Russell (Dec. 22, 1995) ("[W]e would regard the vehicle manufacturer's certification as negated if the brightness and location of the auxiliary lamps were such as to affect an oncoming driver's ability to perceive the front turn signals.").
17 FMVSS 108 Table XVIII. The photometry requirements specified in Table XVIII consist of test points at which the intensity of the light is measured. The requirements at each test point consist of minima and/or maxima. The test points are defined with respect to an angular coordinate system relative to the headlamp. Thus, H-V identifies a test point zero degrees up and zero degrees down relative to the headlamp, and 4D-V identifies a test point 4 degrees down relative to the headlamp. See also Letter from Erika Jones, Chief Counsel, to Byung Soh, Target Marketing Systems (Sept. 13, 1988) ("Effectiveness may be impaired if the device creates a noncompliance in the existing lighting equipment or modifies its candlepower to either below the minima or above the maxima permitted by the standard."); Letter from Erika Jones, Chief Counsel, to George Ziolo (Sept. 12, 1988) (vehicle equipped with two upper beam headlamp systems would violate the impairment provision because it would exceed the upper beam maxima at H-V and 4D-V).

at 4D-V. We consider the upper beam maxima as proper comparators because the Marking Light, like the upper beam, is designed to activate when no other cars are nearby.18 Just as upper beam headlamps are subject to maximum intensity limits, even though they are designed to turn off in the presence of oncoming traffic, the same concerns apply to forward-facing auxiliary lighting.

You argue in your letter that the Marking Light will not glare other road users or mask any of the required signal lighting. You state that the Marking Light is disabled in the presence of oncoming traffic, so that its downward angle does not glare other drivers on a wet or shiny roadway. You also state that because the Marking Light is low to the ground and produces very little light above the horizontal plane of the headlamps, it cannot glare another driver or pedestrians. You state that because of these features, the Marking Light does not impair an oncoming driver's ability to perceive the front turn signals. In a meeting with our office, you also indicated that the spotlamps on each side of the vehicle are generally not additive (combined).

You also provided data on the intensity of the Marking Light (an iso-candela plot) based on on-vehicle measurements at a test laboratory. The photometric testing indicates that the Marking Light's maximum intensity is 113,440 cd (at approximately four degrees down). You noted that the test setup resulted in higher estimated light intensities than what would be more accurately estimated by a goniometric component test conducted in a properly designed component lamp goniometry facility with appropriate stray light control.

We believe that the Marking Light would violate the impairment provision because it would exceed—dramatically—the maximum permissible brightness of upper beams at 4D-V. This extreme intensity is a concern even if the Marking Light beam is aimed at a downward angle and the system is designed so that the light is disabled in the presence of oncoming and preceding vehicles, because it could still glare other motorists if the vision system does not correctly detect an oncoming or preceding vehicle and prevent the Marking Light from activating. This glare could happen, for example, if the vehicle crests the top of a hill when another vehicle is approaching, the vehicle encounters another vehicle at an intersection without detecting the other vehicle approaching from the side, or if the Marking Light reflects off wet pavement.

We recognize that the photometric test setup led to overestimates of the Marking Light's intensity. Nevertheless, the Marking Light is so intense that a more accurate estimate would likely still greatly exceed the upper beam maximum. We also note that the Marking Light's intensity dramatically exceeds not only the upper beam maximum at 4D-V (12,000 cd), but also the maximum allowed for any individual upper beam headlamp (75,000 cd at H-V). This intensity presents a risk that other road users could be subject to significant glare.

Conclusion

I conclude that the Marking Light would be prohibited by the impairment provision in FMVSS No. 108 with respect to the Marking Light's intensity at 4D-V.
18 FMVSS No. 108 S4 (upper beam defined as "beam intended primarily for distance illumination and for use when not meeting or closely following other vehicles").

Page 7
Richard Seoane

If you have any further questions, please contact John Piazza of my staff at (202) 366-2992.

Sincerely,
ADAM RAVIV
Adam Raviv Chief Counsel

Dated: 6/27/24
Ref: Standard No. 108

EXHIBIT C

← SEARCH INTERPRETATIONS

Interpretation ID: NCC-241023-001TSEI-TIMA Letter of Interpretation 571.108 Flashing Amber Lights 12-13-2024.signed.

December 13, 2024

Mr. Chuck Polley

Transportation Safety Equipment Institute

c/o Grote Industries LLC

2600 Lanier Drive

Madison, IN 47250

Mr. John Freiler

Truck Trailer Manufacturers Association

7001 Heritage Village Plaza

Suite 220

Gainesville, VA 20155-3094

Dear Messrs. Polley and Freiler:

This responds to your letter requesting clarification of Federal Motor Vehicle Safety Standard (FMVSS) No. 108, Lamps, reflective devices, and associated equipment, regarding flashing "emergency warning lights." I apologize for the delay in responding. As used in your letter, the term "emergency warning lights" generically refers to a category of vehicle lighting equipment that consists of one or more amber-colored flashing or strobing lamps that is typically installed on certain types slow-moving vehicles and utility vehicles (such as tow trucks, repair vehicles, or vehicles transporting oversized loads) to call the attention of other drivers to the presence of these vehicles.

You ask that the National Highway Traffic Safety Administration (NHTSA) provide clarification of its longstanding interpretations of FMVSS No. 108 and permit original equipment installation of "emergency warning lights." Alternatively, you ask that NHTSA issue guidance regarding the circumstances under which such lighting may be installed by vehicle manufacturers or repair businesses without violating the "make inoperative" provision of the National Traffic and Motor Vehicle Safety Act (Safety Act) (49 U.S.C. §§ 30101 et seq.).

In responding to this request, NHTSA notes that the contents of this letter do not have the force and effect of law and are not meant to bind the public in any way. This letter is only intended to provide clarity regarding existing requirements under the law at the time of signature.

After carefully considering your letter, we reaffirm our previous interpretations that, under current law, "emergency warning lights" may not be installed as original equipment and that persons subject to the make inoperative provision of the Safety Act may not legally install the lamps as original or aftermarket equipment. We explain our reasoning below, based on our understanding of the information you present.

Background

FMVSS No. 108 specifies requirements for original and replacement lamps, reflective devices, and associated equipment. For auxiliary lamps, the primary restriction imposed by FMVSS No. 108 is in S6.2.1, which states that "[n]o additional lamp, reflective device, or other motor vehicle equipment is permitted to be installed that impairs the effectiveness of lighting equipment required by this standard." Additionally, both original equipment and aftermarket lighting can run afoul of the "make inoperative" provision, and NHTSA considers the installation of an aftermarket lamp to violate the "make inoperative" provision if the installation of the same lamp as original equipment would violate FMVSS No. 108.1 Whether there is an impairment is determined in the first instance by the manufacturer of the vehicle (or the entity installing the aftermarket lighting) when it is certified as compliant with FMVSS No. 108. NHTSA may contest such a determination if it is clearly erroneous.2 These prohibitions bar installation by a manufacturer, distributor, dealer, rental company, or motor vehicle repair business of lamps that would impair the effectiveness of required lighting, but do not apply to the owner of a vehicle.

Typically, the impairment determination is made on a case-by-case basis and considers several characteristics of the auxiliary lamp, such as the brightness, color, location, and activation pattern of the lamp, to analyze whether it impairs the effectiveness of required lighting. This list of characteristics is not exhaustive and other considerations may be relevant to the analysis. NHTSA has long maintained that highway traffic safety is enhanced by the drivers' familiarity with established lighting schemes, which enables them to instantly recognize the meaning the lamps convey and respond accordingly. NHTSA has long interpreted FMVSS No. 108 to require that all auxiliary lamps be "steady burning," with the sole exception of auxiliary lamps that supplement required lamps that flash, such as turn signals.3

Discussion

NHTSA's longstanding interpretation of FMVSS No. 108 is that the standard does not permit the "emergency warning lights" to be installed as original equipment because they are auxiliary lighting that is not steady burning and would impair the effectiveness of required lamps by causing confusion among other drivers about the meaning of required lighting or distracting drivers from required lighting.4 Further, because "emergency warning lights" would impair the effectiveness of required lamps, NHTSA has also determined that entities listed in § 30122 of the Safety Act that install "emergency warning lights" on new or used vehicles would violate the "make inoperative" provision of the Act.

Notwithstanding those interpretations, you provide various reasons why you believe that "current regulations permit manufacturers to install such supplemental lighting as original equipment." We respond to your reasons below.

1 E.g., Letter to Timothy C. Murphy (Nov. 1, 2004), available at https://www.nhtsa.gov/interpretations/gf006332.
2 Letter from John Womack to Larry Grabsky (Nov. 16, 1993), available at https://www.nhtsa.gov/interpretations/9251.
3 See, e.g., Letter to Richard Seoane (June 27, 2024), available at https://www.nhtsa.gov/interpretations/ncc-231121- 001-autoliv-veoneer-spotlight-interpretation-1; and Letter to Paul Schaye (Sept. 9, 2019), available at https://www.nhtsa.gov/interpretations/571108-ama-schaye-front-color-changing-light.
4 Letter to J. Adam Krugh IV (May 22, 2003), available at https://www.nhtsa.gov/interpretations/002769drn (explaining that a flashing or strobing lamp on top of a school bus would impair the effectiveness of required signal lamps by diverting other drivers' attention and causing confusion).

Administrative Rewrite of FMVSS No. 108. First, you state that in an administrative rewrite of FMVSS No. 108, NHTSA removed explicit language in the standard that had contained a provision requiring that all lamps be steady burning unless otherwise indicated. You argue that the removal of this provision indicated an intention to loosen the restriction that auxiliary lamps must be steady burning when activated.

NHTSA had no such intention. The removal of the referenced "steady burning" language in the FMVSS No. 108 administrative rewrite did not change the underlying substantive requirements that had applied to auxiliary lighting. Before it was modified in 2007, FMVSS No. 108 included an explicit requirement that, with the exception of certain types of required lamps (e.g., turn signal lamps), all lamps on a vehicle, including auxiliary lamps, must be steady burning. In 2007, NHTSA implemented an administrative reorganization of FMVSS No. 108 which, among other things, clarified the blanket "steady burning" requirement (and its exceptions) by converting it into specified individual activation requirements for each type of required lamp.5 Although the reorganized rule no longer includes a blanket "steady burning" requirement, NHTSA stated in the preamble to the reorganized rule that its "rewrite of FMVSS No. 108 is considered administrative in nature because the standard's existing

requirements and obligations are not being increased, decreased, or substantively modified."6 Further, NHTSA continues to believe that flashing auxiliary lamps would impair the effectiveness of required lamps by distracting or confusing other road users and we have continued to restrict flashing or strobing auxiliary lamps since the rewrite except under a few limited circumstances not relevant here.7 Therefore, because the "emergency warning lights" are not steady burning, they would not comply with FMVSS No. 108 and would impair required lighting.

Motorists are Used to "Emergency Warning Lights." Second, you state that one of NHTSA's reasons for disallowing flashing auxiliary lamps—their tendency to divert attention and cause confusion—is no longer valid for "emergency warning lights" because "the use of flashing-amber lighting has become widespread." You provide no data or information to support this assertion, except to refer to past agency letters which discussed the make inoperative provision as applied to owners installing flashing or strobe lamps on their own vehicles, including a state installing the lamps on state-regulated emergency vehicles.

We disagree with your assertion that the letters are indicative of the pervasiveness of "emergency warning lights." The interpretation letters to which you refer do not endorse the installation of flashing or strobe lamps by individuals or declare that the lights do not impair the effectiveness of required lamps. Rather, those letters simply recognize the limits of NHTSA's authority under the Safety Act to regulate aftermarket lighting equipment. The agency made, and continues to make, no determination as to whether the flashing amber lights are "widespread."

5 72 FR 68234 (Dec. 4, 2007).
6 Id.
7 These exceptions include auxiliary lamps that supplement required flashing lamps like turn signals. See Letter to Jerry Koh (Feb. 6, 1986), available at https://www.nhtsa.gov/interpretations/86-250; see also Letter to Lt. Col. Steve Flaherty (May 2, 2003), available at https://www.nhtsa.gov/interpretations/flaherty (deference to states applies to "the installation and use of emergency lighting devices on [undercover state police] vehicles").

NHTSA has long believed that flashing amber lighting can unduly divert driver attention and cause confusion among drivers, even among those who have seen them before. As we have stated, "traffic safety is enhanced by the familiarity of drivers with established lighting schemes, which facilitates their ability to instantly and unhesitatingly recognize the meaning lamps convey and respond to them."8 Flashing amber lighting, except for turn signal lamps, is not "an established lighting scheme" within the context of FMVSS No. 108. The meaning of flashing lights can vary depending on the nature of the vehicle on which they are installed, the context in which they are used, and state or local laws. Motorists might not know if the flashing amber lamps are meant to signal the presence of the vehicle for general driver awareness or the need for drivers to yield the right-of-way or perform some other driving task. The use of flashing amber lights is not sufficiently established and standardized to avoid unduly diverting driver attention or causing confusion. Thus, we continue to believe these lig impair required lighting equipment.9

Other Federal Regulations and State Laws Recognizing “Emergency Warning Lights.”
Finally, you argue that permitting flashing amber auxiliary lamps as original equipment would “harmonize” NHTSA’s requirements with Federal Motor Carrier Safety Administration (FMCSA) regulations and state laws. You state that an FMCSA regulation (49 C.F.R. § 393.25(e)) permits the use of flashing lights on several vehicle types and that a change in NHTSA’s approach would better ensure such lighting is properly wired and installed. We are also aware of exemptions granted by FMCSA permitting certain entities to use pulsating brake-activated amber lights as well as the operation of commercial motor vehicles equipped with the Intellistop device.10

Our longstanding interpretation of FMVSS No. 108 regarding flashing auxiliary lights is not impacted by these FMCSA regulations, exemptions, or state laws. The FMCSA regulation does not require the flashing lamps to be installed as original equipment or by an entity subject to the make inoperative provision. Additionally, although you allude to safety concerns about owners improperly wiring or installing emergency warning lights on their vehicles to comply with state laws, we are not aware of any state laws requiring installation of these lights specifically as original equipment or by an entity subject to the make inoperative requirement. Nor is allowing installation by such entities necessary to address improper owner installations of these lights.

If you have further questions, please contact Eli Wachtel of my staff at (202) 366-2992.

Sincerely,
ADAM RAVIV
Adam Raviv Chief Counsel

Dated:12/13/24
Ref: Standard No. 108

8 Letter to J. Adam Krugh IV (May 22, 2003), available at https://www.nhtsa.gov/interpretations/002769drn.
9 Nothing in this letter is intended to conflict with our interpretation, stated in our May 2, 2003, Letter to Lt. Col. Steve Flaherty, that deference to states applies to “the installation and use of emergency lighting devices on [the state’s] vehicles.” Letter available at https://www.nhtsa.gov/interpretations/flaherty.
10 List of FMCSA exemptions in effect available at https://www.fmcsa.dot.gov/exemptions.