Soft Lights Foundation

Soft Lights Foundation
9450 SW Gemini Dr., PMB 717836
Beaverton, OR 97008
www.softlights.org

Light should guide us, not blind us.

September 26, 2026

VIA EMAIL

California Traffic Control Devices Committee
c/o Timothy Kong, Executive Secretary
Caltrans Division of Safety Programs
1120 N Street
Sacramento, CA 95814
timothy.kong@dot.ca.gov

Re: Request for Evaluation of LED Flashing Traffic Control Devices: Traffic Safety, the MUTCD Inclusion Objective, and Disability Access

Dear Chair Bronkall and Members of the Committee:

The Soft Lights Foundation respectfully requests that the California Traffic Control Devices Committee take up, at its next available meeting, the evaluation of LED flashing traffic control devices in California, and that it recommend to the California Department of Transportation (Caltrans) that such an evaluation be performed. The devices at issue include rectangular rapid-flashing beacons (RRFBs), flashing warning beacons, and STOP, YIELD, and other signs with embedded flashing LED units.

The evaluation would address three questions: whether these devices, as now specified and deployed, produce the traffic safety benefits attributed to them, particularly in a roadway environment increasingly saturated with LED flashing light sources; whether they meet the MUTCD's stated objective of inclusion for all users of the road network; and whether their use is consistent with Title II of the Americans with Disabilities Act (ADA) and the California Disabled Persons Act.

I. The Committee's Role

The Committee advises Caltrans in fulfilling its obligations under Vehicle Code section 21400, and Vehicle Code section 21401 requires that traffic control devices on California streets and highways conform to the standards Caltrans promulgates. The California MUTCD 2026 Edition incorporated the federal MUTCD, 11th Edition, including Chapter 4L governing RRFBs. The standards the Committee reviews therefore determine the characteristics of every such device in California. The questions raised in this letter concern those standards, not any individual installation.

II. LED Flashing Traffic Control Devices Under the California MUTCD

A. Flash rate

Warning beacons flash at 50 to 60 times per minute under Chapter 4S, approximately one flash per second. RRFBs operate under an express exception. Section 4L.03, Paragraph 6 requires that RRFBs "provide 75 flashing sequences per minute," and Paragraph 7 prescribes an 800-millisecond sequence of alternating left and right illuminations of approximately 50 milliseconds each. Paragraph 8 then limits the flash rate of each individual indication to not more than 5 flashes per second, "to avoid frequencies that might cause seizures."

Paragraph 8 measures each indication in isolation. A road user receives both indications of a unit within a single field of view, which in the Foundation's reading of Paragraph 7 amounts to six flashes in each 800-millisecond sequence, or 7.5 flashes per second. Section 4L.02, Paragraph 6 requires at least two RRFB units at a crosswalk on any approach using post-mounted signs, one on each side of the roadway, and Section 4L.03, Paragraph 2 requires all units at a crosswalk to operate simultaneously. The aggregate flash rate in the visual field is therefore a multiple of the per-indication figure the standard regulates, and no provision of Chapter 4L limits or requires measurement of that aggregate. The Foundation notes that the three-flashes-per-second threshold in the Epilepsy Foundation's expert consensus (Harding et al., Epilepsia, 2005), which the Department of Justice has also adopted for web content at 28 C.F.R. § 35.200 through WCAG 2.1 Success Criterion 2.3.1, is lower than both figures.

Counted this way, four indications operating together at a two-unit crossing place on the order of 15 flashes per second in the visual field. The published distribution of photoparoxysmal response by flash frequency places most responses between 10 and 25 Hz, with the highest proportion between 15 and 20 Hz (Kasteleijn-Nolst Trenité et al., Epilepsy & Behavior Reports, 2025). The count follows FHWA's own definition: Official Interpretation 4(09)-64 (Feb. 23, 2018) states that a flash, as used in the MUTCD, is a period of illumination at constant intensity followed by a period of darkness. The Foundation does not contend that RRFBs violate Paragraph 8; each indication operates at the limit, not above it. The point is that the standard regulates a unit of measurement that does not correspond to what any road user receives.

Paragraph 8 states a ceiling, not a floor. It identifies the rate above which FHWA regards the device as presenting a seizure risk; it does not identify a rate at which the device is safe, and the clinical consensus places the flash-hazard threshold at 3 Hz and records that some individuals respond below it. Paragraph 8 is also the only provision in Chapter 4L that addresses a physiological effect on any person. The chapter does not mention photophobia, migraine, autism, traumatic brain injury, vestibular disorders, or any other condition affected by modulated light, and seizure is the most severe and least common outcome of exposure; limits calibrated to it do not constrain a device at the levels that produce the others.

The RRFB rate was selected for conspicuity, and lower rates were available: beacons generally operate at approximately one flash per second, and a steady-burning indication

presents no modulation at all. The Foundation has located nothing in the rulemaking record identifying what was weighed against the conspicuity gain in setting the figure at five flashes per second per indication rather than below the clinical threshold. Congress assigned the biological safety of electronic products that emit light to the Food and Drug Administration under 21 U.S.C. § 360ii, which directs consultation with other federal agencies on the evaluation of such emissions; the Foundation has located no record of consultation between FHWA and the FDA concerning the RRFB flash rate.

B. Luminance, not luminous intensity

Section 4L.02, Paragraph 12 requires RRFB indications to meet the minimum Class 1 yellow peak luminous intensity specified in SAE J595, the standard for directional flashing optical warning devices on authorized emergency, maintenance, and service vehicles. The Foundation has located no corresponding maximum. Section 4L.02, Paragraph 13 recognizes the resulting problem, providing as an option that "[i]f the RRFB indications are so bright that they cause excessive glare during nighttime conditions, an automatic signal dimming device may be used to reduce the brilliance of the RRFB indications during nighttime conditions." Dimming is permitted but not required.

The metric itself is the more fundamental issue. Luminous intensity, measured in candelas, describes how much light a source emits in a given direction. It says nothing about the size of the area from which that light is emitted. Luminance, measured in candelas per square meter, is luminous intensity divided by the projected area of the emitting surface. For a light that road users look at directly, as they do an RRFB, a beacon, or a flashing sign, luminance is the quantity that determines how bright the source appears, how much light falls on each part of the retina, and how much glare it produces. Two indications with identical luminous intensity can differ in luminance by orders of magnitude if one emits from a large lens and the other from a few small LED emitters.

LED technology makes that difference acute. By way of illustration, the lamp measured in the Night/Light Consulting report described in Part II.D emitted an average peak luminous intensity of 728 candela from a total emitting area of 10.4 square centimeters, a luminance of approximately 700,000 candelas per square meter. The same 728 candela spread evenly across a 12-inch circular lens, the size of a conventional signal indication, would correspond to a luminance of roughly 10,000 candelas per square meter, about one-seventieth as much. A luminous-intensity specification treats those two sources as equivalent. The eye does not.

The clinical literature already uses luminance. The flash-hazard criteria in the Epilepsy Foundation's expert consensus are stated in luminance, identifying a flash as a potential hazard at 20 candelas per square meter or greater. A standard written in luminous intensity cannot be compared against those criteria, and cannot by itself ensure that an indication is bright enough to be seen in daylight without being so bright, at close range or at night, that some road users cannot look toward it. The Foundation therefore asks that the California MUTCD specify both a minimum and a maximum luminance for LED indications used in traffic control devices, stated in candelas per square meter at defined viewing conditions, with separate values for daytime and nighttime operation as the evidence supports. The

Foundation does not propose particular values; developing them is the evaluation this letter requests.

C. Rise and decay times

Flash rate describes how often a light flashes. Rise and decay times describe how each flash begins and ends. An incandescent beacon rises and decays over a perceptible interval because its filament must heat and cool; a digitally driven LED can switch between full output and darkness almost instantaneously. Two devices with the same flash rate and peak luminance can therefore present very different stimuli. The Foundation is not aware of any provision of the California MUTCD that addresses rise or decay time. The 50-millisecond illuminations Paragraph 7 prescribes for RRFBs leave little room for a gradual transition.

D. Measured characteristics of an SAE J595 Class 1 LED strobe

Measured data for a lamp in the SAE J595 Class 1 category are available. Ken Walczak of Night/Light Consulting, LLC, a board member of DarkSky International and a member of the Illuminating Engineering Society, published an instrumented assessment dated September 10, 2026, commissioned by the Soft Lights Foundation, of an Abrams Manufacturing TG-300-B blue LED strobe lamp that its manufacturer classifies as SAE J595 Class 1. The report found:

- A strobe frequency of 20.9 Hz at 77.4 percent modulation, with a separate 100.1 Hz flicker component at 63.9 percent modulation, both of which the report places in the high-risk region of IEEE Std 1789-2015;
- Peak luminance of 700,000 candelas per square meter in the direction of peak emission, with an average peak luminous intensity of 728 candela;
- More than 80 percent of emitted light in the blue region, peaking at 456 nanometers; and
- Small-source Unified Glare Rating values of 24.3 to 45.9 at distances of 90 to 4 meters at one surveyed site, against a value of 19 that the scale treats as the boundary of acceptability.

The report states its own limits, and the Foundation repeats them. The luminance figure was measured with the lamp in steady-burn mode. The glare method was developed for interior lighting and is applied illustratively. The units surveyed were mounted on private mobile surveillance equipment, not on RRFBs, and the lamp is blue rather than yellow. The report is offered for a narrower proposition: an LED lamp meeting the same SAE J595 Class 1 classification the California MUTCD references for RRFB intensity can produce luminance and glare of this magnitude, and the California MUTCD sets no ceiling that would prevent it. Comparable measurements of RRFB units in California service have not, to the Foundation's knowledge, been made.

III. Flashing LED Units on STOP, YIELD, and Other Signs

A separate category of device warrants its own evaluation: LED units mounted in the border of STOP, YIELD, and other signs. Section 2A.12 of the California MUTCD permits LED units to be used individually within the symbol, legend, or border of a sign to enhance its

conspicuity (Paragraph 4), and for STOP, YIELD, DO NOT ENTER, and WRONG WAY signs permits them within the border or within one border width into the background (Paragraph 16). If the units are flashed, all must flash simultaneously at a steady rate between 50 and 60 times per minute (Paragraph 10). In STOP and YIELD signs, flashing LED units "shall operate continuously," and actuation is not allowed (Paragraph 11). A flashing STOP sign therefore flashes day and night, whether or not any vehicle or pedestrian is present. A single sign may carry eight or more LED units around its perimeter.

The luminance concern described in Part II.B applies with particular force. Paragraph 9 limits each LED unit to a maximum diameter of one-quarter inch. Each unit is therefore a very small emitting area, and a given luminous intensity from so small a source produces a correspondingly high luminance. Section 2A.12 sets no luminance limit. Paragraph 15 requires that the uniformity of the sign design be maintained "without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions," but the standard does not specify how that is to be measured or verified.

The published research reports both benefits and costs. A February 2023 literature review by the Oregon Department of Transportation Library, Flashing LED Stop Signs, summarizes studies reporting reductions in crashes and in vehicles failing to stop fully, including a Minnesota study reporting a 41.5 percent crash reduction with uncertain confidence due to small sample sizes, and a Texas evaluation reporting a 28.9 percent reduction in vehicles not fully stopping. The same review reports, from research by Fitzpatrick, Chrysler, and colleagues (2011), that legibility distance suffers because of glare; that at night, words were detected earlier on signs without lights than on signs with flashing lights; and that observers were 13 times more likely to rate flashing lights unbearably bright at night than in daytime. The review also records researchers' concern that the brightness of the LEDs "might not be advantageous if the distraction of the LED lights draws the attention of the driver away from other critical features."

That concern is the Foundation's as well. A flashing LED STOP sign is conspicuous from distances far greater than the distance at which a driver must act on it, and it continues to draw the eye as the driver approaches. The critical features at a STOP-controlled intersection are the pedestrians in the crosswalk beside the sign and the vehicles on the cross street. A device that produces glare in the driver's line of sight to the crosswalk, or that holds the driver's attention on the sign rather than on the intersection, works against the safety purpose for which it was installed. The STOP sign's message is already conveyed by a shape, color, and legend that are uniform nationwide; the LED units add conspicuity, not information.

The effect on road users with disabilities has not, to the Foundation's knowledge, been studied. A continuously flashing array of high-luminance point sources can produce involuntary attention capture and sensory overload in people with autism or post-traumatic stress disorder, and can trigger migraine in people susceptible to it. A flash rate of approximately one per second is below the three-flashes-per-second threshold in the Epilepsy Foundation's consensus, which reduces but does not eliminate the concern for photosensitive epilepsy; the consensus records that some individuals respond below that threshold, and its criteria also depend on luminance and the area of the visual field the

flashing occupies. These are questions for the requested evaluation, which the Foundation asks include LED-embedded signs specifically, together with the alternatives already available for improving sign conspicuity, such as larger signs, retroreflective strips on sign supports, and advance warning signs.

One further alternative addresses the underlying safety problem rather than the sign's conspicuity. A raised intersection brings the entire intersection, including its crosswalks, up to sidewalk level, so that approaching vehicles must slow as they ramp up into it. At a STOP-controlled intersection, where every vehicle is already required to stop, the vertical deflection reinforces that requirement through the geometry of the road itself rather than through attention capture. Like raised crosswalks and other vertical deflection treatments, it acts on the vehicle, works whether or not the driver has noticed a device, and does not lose effectiveness as more of them are built. It also emits no light. Section 1A.02, Paragraph 02 of the MUTCD identifies raised roadway surfaces as something other than traffic control devices, so a raised intersection falls outside the standards the Committee reviews; the Foundation raises it because an evaluation of whether flashing LED signs are needed at a location should compare them against treatments that address the same safety need by other means.

IV. Traffic Safety

A. The cumulative flashing-light environment

When RRFBs were introduced, LED flashing light sources on the roadway were comparatively rare. They are now pervasive: on police, fire, and ambulance vehicles, tow trucks, utility, construction, maintenance, and delivery vehicles, mobile surveillance units, school zones, and an expanding number of flashing beacons and signs. The effectiveness of a device that works by drawing attention depends on its salience relative to everything else competing for the driver's attention.

The National Highway Traffic Safety Administration (NHTSA) has addressed this concern for vehicle lighting. Federal Motor Vehicle Safety Standard No. 108 provides at 49 C.F.R. § 571.108, S6.2.1, that no additional lamp or other equipment may be installed that impairs the effectiveness of required lighting equipment, a prohibition that has been part of the standard since it was first issued in 1967. NHTSA has long interpreted that provision to require that auxiliary lamps be steady burning, and in its interpretation letter of December 13, 2024, stated that it "continues to believe that flashing auxiliary lamps would impair the effectiveness of required lamps by distracting or confusing other road users."

FMVSS No. 108 governs motor vehicle equipment, not traffic control devices, and the Foundation does not suggest that it applies to devices within the Committee's purview. The reasoning, however, is a traffic safety principle, and it bears on the devices the Committee regulates: flashing lights distract and confuse, and the effect compounds as flashing sources multiply. The Foundation asks that the Committee consider NHTSA's steady-burning position as a factor in evaluating whether continued expansion of LED flashing traffic control devices improves or degrades traffic safety, given the number of LED flashing sources now present on California roads.

B. Evidence on effectiveness and intensity

The published evidence does not establish that RRFBs outperform non-flashing alternatives. In NCHRP Research Report 841 (Zegeer et al., 2017), which evaluated uncontrolled pedestrian crossing treatments at approximately 1,000 sites, all four treatments studied were associated with reduced pedestrian crash risk, and the authors reported that pedestrian hybrid beacons were associated with the greatest benefit, followed by refuge islands, advance yield or stop lines and signs, and RRFBs. Two non-flashing treatments ranked above RRFBs. A December 2021 study commissioned by the Emergency Responder Safety Institute (Bullough et al.) found that higher-intensity emergency lights were rated only marginally more visible than lower-intensity lights but produced significantly more discomfort glare, and concluded that "[u]sing lower intensities at night will reduce discomfort glare without reducing their visibility." Whether these findings extend to RRFBs and flashing signs is a question the requested evaluation would answer.

The reported figures are also not internally consistent. FHWA's Proven Safety Countermeasure page for RRFBs states that they "can reduce pedestrian crashes up to 47%," a figure drawn from the same body of research in which the NCHRP 841 authors ranked RRFBs fourth of four treatments. Yielding figures compound the ambiguity: FHWA reports motorist yielding rates "as high at 98 percent" at some locations, but a device may raise the share of drivers who yield without producing a commensurate reduction in crashes, and the two measures are frequently reported together. An evaluation should distinguish them.

FHWA's own guidance also bears on the cumulative-exposure concern in Part IV.A. FHWA advises agencies to "[r]eserve the use of RRFBs for locations with significant pedestrian safety issues, as over-use of RRFB treatments may diminish their effectiveness." No comparable caution attaches to raised crosswalks, refuge islands, curb extensions, or road diets, which act on the vehicle and work whether or not the driver has seen one before. A caution that effectiveness declines with over-use is a statement that the device depends on salience, and salience declines as exposure increases, both to RRFBs and to every other LED flashing source competing for the driver's attention. The Foundation asks that the Committee consider that implication in light of the number of RRFBs now installed in California and the growth of LED flashing sources generally.

V. The MUTCD Inclusion Objective

Section 1A.01, Paragraph 02 of the MUTCD and the California MUTCD states that the purpose of the MUTCD is achieved through objectives, the first of which is to "[p]romote safety, inclusion, and mobility for all users of the road network." Section 1A.02, Paragraph 01 defines traffic control devices as devices used "for the primary purpose of communicating a regulatory, warning, or guidance message to road users." A device that some road users cannot look toward, or cannot interpret, does not communicate its message to them. The Foundation is not aware of any analysis, by the Federal Highway Administration (FHWA), Caltrans, or this Committee, of whether RRFBs or other LED flashing traffic control devices meet the inclusion objective for road users with

photosensitive epilepsy, migraine, autism, traumatic brain injury, or other conditions affected by modulated or high-luminance light.

VI. The Americans with Disabilities Act and the California Disabled Persons Act

Caltrans is a public entity under Title II of the ADA, and the standards it adopts in the California MUTCD are among its policies and methods of administration. Three provisions of the Title II regulations bear on those standards:

- 28 C.F.R. § 35.105 requires a public entity to evaluate its current services, policies, and practices, and the effects thereof, for compliance with Title II.
- 28 C.F.R. § 35.130(b)(3) prohibits a public entity from utilizing criteria or methods of administration "[t]hat have the effect of subjecting qualified individuals with disabilities to discrimination on the basis of disability."
- 28 C.F.R. § 35.160(a)(1) requires a public entity to take appropriate steps to ensure that its communications with members of the public with disabilities are as effective as its communications with others. Traffic control devices exist to communicate.

The California Disabled Persons Act provides that individuals with disabilities "have the same right as the general public to the full and free use of the streets, highways, sidewalks, walkways, … and other public places," Civil Code section 54, subdivision (a), and that "[a] violation of the right of an individual under the Americans with Disabilities Act of 1990 … also constitutes a violation of this section," id., subdivision (c).

The question has been examined elsewhere. On June 15, 2023, the Minnesota Department of Human Rights found probable cause that a Minnesota city violated the Minnesota Human Rights Act, Minn. Stat. § 363A.12, by failing to reasonably accommodate a resident whose disability was triggered by the strobing LED output of an RRFB the city had installed. That determination is a probable-cause finding rather than a final adjudication, applies a state civil rights statute rather than Title II, and concerns a single location. It establishes that a government agency charged with enforcing a disability discrimination law has examined an RRFB accommodation request and found the refusal to accommodate legally insufficient.

The Foundation is not aware of any evaluation of the effects of LED flashing traffic control devices on individuals with disabilities by FHWA, NHTSA, the Food and Drug Administration, Caltrans, or this Committee. In an October 19, 2022 letter (HCR-40, DOT#2022-0375), FHWA's Office of Civil Rights stated that allegations about the health impacts of RRFBs raise complex issues related to the regulation of all LED lights that extend beyond FHWA's authority. The seizure-avoidance limit in Section 4L.03, Paragraph 8 is the only provision in Chapter 4L that addresses a physiological effect on any person, and the Foundation has located no health-agency analysis supporting it. Because local agencies install these devices in conformity with the standards the Committee reviews, a gap at the level of the standard is replicated at every installation in the State.

VII. Requested Action

The Foundation respectfully requests that the Committee:

1. Place the evaluation of LED flashing traffic control devices on the agenda of its next available meeting for public discussion;
2. Recommend that Caltrans evaluate the traffic safety effects of RRFBs and other LED flashing traffic control devices relative to non-flashing alternatives, taking into account the cumulative number of LED flashing light sources now present on California roads and NHTSA's steady-burning position;
3. Recommend that Caltrans evaluate whether these devices meet the inclusion objective of Section 1A.01, Paragraph 02, and whether the governing standards comply with Title II of the ADA and the California Disabled Persons Act, including the aggregate flash rate in the visual field, peak luminance, rise and decay times, and spectral content;
4. Recommend that the California MUTCD specify minimum and maximum luminance values, in candelas per square meter, for LED indications used in traffic control devices, with separate daytime and nighttime values as the evidence supports, in place of or in addition to the current luminous-intensity specification; and consider whether to require the automatic dimming now optional under Section 4L.02, Paragraph 13, and to address rise and decay times;
5. Recommend that Caltrans evaluate LED units in STOP, YIELD, and other signs specifically, including whether continuous flashing operation under Section 2A.12, Paragraph 11 should continue to be required where flashing is used, whether nighttime dimming should be mandatory, and how those devices compare with non-flashing conspicuity treatments and with geometric treatments such as raised intersections; and
6. If Committee procedures require it, identify a voting or alternate member willing to sponsor the item.

The Foundation would be glad to provide the Committee and Caltrans staff with the primary sources referenced in this letter and to present at a Committee meeting. Thank you for your consideration.

Respectfully submitted,

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

cc: Jaime Sanchez, Alternate Secretary

References

- Soft Lights Foundation, *NHTSA Steady-Burning Position* (Sept. 12, 2026): https://www.softlights.org/wp-

content/uploads/2026/09/NHTSA_Steady_Burning_Position_White_Paper_Rev B.pdf

- Soft Lights Foundation, *Self-Evaluation, Individualized Inquiry, and the Architecture of ADA Title II Compliance* (Sept. 3, 2026): https://www.softlights.org/wp-content/uploads/2026/09/ADA-Title-II-Compliance.pdf
- Walczak, K., *The Assessment of LVT Mobile Surveillance Units Regarding Potential Lighting Issues* (Night/Light Consulting, LLC, Sept. 10, 2026): https://www.softlights.org/wp-content/uploads/2026/09/LVT-Lighting-Report-v2-compressed.pdf
- Bullough, J.D., Parr, S.A., Sblendorio, A., & Hiebner, E., *Effects of Emergency Vehicle Lighting Characteristics on Driver Perception and Behavior* (Emergency Responder Safety Institute, Dec. 2021): https://static.respondersafety.com/Downloads/f31a5f73-7b95-44c7-bd25-1e4cdfce5229/1/EffectsEmergencyVehicleLightingCharacteristics.pdf
- Federal Highway Administration, *Proven Safety Countermeasures: Rectangular Rapid Flashing Beacons*: https://highways.dot.gov/safety/proven-safety-countermeasures/rectangular-rapid-flashing-beacons-rrfb
- Carmanah Technologies, *RRFB demonstration video*: https://www.youtube.com/watch?v=2RB3en7IA8Q
- Federal Highway Administration, *Manual on Uniform Traffic Control Devices, 11th Edition*: https://mutcd.fhwa.dot.gov/pdfs/11th_Edition/mutcd11thedition.pdf
- Caltrans, *California MUTCD 2026 Edition, Part 1*: https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/2026/2026-camutcd-2026-1a-1-a11y.pdf
- Oregon Department of Transportation Library, *Flashing LED Stop Signs* (literature review, Feb. 2023): https://www.oregon.gov/odot/About/Documents/Flashing%20LED%20Stop%20Signs.pdf
- Caltrans, *California MUTCD 2026 Edition, Chapter 2A*: https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/2026/2026-camutcd-2026-2a--a11y.pdf
- Caltrans, *California MUTCD 2026 Edition, Chapter 4L*: https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/2026/2026-camutcd-2026-4l-a11y.pdf