

May 14, 2021

Docket Management Facility

U.S. Department of Transportation

1200 New Jersey Avenue SE

West Building Ground Floor

Room W12-140

Washington, DC 20590-0001

[**Docket No.** **FHWA-2020-0001-0001**]

**23 CFR Parts 470, 635, and 655**

**NPA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)**

Subject: NPA where FHWA is requesting comment to revise standards, guidance, options, and supporting information relating to the traffic control devices in all parts of the MUTCD.

The Automotive Safety Council (ASC) is an industry trade association of 45 of the world’s leading suppliers of Autonomous, Crash Avoidance and Occupant Protection automotive safety systems to the automobile industry. The mission of the Automotive Safety Council is to improve the safety of people through-out the world through the development, production and implementation of the latest automotive safety equipment by preventing accidents, protecting occupants and pedestrians when in a collision and to notify emergency responders after the collision when necessary.

The ASC is providing comments on the NPA for the proposed revision of the MUTCD. (Docket No. FHWA-2020-0001). The ASC appreciates the opportunity to comment on this topic and looks forward to making continued progress on this important proposal.

**General Comments:**

The Automotive Safety Council (ASC) appreciates that FHWA seeks to further revise the MUTCD which can aid the development and capability of new Advanced Driving Assist Systems (ADAS) and Automated Driving Systems (ADS) technologies to navigate the infrastructure better while not impeding innovation. We applaud the hard work your team has invested in developing the proposed update to the 2009 edition of the Manual on Uniform Traffic Control Devices (MUTCD). We gladly accept the invitation to collaborate vehicle sensing technology with infrastructure regulations to achieve the best life saving capabilities for the public. We fully support the FHWA NPA 2020-0001 and request that the FHWA release a final rule in as expedited a manner as possible.

One of the most important factors in making the most roadways useable by ADAS/ADS equipped vehicles while interfacing with the infrastructure and other road users is standardization. Vehicles should not need to adjust to individual state traffic control devices and pavement markings as they cross state boundaries or even county boundaries. The less complexity and variation the vehicle encounters, the more reliable and predictable the life saving benefits can be from these vehicle technologies. In the past, infrastructure and vehicle design were carried out in separate silos as the human was the interface, but now with ADAS/ADS safety improvement possibilities, the two silos need to become a collaborative initiative to maximize the benefit to the public. The more roadway miles that can be navigated by these equipped vehicles, the greater the benefit to the public. Infrastructure planners and vehicle technology developers need to become a common goal-oriented group, in-order to create the safest transportation system for all users. The Automotive Safety Council has been engaging with the infrastructure providers and government regulators over the past 3 years to educate each other about technology capabilities and how we can work together to provide a coordinated approach to attaining our common goals of improved public safety and fully reaping the benefits of these new technologies. Standardization is the first low-cost way to accomplish this goal. In addition to vehicles being more capable in navigating the roadways, the standardization should lead to reduced cost signage and lights as well as pavement markings due to higher volume of standard designs as well as uniform placement.

We are pleased to see that some of the changes proposed in the revised NPA MUTCD are because of this collaboration between the Automotive Safety Council and infrastructure providers and planners. The ASC worked closely with the National Committee on Uniform Traffic Control Devices (NCUTCD) to develop proposed language that was adopted by the NCUTCD full Council on January 10, 2020. We feel there is much more to be done, but this is a good start. The ASC is fully supportive of the latest proposed changes to the MUTCD per the FHWA NPA 2020-0001 as these changes will greatly help the ability of ADAS/ AD vehicles to navigate the roadways through uniform state-to-state pavement markings that are more easily detected at longer distances, and by improving guidance at highway entry and exit ramps.

We are especially pleased with proposed changes to Part 3-Markings that establish a nationwide standard related to marking width (6” and 10”), the use of dotted edge line extensions at exit and entrance ramps, and support for continuous markings in work zone applications. These changes, implemented over the next decade, will facilitate the deployment of Advanced Driving Assistance System (ADAS) and Automated Driving System (ADS) technologies on high-speed U.S. roadways. We support proposals to prohibit the use of raised pavement markers as a substitute for pavement markings, encouraging agencies to install chevron markings, and discouraging agencies from using decorative elements in crosswalks on roadways designed for machine vision use.

The FHWA proposal to create a new section focused on driving automation (NPA Part 5 – Automated Vehicles) creates an important nexus linking future traffic and automotive engineers. This new Part 5 creates a transparent process through which FHWA can authoritatively transmit practices that enhance system performance and risk reduction. As driving automation systems become more complex, integrated, and ubiquitous, this Part will increase in value to practitioners. We strongly encourage its retention as part of the 11th edition.

One challenge not fully addressed in the NPA relates directly to the issue of sensing pavement markings on light colored pavements and in rainy conditions. Machine vision systems detect the contrast between road markings and the pavement. Headlamp and low-sun glare on light colored pavements may result in detection challenges. Human drivers face similar challenges. We will discuss this issue further in Section 5. Road agencies often install various forms of black pavement marking treatments to address glare issues for human drivers. This treatment is also effective for machine vision systems. Machine vision system developers have encountered various types of contrast treatment patterns. The “oreo” broken line striping pattern, where standard white lines are outlined or flanked on both sides by a 1-2” black stripe, is inadequate. Machine vision (cameras) vehicle-based systems, which are becoming standard equipment on most new vehicles, have resolution limitations that limit their ability to perceive these narrow black stripes until the vehicle is remarkably close to the striped surface which is inadequate. We prefer the “lead-lag” pattern, in which the white broken line is matched with a black line of equal width and length. This “lead-lag” pattern allows machine vision systems and human drivers to see the black markings at an adequate distance, allowing for safer operation of the vehicle. In Sections 3A.03 and 5B.02 of the proposed MUTCD update, we suggest the inclusion of the following support language: “Contrast markings in which a black lane line of the same dimension immediately follows a normal white lane line, improves machine vision system lane recognition in glare conditions.” ASC would be happy to discuss this issue further or provide data about camera capabilities.

**Discussion of Proposed New Part 5 Automated Vehicles**

448. As part of the relocation of material related to low-volume roads to other parts within the Manual, FHWA proposes to provide content and retitle Part 5 Automated Vehicles. FHWA proposes all new content for this part. The purpose of this new part is to provide agencies with general considerations for vehicle automation as they assess their infrastructure needs, prepare their roadways for automated vehicle (AV) technologies, and to support the safe deployment of AVs.

**453. FHWA proposes a new chapter titled, ‘‘Chapter 5B Provisions for Traffic Control Devices’’ with sections regarding signs, markings, traffic signals, and temporary traffic control, as well as provisions for traffic control at railroad and light rail transit grade crossings, and traffic control for bicycle facilities.**

**454. In new ‘‘Section 5B.01 Signs,’’ FHWA proposes to include Support and Guidance statements regarding signs. In the Guidance statement, FHWA recommends that signs be clearly associated to the specific lane/road to which they apply, such as parallel roads with different speed limits and that information spreading practices be employed to minimize informational load. FHWA also proposes that standard sign designs be retained as much as possible. Finally, FHWA proposes that the illuminated portion of electronic signs should have a standard refresh/ flicker rate, greater than 200 Hz. FHWA proposes this language to accommodate machine vision technology, while also helping human drivers.**

5B.01 – Signs

For automated and ADAS-equipped vehicles, having dedicated traffic signs directly above each lane where possible in complex road environments simplifies the task of the Driving Automation System and improves the accuracy of environment interpretation. The elimination of lane intent confusion by having each lane with a standardized sign placement above each lane would be beneficial for not only ADAS/ADS vehicles, but for human drivers as well. Pavement markings for lane direction intent can be obscured by other vehicles and lead to lane direction confusion while signs on the side of the road indicating lane direction also lead to confusion. Standardized overhead specific lane signs will give the best result.

Standardizing the placement and minimizing the variety of road signs as much as possible also improves the accuracy of environment interpretation.

The illuminated portion of electronic-display signs using LEDs should have a minimum refresh/flicker rate. As modern ADAS/ADS vehicle machine vision cameras can operate up to 40 frames per second (and perhaps even higher in the future), the refresh rate of the LEDs should be 200 Hz or greater to be ensure that the sign is detected correctly.

**455. In new ‘‘Section 5B.02 Markings,’’ FHWA proposes to include Support and Guidance statements with a list of considerations that should be used to accommodate machine vision used to support the automation of vehicles and benefit the performance of the human vehicle operator. Most of these considerations are addressed in more detail in Part 3 and references are provided to the primary Sections. These considerations include uniform line widths, the use of** **dotted edge line extensions along all entrance and exit ramps, along all auxiliary lanes, and along all tapers where a deceleration or auxiliary lane is added, use of chevron markings in exit gore areas, continuous markings in work zones and in all lane transitions, and minimum dimensions for dashed lines. FHWA also proposes to recommend that** **raised pavement markers not be used as a substitute for markings and that decorative elements in crosswalks be avoided to minimize any potential confusion for automated systems.**

5B.02 – Road Markings

The Automotive Safety Council was pleased to see this in Part 3 and again here in part 5 as these are some of the changes we collaborated on with the infrastructure providers and presented to the National Committee for inclusion in this NPA. For machine vision systems there are technical challenges to the detection of narrow objects at highway speeds, due to limitations in the horizontal resolution of automotive-grade camera imagers. In the case of lane markings, this limits the detection range. Increasing the width of longitudinal lines from 4 inches to 6 inches wide on freeways, expressways, and ramps on roads with posted speeds greater than 40 mph can significantly extend their detection range by machine vision systems and give earlier warning of approaching curves.

Dotted edge line extensions along all entrance and exit ramps, along all auxiliary lanes, and along all tapers where a deceleration or auxiliary lane is added, use of chevron markings in exit gore areas, continuous markings in work zones and in all lane transitions, and minimum dimensions for dashed lines all improve the vehicle’s ability to distinguish intended lane of travel and reduce confusion.

Eliminating raised pavement markers as a substitute for markings and that decorative elements in crosswalks be avoided to minimize any potential confusion for automated systems are beneficial to machine vision systems to reduce confusion.

All these pavement marking changes will improve the accuracy of environment detection and interpretation by the vehicle and human drivers.

One of the other challenges we have as the leading suppliers of ADAS and ADS sensing technologies is the issue of sensing the pavement markings on light colored pavements and in rainy conditions. The contrast of the current and sometimes worn white pavement markings against light colored pavement can be difficult to sense under certain lighting and weather conditions. The addition of a black contrast pavement marking is beneficial in helping to solve this issue which will allow roads to be better sensed with vehicle control for both machine vision and by human drivers. We have seen proposed “Oreo” striping patterns where the standard white line is outlined or flanked on both sides by a 1-2” black stripe. Machine vision (cameras) vehicle-based systems which are becoming standard equipment on most new vehicles have pixel count limitations per degree that limit the ability to see narrow black stripes such as the suggested “Oreo” pattern until the vehicle is remarkably close to the striped surface which is inadequate. We prefer the “lead-lag” pattern which allows machine vision systems and human drivers to see the black markings at a greater distance, allowing for safer operation of the vehicle. A lead-lag pattern of white pavement markings immediately followed by the same width and length black pavement markings would satisfy this need and improve the ability for both humans and machine vision systems to view the roadway successfully.

In Section 3A.03 and in Part 5 of the proposed MUTCD, we suggest the option statement to read, “If used, contrast markings for lane lines should constitute a normal white lane line followed immediately by a black lane line of the same dimensions.”

**456. In new ‘‘Section 5B.03 Highway Traffic Signals,’’ FHWA proposes to include a Guidance statement with a list of considerations that should be used to accommodate machine vision used to support the automation of vehicles and benefit the performance of the human vehicle operator. The list includes consistency along a corridor of traffic signal design and placement with respect to approach lanes, and consistent LED refresh rates greater than 200 Hz. In concert with this change, FHWA proposes a Support statement describing the challenges in achieving corridor-based consistency necessary for machine vision. Information is provided on the benefits of using vehicle-to-infrastructure (V2I) technology for traffic signal systems to address inconsistencies in a corridor.**

5B.03 – Highway Traffic Signals

As identified above, due to the high frame capture rates of modern machine vision cameras, the refresh rate of LED traffic signals should be 200Hz or greater to allow accurate detection.

In addition, dark-colored backing plates around traffic signals with retroreflective borders assist in the detection of active traffic signals and their status at night. These backing plates would also assist in detecting the light status in cases of sun glare, especially at sunset or sunrise.

Additional signage or borders could also assist with distinguishing between single flashing red and yellow signals. Currently ADAS/ADS vehicles use the illuminated light position in standard 3 light traffic signals as an input to determine condition. However, with single flashing light signals of yellow or red, it would be helpful to have additional information as to which they are as yellow lights can have some amount of red in their characteristic and therefore some cameras may have issues distinguishing between the single-color lights.

**457. In new ‘‘Section 5B.04 Temporary Traffic Control,’’ FHWA proposes Guidance and Standard statements regarding the use of signs and pavement markings to accommodate machine vision better and benefit the performance of the human vehicle operator in and through work zones. FHWA proposes that type of signs, spacing, and mounting height should follow the requirements in Part 6 and that the END ROAD WORK sign should be used to establish the end of the work zone.**

**In the Standard, FHWA proposes existing pavement markings be maintained in all long-term stationary temporary traffic control zones in accordance with other referenced areas of the Manual. FHWA also proposes pavement markings match the alignment of the markings in place at both ends of the Temporary Traffic Control (TTC) zone and that they be placed along the entire length of any paved detour or temporary roadway prior to the detour or roadway being opened to road users. FHWA also proposes pavement markings in the temporary traveled way that are no longer applicable be removed or obliterated as soon as practical. As part of this requirement, FHWA proposes that pavement marking obliteration remove the non-applicable pavement marking material, the obliteration method minimize pavement scarring, and painting over existing pavement markings with black paint or spraying with asphalt shall not be accepted as a substitute for removal or obliteration. FHWA proposes these changes to accommodate machine vision of AVs, which might not have the capabilities to distinguish between markings that appear to conflict with one another in the same way that a human road user can.**

**Finally, FHWA proposes a Guidance statement to recommend provisions to enhance the visibility of vertical panels, tubes, and other channelizing devices, as well as markings, to accommodate machine vision as well as human vehicle operators.**

5B.04 – Temporary Traffic Control (Work Zones)

As identified above, machine vision cameras used to support the automation of vehicles have some limitations around the detection of narrow objects at highway speeds, and in particular discrete objects like construction markers that cannot be tracked through interpolation like lane markings. Therefore, construction channelizing devices should be at least 8 inches wide with retroreflective material for more reliable machine vision detection in all weather and ambient lighting conditions; however, 18-inch-wide barrels are preferred as they can be detected at longer distances and give more time for automated steering systems to respond. Standardizing and reducing variety of the construction zone channelizing devices as much as possible also improves the accuracy of environment interpretation by machine vision systems.

In addition, markings at the beginning of a work zone and through lane shifts should be made with highly visible and continuous materials, not intermittent buttons and reflectors. We fully agree with the balance of the proposed changes in this section with special emphasis on standardization being one of the keys.

**458. In new ‘‘Section 5B.05 Traffic Control for Railroad and Light Rail Transit Grade Crossings,’’ FHWA proposes a Guidance statement recommending that placement of signs and markings be consistent within a corridor at both passive and active highway-rail grade crossings. In addition, FHWA proposes Guidance recommending that V2I communication be employed at a highway-rail grade crossing. Finally, FHWA proposes a Support statement recommending signs and pavement marking associated with railroad crossings and tracks that are no longer active be removed. FHWA proposes this language to accommodate machine vision better and benefit the performance of the human vehicle operator.**

5B.05 – Railroad Crossings

For passive and active railway grade crossings, the selection and placement of signs and markings should be consistent and uniform to improve the accuracy of machine vision technology to correctly detect and classify them. Standardized signs and location can reduce confusion and improve the accuracy of environment interpretation.

Removing inactive crossing signs and pavement markings will also assist in correct environment interpretation.

**459. In new ‘‘Section 5B.06 Traffic Control for Bicycle Facilities,’’ FHWA proposes a Guidance statement recommending that bicycle facilities be segregated from other vehicle traffic using physical barriers where practicable and that road markings are needed to denote the end of a bike lane that is merged with traffic. FHWA proposes this language to accommodate machine vision better and benefit the performance of the human vehicle operator.**

5B.06 – Bicycle Facilities

Machine vision systems are quite capable of detecting and tracking bicycles on the roadway, but segregating bicycles can improve cyclist safety and prevent sudden lateral movements of a bicycle outside the designated lane, which is difficult for human drivers and ADAS/ADS vehicles to respond to imminent lane intrusion.

Standardizing of bicycle lane markings as much as possible will also facilitate accurate detection by machine vision systems.

In conclusion, the ASC welcomes this opportunity to comment onthe NPA for the proposed revised MUTCD. We fully support the proposed changes and would emphasize the need for standardization across all 50 states and want to see additional changes incorporated through this public comment phase that could prepare the infrastructure for the increasing rate of ADAS/ADS equipped vehicles on the roadways.

The standardization of V2V, V2I and V2X communication protocols also needs to be done soon so other infrastructure to vehicle safety communications can begin to be incorporated and allow the public to reap the benefits of safer roadways.

We have included specific responses to the NPA below, using the format requested in the docket. We look forward to working with FHWA to address infrastructure that prepares roadways for ADAS and ADS vehicles both now and in the future.

We welcome any invitation to visit the FHWA office for a detailed discussion of these comments should the need arise.

Sincerely,



Douglas P. Campbell

President

Automotive Safety Council

Please use this form to provide comments on the Notice of Proposed Amendments for the MUTCD.

**INSTRUCTIONS:**

1. Add your name or organization name where indicted in the footer of this form.
2. Use Table 1 to provide your original comments.
3. Use Table 2 to indicate your agreement with a comment that another commenter has submitted to the docket.
4. Do not adjust formatting of the rows and columns; text will automatically wrap and expand the row height as you type.
5. To add rows to this form, use the “Insert Rows” function, or hover just outside the left edge of the row below which you would like to add a row and click the encircled “+” that appears.
6. If you choose to provide a letter to accompany this comment form, please **print the document as a PDF**; **please do not scan a hard copy**. This will assist FHWA with cataloging your comments.

**TABLE 1. ORIGINAL COMMENTS ON PROPOSED CHANGES.** Please indicate the applicable proposed Section numbers in the far-left column. In the next three columns, please indicate your agreement, disagreement, or whether the column is applicable to your response by placing a “YES,” “NO,” or “N/A” in the appropriate column of the row. If you agree with a proposed change, then there is no need to fill out the additional columns beyond the first two. However, it can be helpful to explain why you agree with a proposed change based on your objective experience as a roadway operator and/or empirical data. If you disagree in part or in whole, then please provide additional information that FHWA may find helpful.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Proposed  Section Number(s) | Agree with concept and text as proposed | Agree with concept; suggested rewording of text in Comments | Disagree with concept | Comments  *Please include justification for your position based on objective experience and empirical data. If there is a specific statement with which you take exception, please provide the Page and Line numbers from the mark-up version of the proposed MUTCD text.* |
| (**EXAMPLE**)  1D.08 | YES | N/A | N/A | Agree - maintains uniformity. |
|  |  |  |  |  |
| 1A.03 (Target Road Users) |  | YES |  | Traffic control devices are a mechanism through which regulatory, warning, or guidance messages are communicated to road users. The introduction of technologies specifically designed to automate driving tasks expands the concept of “target road user.” Vehicles equipped with driving automation system technology are often connected to networks or can receive wireless signals through which traffic information can be received. The value of vehicle automation technologies was recognized in the NPA by the creation of a new Part 5 – Automated Vehicles. We request that 1A.03 be amended to include a reference to driving automation system technologies. |
| 1B.06 (Experimentation) |  |  | YES | We recognize the importance of road network uniformity. We are concerned, however, that the standards language in 1B.06 will stifle innovations specifically designed to enhance deployment of driving automation system technologies. In NPA 1A.04, FHWA strengthens language regarding professional credentials necessary for engineering studies and to apply engineering judgement. We request that FHWA amend line 17 of 1B.06 to wit: “…Section 1A.13) without first receiving official approval to experiment from the notifying…”. We also request that standards language 1B.06 on page 10, line 41 through page 12, line 17 be stricken. We are concerned that costs associated with the experimentation process will slow innovation. We would prefer the process for experimentation with traffic control devices be left to individual state agencies.  Our recent experience with Michigan DOT’s request to experiment with orange pavement markings in work zones informs our concern. Multiple other states have conducted experimentation with orange marking material in work zones and conducted human factors research that showed promising results. We worked with Michigan DOT’s Operations and Automated Vehicle teams to develop a project that was designed to evaluate how machine vision systems perceived orange markings. If machine vision systems could be trained to recognize and prioritize orange markings, a powerful new tool could be provided to traffic engineers and system developers. The request for experimentation was submitted. FHWA required another human factors study be included before we could proceed. The estimated cost: $75,000 - $125,000. Project frozen.  At a key point in the development of machine vision technology, a potential work zone safety improvement is now shelved. While this is only one example, we are concerned that the language proposed will substantially reduce our ability to partner with local agencies to resolve edge case issues as we transition from driver assistance to automated driving system (ADS) technologies. This is especially concerning as it relates to urban driving environments with increasingly complex road user situations. State and local agencies need greater flexibility to experiment in the early stages of evaluation. |
| 3A.04E | YES |  |  | Agree. We support the specific listing of dotted lane line extensions for the purposes described. |
| 3A.04 (A) | YES |  |  | Agree. We support language in 3A.04, the widths and patterns of longitudinal lines (A) Normal width line. The adoption of a uniform 6-inches wide pavement marking standard for high-speed roadways brings the United States in-line with marking standards in Europe (150mm) and greatly assists machine vision system developers. The wider markings will permit machine vision systems to detect and track lanes significantly further ahead and enable earlier detection of curves. [This would benefit from more details] |
| 3A.04 Widths (B) | YES |  |  | Agree. We support language in 3A.04, the widths and patterns of longitudinal lines (B) Wide Line. Establishing 10 inches in width for wide lines when used in concert with 6 inches wide normal lines on high-speed roadways provides a uniform contrast for machine vision systems at transition areas. |
| 3A.04(C) | YES |  |  | Agree. We support language regarding the use of contrast markings within double line segments. These are especially useful on light-colored pavement in situations where daytime glare conditions are extreme. |
| 3A.04 Guidance (Page 338) |  | YES |  | Agree, in part. The ASC worked closely with the National Committee on Uniform Traffic Control Devices (NCUTCD) to develop proposed language that was adopted by the NCUTCD full Council on January 10, 2020 (Attachment No. 4, Item No: 19B-MKG-02). A significant element within that document was new Guidance language relative to broken lines on high-speed roadways. “On Interstates, freeways, and expressways, 15-foot line segments and 25-foot gaps should be used for broken line.” We ask FHWA to include this as an additional exception on line 9. |
| 3A.05 |  | YES |  | We are disappointed that FHWA has not released a final rule establishing a minimum pavement marking retro-reflectivity standard. The installation and maintenance of pavement markings is essential to maximizing the safety benefits of advanced driver assistance systems (ADAS). SAE Level 2 systems operating on U.S. highways use pavement markings for guidance. While we would prefer minimum retro-reflectivity levels that mirror those currently under review in Europe (150 mcd/m2/lx), any minimum performance criteria would enhance system reliability and serve as a national maintenance standard. |
| 3B.07 | YES |  |  | Agree. The ASC supports the NPA proposal to require the installation of dotted white line extensions for exit and entrance ramps and in advance of freeway route splits with an option lane. Machine vision systems use lane lines to center the vehicle between the two lines. When those lines disappear at exit and entrance ramps, the vehicle may seek to center the vehicle between the nearest two lines, which may be diverging or converging at ramps and could lead to undesired automated steering actions. Requiring the use of dotted edge line extensions will address this issue and provide additional clarity for all drivers. |
| 3B.09 | YES |  |  | Agree. The ASC supports language included 3B.09 Edge Line Pavement Markings requiring that edge lines, if installed, shall consist of a normal width solid white line to delineate the right-hand edge of the roadway. This section, when combined with language in 3A.04 on the width of markings, provides machine vision system developers with clear guidance relative to the size of markings on all roads based on posted speed. If a road has a posted speed >40 mph, edge line markings will be 6 inches wide. If the posted speed is ≤ 40 mph, the edge line marking will be 4-6 inches wide. As system designers develop specific Operational Design Domains (ODD), understanding the width of markings based on posted speed will be beneficial. This proposal provides a level of transparency that simply does not exist today. |
| 3B.25 | YES |  |  | Agree. Chevron or diagonal markings clearly delineate areas where driving is discouraged such as shoulders, neutral areas, and flush median areas. We support FHWA upgrading the installation of chevron markings from an option to “Guidance.” The use of chevron markings is especially beneficial in left-exit transition areas on high-speed freeways, expressways, and ramps. |
| 3H.03, Aesthetic Treatments in Crosswalks Guidance, Line 26-27 | YES |  |  | Agree. Aesthetic treatments in crosswalks create problems with machine vision systems. Machines match road design features with catalogs. Aesthetic treatments are the antithesis of uniformity and may be disregarded by machine systems and may also be a distraction for human drivers. ASC supports Guidance language limiting the use of aesthetic treatments within crosswalks to roadways with a speed limit of 30 mph. |
| 3H.05 | YES |  |  | Agree. Section 3H.05 includes the option to use white-colored pavement instead of chevron markings (see Sections 3B.13 and 3B.25) in neutral areas. We support allowing this as an optional treatment instead of chevron markings. |
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| Part 5 – Automated Vehicles |  | YES |  | Agree. ASC supports the creation of Part 5 – Automated Vehicles within the MUTCD. Government agencies seeking to improve their roadways in support of ADAS or ADS technologies often seek an authoritative source. They are concerned that investments today will not correspond to technology needs tomorrow. Including provisions within this section that guide the practitioner towards supplemental practices in support of driving automation technologies reinforces system uniformity. We encourage FHWA to retain this new Part and commit to working with you to assist in its development. |
| 5B.01 Signs |  | YES |  | Agree, in part. Machine vision technology deployed in vehicles today operates under a slightly different principle than that articulated in lines 4-6. System developers have a catalog of traffic signs. Camera systems today scan for signs that match the picture. Technically they are not “reading” the sign but matching the pictures. Once a picture is identified, the message is processed within the driving system and appropriate action is taken. |
| 5B.01, Lines 7-10 | Yes |  |  | Agree. The issue of sign confusion on parallel roads, such as when a highway and a toll lane operate in parallel, is a problem. We appreciate FHWA raising this issue so traffic engineers can take appropriate action. |
| 5B.01, Lines 11-12 | YES |  |  | Agree. This is an issue for camera systems. Since cameras are looking for signs as a class, when two or more signs are placed together, they are often unrecognized. |
| 5B.01, Lines 13-15 |  | YES |  | Agree, in part. Machine vision system developers currently have no resource for signs that are not included in the MUTCD or the Standard Highway Signs publication. Unfortunately, using any specific design practices for signs would be of little help since machines currently do not read signs. We request that these lines be revised to inform agencies that any sign that is not currently available in the MUTCD or the Standard Highway Signs publication is unlikely to be recognized by machine systems. |
| 5B.01 Lines 16-17 | YES |  |  | Agree. This is an issue being studied by IEEE in coordination with the automotive industry. We support the language in this section related to LEDs and 200 Hz. |
| 5B.02, Markings Lines 20-24 | YES |  |  | Agree. |
| 5B.02, Markings Lines 25-28 |  | YES |  | The NPA provides new Standard language in Part 3.04 relative to the width of markings. We would request that Part 5B.02 A and B be removed this section. |
| 5B.02, Markings Lines 29-41 | YES |  |  | Agree. These are sound recommendations. We would ask that the phrase “at least” be removed from A and B. We seek uniformity and 6 inches wide as a standard is sufficient. |
| 5B.02 Markings (G) |  | Yes |  | Agree. The ASC supports the intent of Section 5B.02(G) addressing the issue of contrast markings on light-colored pavements. We request that FHWA provide Guidance language in Part 3A.04 Functions, Widths, and patterns of Longitudinal Pavement Markings, as follows: “*Guidance. If black contrast markings are used on light-colored pavements in conjunction with broken or dotted lane lines, the marking pattern should be in a lead-lag pattern and the broken line should be the same width and length as the broken or dotted line*.”  A picture containing scene, way, road, outdoor  Description automatically generated  Lead-Lag  Machine vision systems and humans occasionally have difficulties detecting white lane markings on a light road surface under certain ambient light levels and sun position. This is especially true of broken line markings that need to be detected individually. Applying a lead-lag pattern with white markings followed by a black marking of equal length and width provides machine vision detection advantages over other contrast patterns, such as the “oreo” pattern above.  The figure below provides a more detailed explanation regarding camera detection capabilities of each pattern. Vehicles traveling at higher speeds receive significant detection benefits from lead-lag patterns versus the “oreo” pattern.  Diagram  Description automatically generated    If black contrast markings are installed to provide contrast on longitudinal edge lines, the black contrast should be installed on the outside of the edge line. |
| 5B.02, Markings Line 43 (H) |  |  | YES | The ASC worked closely with the National Committee on Uniform Traffic Control Devices (NCUTCD) to develop proposed language that was adopted by the NCUTCD full Council on January 10, 2020 (Attachment No. 4, Item No: 19B-MKG-02). A significant element within that document was new Guidance language relative to broken lines on high-speed roadways. “On Interstates, freeways, and expressways, 15-foot line segments and 25-foot gaps should be used for broken line.” We ask FHWA to include this as an additional exception on line 9. If not, we ask that it be included here in lieu of the current language in H. |
| 5B.02, Markings (I) | YES |  |  | Agree. Aesthetic treatments in crosswalks complicate machine vision recognition and are the antithesis of uniformity. Every crosswalk variation installed requires the development of a new catalog item. It is important that road agencies understand that aesthetic treatments, especially on higher speed roadways, complicate recognition by machine vision systems. |
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**TABLE 2. AGREE WITH ANOTHER COMMENTER.** If you agree with another commenter, please indicate the commenter with whom you agree with and note any additional information FHWA may find helpful or any exceptions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Docket Comment Number and/or Commenter Name | Agree with commenter’s comments as written | Agree with commenter; with exception(s) | | Additional information helpful to FHWA, or exceptions to commenter’s comments | |
| (**EXAMPLE**)  FHWA-2020-0001-59 | YES | N/A |  | |
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|  |  |  |  | |
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