VOLKSWAGEN
GROUP OF AMERICA

Ms. Stephanie Pollack
Acting Administrator
Federal Highway Administration
1200 New Jersey Avenue S.E.,
West Building
Washington D.C. 20590-0001

Thomas Zorn Name
Senior Director Title
Safety Affairs & Advanced Research Dept.
248-754-6480 Phone
248-754-4511 Fax
thomas.zorn@vw.com e-mail
May 14, 2021 Date

Subject: FHWA Advance Notice of Proposed Amendments: *National Standards for Traffic Control Devices; the Manual on Uniform Traffic Control Devices for Streets and Highways; Revision*, FHWA Docket No. 2020-0001, 85 Fed. Reg. 80898 (December 14, 2020)

Dear Acting Administrator Pollack,

Volkswagen Group of America, Inc. (VWGoA) appreciates the opportunity to provide comments to the Federal Highway Administration (FHWA or "Agency") on its Notice of Proposed Amendments (NPA) for revisions to the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD or "the manual"). As a member of the Alliance for Automotive Innovation (Auto Innovators), VWGoA supports the comments submitted by the Auto Innovators. These additional comments are intended to highlight certain aspects that we see as high priority regarding the Amendment's inclusion of new considerations for Agencies to prepare roadways for vehicles equipped with driving automation systems.

VWGoA agrees with the Agency that disparities in traffic control devices should be avoided as much as possible in the future. This is particularly true for vehicles that are being developed with various levels of driving automation installed. As we look to the future and continue to develop new driving automation technologies for vehicles with Operational Design Domains (ODDs) that extend beyond one city, county, or state, consistency in all traffic control devices will help drive consistent system performance and while optimizing the development process for the developers of the technology.

In additional to control device consistency, it is also critical that certain devices are reviewed for possible improvements to increase conspicuity to the human eye and machine vision systems. Even small improvements to sign illumination or reflective material can have significant impacts to the operation of driving automation systems. It is worth noting that these improvements should also have a positive impact to human operated vehicles as improvements to consistency and conspicuity serve to provide a safer driving environment to humans as well as machine vision systems.

VWGoA agrees with the content of the proposed changes to the MUTCD in Part 5 for Automated Vehicles. We support the adoption of the terms from SAE J3016 as it is

consistent with the adoption from other regulators involved in automated driving including NHTSA[1]. VWGoA also supports the inclusion of Part 5C to provide a placeholder for future considerations relative to AV technology. This will undoubtedly come into play as industry and government continue to learn and collaborate on lessons learned from AV deployments. In order to provide more detailed recommendations for the Agency's consideration, we have included a list of specific suggestions as an Appendix to this document. The Appendix provides suggestions related to lane markings, traffic signs, and other traffic control devices.

As we look to the future of additional traffic control devices that FHWA should consider, we encourage the Agency to evaluate Vehicle-to-Infrastructure (V2I) technologies as these could have a profound impact on road safety and efficiency in the US. Again, the benefits of a robust V2I network would enhance automated vehicles as well as human operated vehicles. There are, of course, benefits that would be unique to automated vehicles including opportunities for identification of pedestrian crosswalk status, the presence of emergency vehicles, traffic light status, indicating hazards on roadways, temporary lane closures, the status of construction zones, among many other valuable pieces of information.

In conclusion, VWGoA appreciates FHWA's proposed amendments to the provisions of the MUTCD. We support the inclusion of a new section specifically tailored for automated vehicle considerations and we think that it is important to continue to revisit this section periodically to implement new amendments for AVs. We look forward to participating in this discussion moving forward and think it is imperative that the FHWA continue to work closely with the developers of automated driving technologies in order to collaborate on future amendments to the MUTCD.

Please do not hesitate to contact me at 248-754-6480, or John Lobsiger, a member of my staff, at 248-754-6015 if you would like to discuss this submission.

Sincerely,

Zorn Thomas VWPKI 1C4D1DCDB530EB48

Digitally signed by Zorn Thomas VWPKI 1C4D1DCDB530EB48
Date: 2021.05.14 13:44:18 -04'00'

Thomas Zorn
Sr. Director – Safety Affairs and Advanced Research
Volkswagen Group of America, Inc.

[1] NHTSA Federal Automated Vehicles Policy (2016), pg. 10: "NHTSA expects manufacturers and entities to classify their HAV system(s) as described in SAE J3016. Examples and the application of classifying HAV systems to the SAE levels of automation can be seen in the paper "Key Considerations in the Development of Driving Automation Systems.""

VOLKSWAGEN
GROUP OF AMERICA

Appendix: VWGoA Automated Vehicle Enhancement Suggestions for the MUTCD

Table of Contents

Table of Illustrations

VOLKSWAGEN
GROUP OF AMERICA

1. Lane guidance

1.1. Painted lane-boundaries with good contrast

Perception of lane markings depends on high level of contrast difference between the lane marking and the road surface. Lane markings, painted on a bright road surface such as concrete or other, should be enhanced by additional contrasting colored markings such as black markings left and right of the main lane mark

Yellow lane markings, indicating the left edge of the drivable road, should be enhanced as well by supporting the bright yellow color with black markings left and right to the main marking.

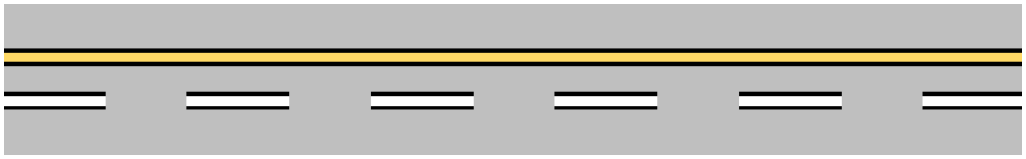


Figure 1: lane markings supported by additional markings of a different color

1.2. Non-dedicated exit lanes

Non-dedicated exit lanes leave areas with uncertainty where there is no sufficient guidance available. These areas should be avoided by adding specific dashed lines along an exit scenario to drag traffic towards the main suggested path.

Figure 2: non dedicated scenarios added with dashed lane markings for additional guidance

VOLKSWAGEN
GROUP OF AMERICA

1.3. Emergency areas/shoulders

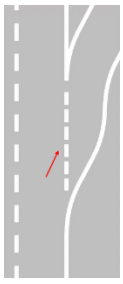
All freeways should be equipped with emergency areas/shoulders on the side of the lanes.
Even dedicated lanes (special lanes like HOV) which are separated from the main lanes of the freeway should have access to emergency areas.

1.4. Botts dots

Botts dots should be supported by a painted line underneath for better visibility by computer vision. The Botts dot itself should also be colored in a way that enhances its visibility in all weather or lighting scenarios.

- Should be avoided in general
- If required, then only together with lane markings/dashed lane
- Lane markings which provide acoustic feedback are generally preferred

1.5. Short dashed lane markings indicating exit only lanes



Short dashed lane markings should be standardized in terms of

- Marking length (> 3ft)
- Marking width (> 10in)
- Distance between individual markings (> 5ft)

No other markings and/or other obstacles should be placed between the individual marks of a high frequency lane.

1.6. HOV/Express lanes

Dedicated separated lanes, such as carpool or express lanes, should be separated from the main flow of traffic in a standardized and uniform way including:

- Separation to the main flow of traffic by a special type of lane markings (for example 2 or 3 solid white lane markings)
- Yellow lane markings for left road edge of separated lane
- Uniform entrance and exit scenarios including dashed lane markings

1.7. Hatched areas

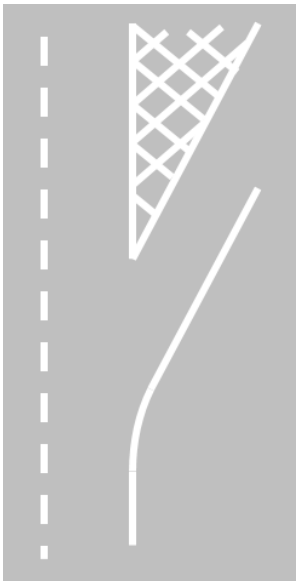


Figure 3: Hatched area after an exit scenario

In an exit scenario, an open free space is created after the two separating lanes diverge from each other. This free space should be marked as a non-drivable area of some sort. It is suggested to mark these areas by crossing lines in sort of a grid or hatch pattern. (See Figure 3)

Other non-drivable areas, such as gore exit areas or areas in front of poles or barriers caused by the free space created by an exit, may be specially marked as well.

It is important that all non-drivable areas be marked clearly in order to detect and distinguish from drivable areas.

2. Traffic Signs

2.1. General

All traffic signs (e.g., speed limit signs, do not pass signs, no turn on red signs, ramp advisory speed signs, no U-turn signs, etc.)

2.1.1. Standardize all traffic signs throughout the entire country.

2.1.2. Use mainly pictograms, limit use of text.
In situations where text is necessary: The content of the text should be standardized

2.1.3. Do not allow unique state specific traffic signs.

2.1.4. All road signage should have good retroreflective background.
The illumination devices installed around or on traffic signs, to attract the attention of humans, can obstruct the camera's ability to perceive the sign. We recommend that illumination added to traffic signs be installed separately from the sign itself. For example, placed below the sign and not surrounding the sign perimeter. Flashing lights should also be avoided.

2.1.5. Position – The height of all signs, including electronic signs, should be standardized and not exceed 17 feet in height as measured from the ground to the bottom of the sign.

2.1.6. In general, all sign characteristics should be standardized including shapes, dimensions (length, width, and height), color, etc.

2.2. Electronic Signs

Electronic Signs need to be standardized with reference to:

2.2.1. Color – White background color with black text. This background should be retroreflective or illuminated.
2.2.2. The entire sign should be illuminated.
2.2.3. The illuminated portion should have a standard refresh/flicker rate. The refresh rate of the LEDs should be greater than 200 Hz to be easier for the camera to detect. If the refresh rate is known and is standard for all electronic signs, then they will be much easier to correctly detect.

2.3. Speed Limit Signs

2.3.1. The speed limit sign should be clearly associated to its specific lane/road. For example in the case of parallel roads with different speed limits.

2.4. School signs

School speed limit signs need to be standardized with reference to:

2.4.1. Design – All school speed limit should have a yellow "SCHOOL" sign affixed directly above a speed limit sign.
2.4.2. If there are conditional school signs (for example, "When Children Are Present), the content of the text should be standardized.
2.4.3. Shape – All school speed limit signs should be rectangular in shape and have the same dimensions (standard length and width).
2.4.4. Position – The height of all school speed limit signs should be standardized and not exceed 17 feet in height as measured from the ground to the bottom of the sign.
2.4.5. Illumination – If the speed limit value of a school sign is to be illuminated, it should have a standard refresh/flicker rate. The refresh rate of the LEDs should be greater than 200 Hz to be easier for the camera to detect. If the refresh rate is known and is standard for all electronic signs, then they will be much easier to correctly detect.

2.5. End school zone

End school zone signs need to be standardized with reference to:

2.5.1. Design – All end school zone signs should display the text "END SCHOOL ZONE" with no other additional text.
2.5.2. Shape – All school speed limit signs should be rectangular in shape and have the same dimensions (standard length and width).
2.5.3. Position – The height of all end school zone signs should be standardized and not exceed 17 feet in height as measured from the ground to the bottom of the sign.

2.6. Traffic lights

2.6.1. Traffic lights should be standardized for the entire country including: Position, location, color, shape, refresh rate (greater than 200 Hz).

2.6.2. The shape of traffic lights should be in the shape of light strips, either vertical or horizontal. There should not be block-shaped, T-shaped, or L-shaped traffic lights.

2.6.3. The traffic lights should have a clear, unambiguous association with the specific lanes.

2.6.4. Traffic lights should have a reflective material surrounding the device to help differentiate it from other lighting devices such as street lights or sidewalk illumination.

2.6.5. Traffic signals used for other forms of traffic, e.g. transit, buses, rail, should have clear separation from other signals and be visually shielded.

2.6.6. Avoid the use of traffic lights that utilized double arrow designs (see figure 4).

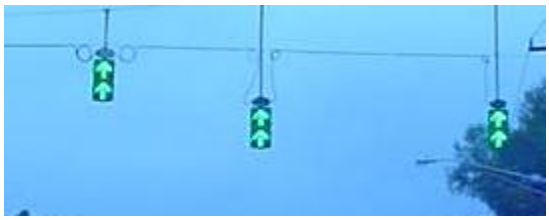


Figure 4: Double arrows used in traffic signal

3. Other Traffic Control Devices

3.1. Uniformity

3.1.1. The MUTCD should be consistently applied as a standard throughout all of the states.

3.2. Construction

3.2.1. All construction sites should have traffic signs that warn the driver of an upcoming construction zone (e.g., Construction Site in ½ Miles).

3.2.2. The end of a construction zone should be indicated by a clear standardized sign.

3.2.3. Construction sites/road work should be clearly marked with e.g. orange temporarily lines that remain at their place on the road for a long time, if there is a situation where the construction project has caused an absence of clear and visible lane markings for an extended period of time. These markings should also be visible in rain or when run over to allow for good lane-keeping guidance.

3.2.4. If the lanes become narrow, that has to be displayed in advance.

3.2.5. Beacons/cones/barrels on construction sites should be equipped with good reflective materials/stickers with a sufficient size for a good detection rate by computer vision even in rain and at night.

3.2.6. Standardize the shape and size of the above beacons/cones/barrels.

3.3. Poles

3.3.1. In some situations, thin vertical poles are challenging to be detected by computer vision. For these reasons, poles should only be used in combination with proper lane marking for traffic guidance.

3.3.2. Poles should always be equipped with high reflective material in order to be better detected.

3.4. Barriers

3.4.1. Concrete walls, such as dividers, should be marked with highly reflective markers, especially in the beginning section to enhance the visibility.

3.4.2. The barrier and road separation should be clearly differentiated (good contrast between the barrier and road).

3.4.3. Steel-rope-barriers are less visible than steel-beam-barriers by computer vision. Steel-beam-barriers or concrete walls with clear reflective markings are preferred.

3.4.4. Beacons/cones on construction sites should be equipped with good reflective materials/stickers and with a sufficient size for a good detection rate by computer vision even in rain and at night.

3.5. General

3.5.1. Centralized database that can record and store traffic data on the following topics:

3.5.1.1. Centralized database for construction sites, road incidents, road closures, natural disasters affecting roadways.

3.5.1.2. Database with road signs and sign location (latitude and longitude) at least for new signs.

3.5.2. Car accident sites on the roads should not be marked just by police signal lights (the small flare like signal lights on the road) but by larger, more conspicuous standardized lights that have better visibility to computer vision. Special markers indicating the lane number to enable lane level positioning.