

THE FUTURE OF VDOT PAVEMENT MARKINGS

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Agenda

- **Background**
 - Why do we have markings?
 - VDOT Pavement Marking Goals
- **The Near Future**
 - CAV Accommodations
 - Data-Driven Analysis
 - Multimodal Accommodations
- **MUTCD Status**
- **The Long-Term Future?**
- **Q&A**

Background | *Why Do We Have Pavement Markings?*

- **Visibility (in all weather conditions)**
- **Consistency (in terms of color, pattern, width, etc.)**
- **Safety**
 - **Roadway departures account for 52% of all nationwide traffic fatalities¹**
- **For all road users**
 - **Drivers relying on human vision (including mature drivers)**
 - **Drivers relying on Automated Driver Assistance Systems (ADAS) or full automation**
 - **Bicyclists, pedestrians, and transit users**

¹ Source: FHWA Roadway Departure Strategic Plan (2013)

Background | *VDOT's Pavement Marking Goals*

- **Comply with all current/future MUTCD mandates**
- **Reduce risk of crashes**
 - **Poor markings can increase crash risk for a wide range of crash types**
 - **Each restriping activity exposes workers, contractors, and the public to risk of a work zone crash**
- **Keep Virginia Moving**
- **Maximize Return on Investment**
 - **Benefit/cost models need to holistically consider all life-cycle costs (initial installation, restriping activities, associated MOT) as well as expected reduction in crash risk**
- **Implement a program that is sustainable by Industry**

The Near Future - CAVs | *Challenges and Opportunities*

- **Challenges:**

- Automated Driver Assistance Systems (Lane Keep Assist, Lane Departure Warning) are here! 40%~80% of new vehicles come with LDW and 10%~24% of new vehicles come with LKA
- ADAS cameras have different needs than human vision
- Improving and sustaining wider/more visible lines could have significant cost impacts for road agencies
- Substantial percentage of vehicles will be non-automated for many years to come

- **Opportunities:**

- ADAS Technology has significant potential safety benefits

The Near Future - CAVs | *What the Camera Needs*

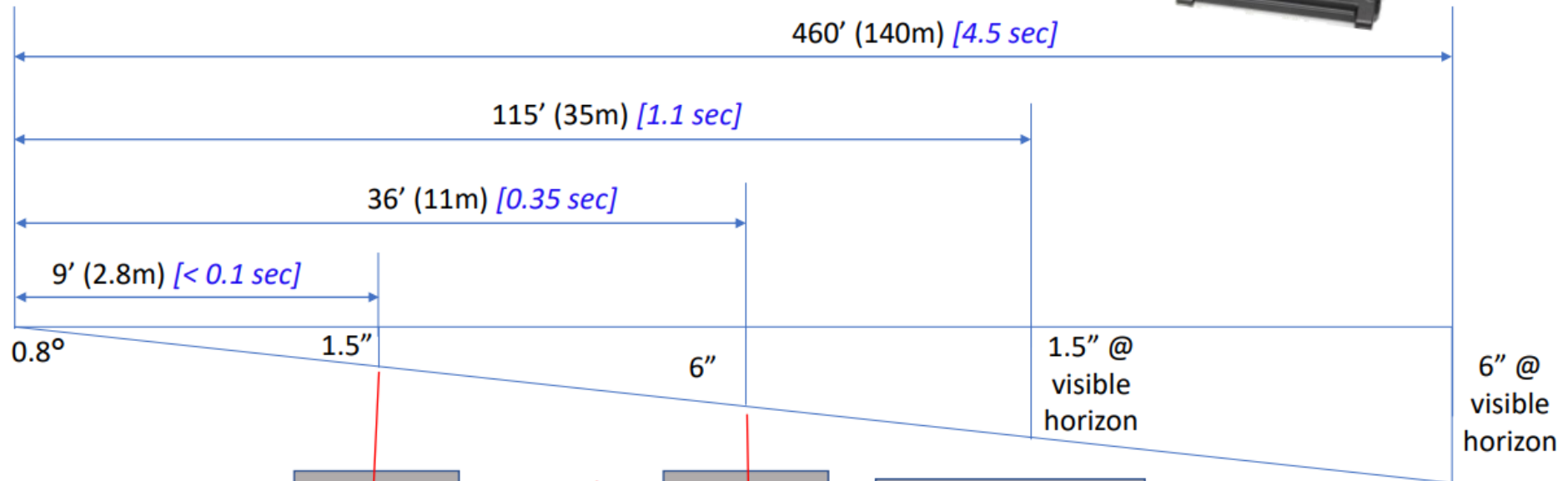
- **Less reliant on retroreflectivity and more reliant on presence and contrast, as compared to human vision**
- **Cameras may be susceptible to confusion by:**
 - “ghost lines” from pavement marking eradication
 - Type E blackout lines
 - Crack sealing
 - White lines on concrete bridge decks/roads without contrast properties



The Near Future - CAVs | What the Camera Needs

Lane Marking Detection Range: Cameras 2015-21

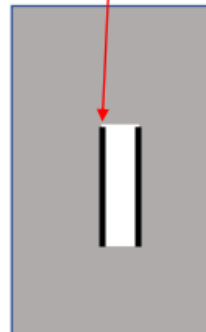
1.2 MP: 25 pixels per degree @ 52° Field of View



Note:

70mph = 31.3 m/sec

Contrast Marking Slide
Courtesy of ASC

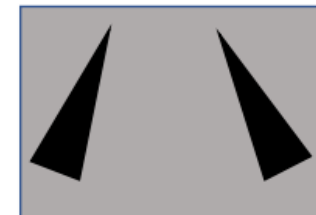


Detection ranges for individual, discrete narrow objects



"Oreo" pattern

Detection ranges for extrapolated narrow objects



"Lead-lag" pattern

The Near Future - CAVs | *VDOT's path forward*

- Evaluate expansion of 6" edge lines as a component of systemic safety improvements, particularly for high-risk rural roads
- Monitor future research into cost/benefit analysis of contrast pavement markings
- Revise VDOT policies as required once new MUTCD is issued

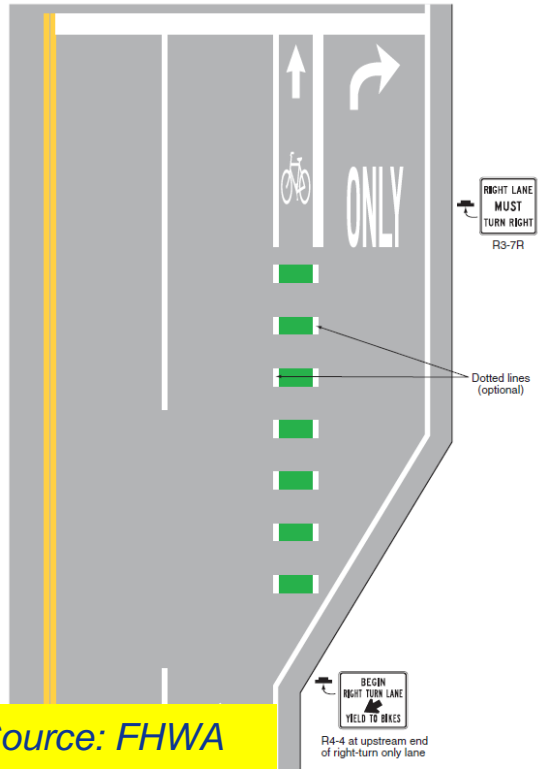
The Near Future – Data-Driven Analysis | *Background*

- **Current VDOT state of play:**
 - No statewide GIS-based pavement marking inventory
 - No program for analyzing pavement marking condition or Retroreflectivity on systemic basis
 - VDOT owns hand-held retroreflectivity meters (“retro meters”) for spot measurements, but no program for Mobile Retroreflectivity Unit (MRU) or other condition assessments at highway speeds
 - No policy regarding minimum retroreflectivity thresholds

The Near Future – Data-Driven Analysis | *Future Options*

- **Data Logger Systems**
 - On-truck instrumentation that automatically records application rates
 - Can also provides a GPS data file for each line
 - VDOT planning to pilot mandatory DLS for select on-call marking contracts in 2022
- **Facilitate ability of Districts to make marking strategy decisions that holistically capture all life-cycle costs/benefits**
- **Potential programs to capture network-level condition data – “what gets measured gets improved”**
 - **Mobile Retroreflectivity Units**
 - **Machine Learning algorithm analysis of dashcam video (?)**

The Near Future – Multimodal Accommodations



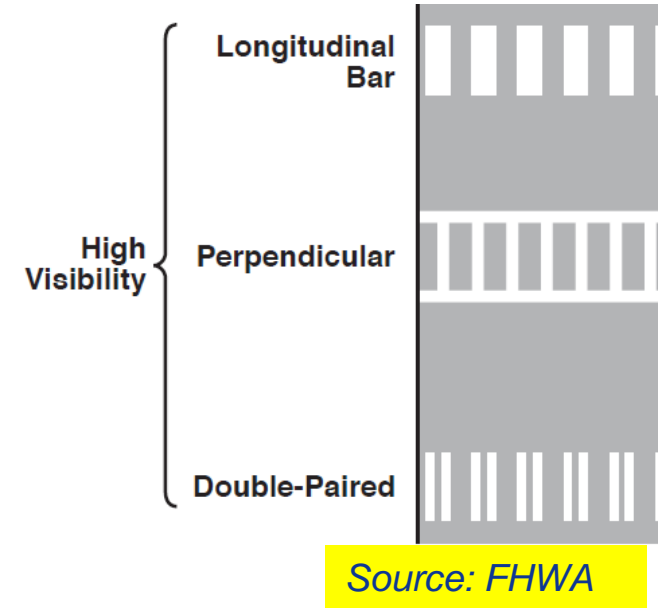
Source: FHWA



Source: Richmond.com



Source: NACTO



MUTCD Status

- **Current MUTCD (10th Edition) dates to 2009**
- **FHWA Schedule for new MUTCD**
 - **Notice of Proposed Amendments (NPA) for 11th Edition issued in December 2020; 647 proposed changes**
 - **Comment period closed in Spring 2021; tens of thousands of comments submitted**



MUTCD Status | IIJA Requirements

- **The new Infrastructure Investment & Jobs Act (IIJA) (aka Bipartisan Infrastructure Deal) has several MUTCD requirements**
- **FHWA shall issue a new MUTCD within 18 months of enactment – i.e. by May 2023 – and every 4 years thereafter**
- **New MUTCD shall provide for the following:**
 - Protection of vulnerable road users
 - Support safe testing of CAV technology and any preparation for safe integration of CAVs onto public streets
 - Minimum retro for traffic control devices and pavement markings
 - Future NCUTCD recommendations



MUTCD Status | *VDOT's MUTCD Adoption Process*

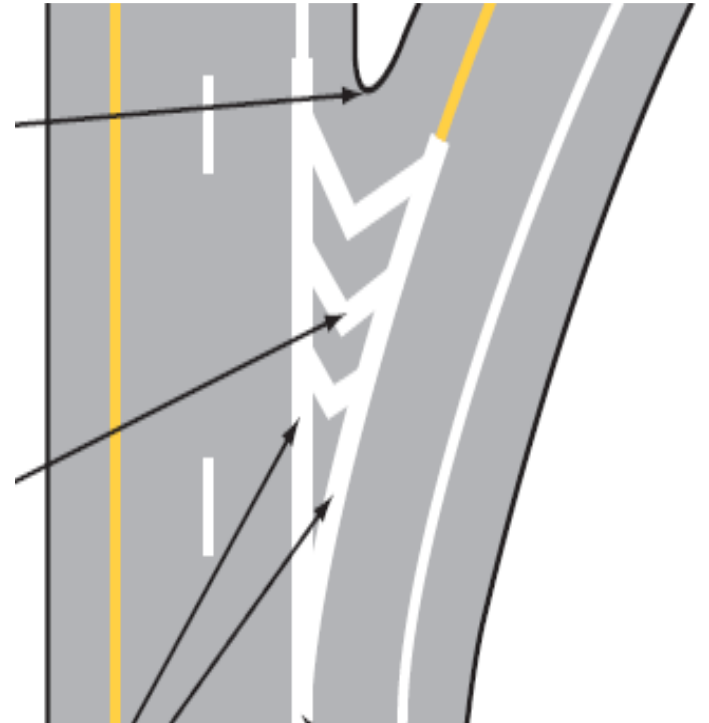
- **Following issuance of the MUTCD 11th Edition, VDOT will likely have up to two years to:**
 - **Analyze and plan for fiscal impacts**
 - **Develop a new Virginia MUTCD**
 - **Obtain FHWA concurrence that new VA MUTCD is in substantial conformance with federal MUTCD**
 - **Obtain CTB approval of new MUTCD**
 - **Update other related policies and procedures**
 - **Integrate new Virginia MUTCD and related policies into VDOT pavement marking activities**

MUTCD Status | *Line Widths and CAV Accommodations*

- **The NPA proposed multiple significant revisions to address both road departure crashes and accommodation of CAVs**
 - **FHWA proposed a new MUTCD Part 5 dedicated specifically to CAVs**
- **New proposed line width requirements:**
 - **Undivided roads:**
 - all edge lines should be 6”
 - All lines (edge lines + center lines) on roads \geq 40 mph shall be 6”
 - **Divided non-limited access highways:**
 - All edge lines on roads \geq 40 mph shall be 6”
 - **Divided highways shall be 6” minimum (already VDOT practice)**
 - **Estimated \$7M-\$15M per year impact to VDOT**

MUTCD Status | *Chevrons*

- The NPA also stated that chevron markings should be used in all entrance and exit ramp gore areas
- Estimated \$2.4M per year impact to VDOT



MUTCD Status | *Retroreflectivity Requirements*

- **Current MUTCD does not require agencies to have any particular practice related to pavement marking maintenance**
- **FHWA Supplemental Notice of Proposed Rulemaking (January 2017) proposed to require the following:**
 - **Agencies shall have a method/plan in place for maintaining markings to at or above certain thresholds**
 - **Plan shall aim for ≥ 50 mcd/sf/fc for longitudinal lines where ≥ 35 mph**
 - **Plan should aim for ≥ 100 mcd/sf/fc for longitudinal lines where ≥ 70 mph**
 - **Exceptions for roads with ambient lighting or $\leq 6,000$ ADT**
 - **Does not apply to transverse lines, on-street parking lines, symbols, etc.**
 - **Agencies must finalize their plan within 4 years of Final Rule**

MUTCD Status | *Retroreflectivity Requirements (cont.)*

- **No FHWA action since SNPA was published in 2017**
- **Numerous comments were submitted to FHWA; Final Rule (when issued) may differ substantially from the SNPA**
- **New IIJA requires FHWA to include a pavement marking retroreflectivity mandate in the new MUTCD**
- **Depending on when the new MUTCD is issued and how it is worded, VDOT may be mandated to have its plan finalized by 2026~2028**

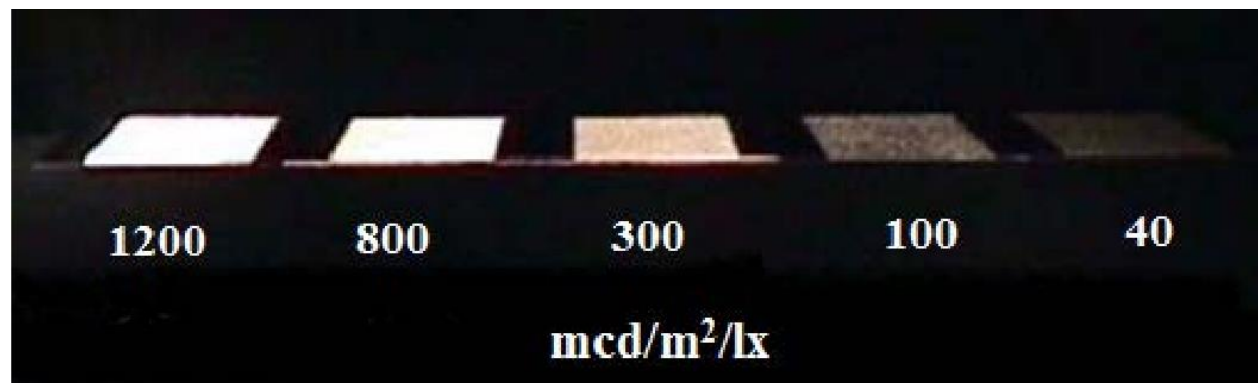
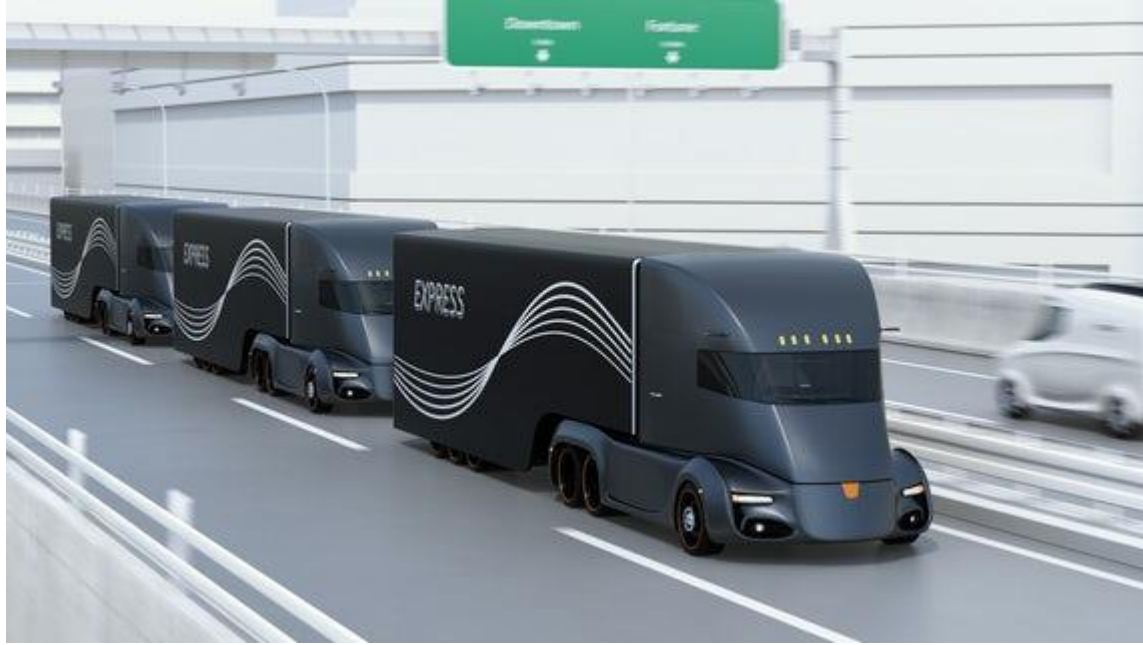


Figure 2.5 Pavement markings at various retroreflectivity levels (Opiela 2004)

The Far Future?





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