

2018 MICHIGAN WINTER OPERATIONS CONFERENCE

EVALUATION OF A COLLISION AVOIDANCE & MITIGATION SYSTEM (CAMS) ON WINTER MAINTENANCE TRUCKS



CAMS Study Objectives

- Evaluate CAMS during actual winter maintenance activities:
 - Operational performance - did the warning light operate properly?
 - Impacts on driver behavior - did the warning light have an effect on drivers following too closely?
- Survey of winter maintenance personnel
 - MDOT WMT drivers with CAMS experience
 - MDOT WMT drivers without CAMS experience
 - Survey Michigan county road agencies and other states
- Perform a benefit/cost analysis of the CAMS system
 - Crash reduction potential vs. cost to install/life cycle and O&M
- Recommendations for use of CAMS system on WMTs in Michigan



CAMS Equipment and Configuration

- CAMS equipment:
 - Radar system, rear facing camera, data logger & processor, in-vehicle display
 - Washing system
 - Warning light bar (three individual amber lights)
- Radar system monitors relative distance & speed of following vehicles



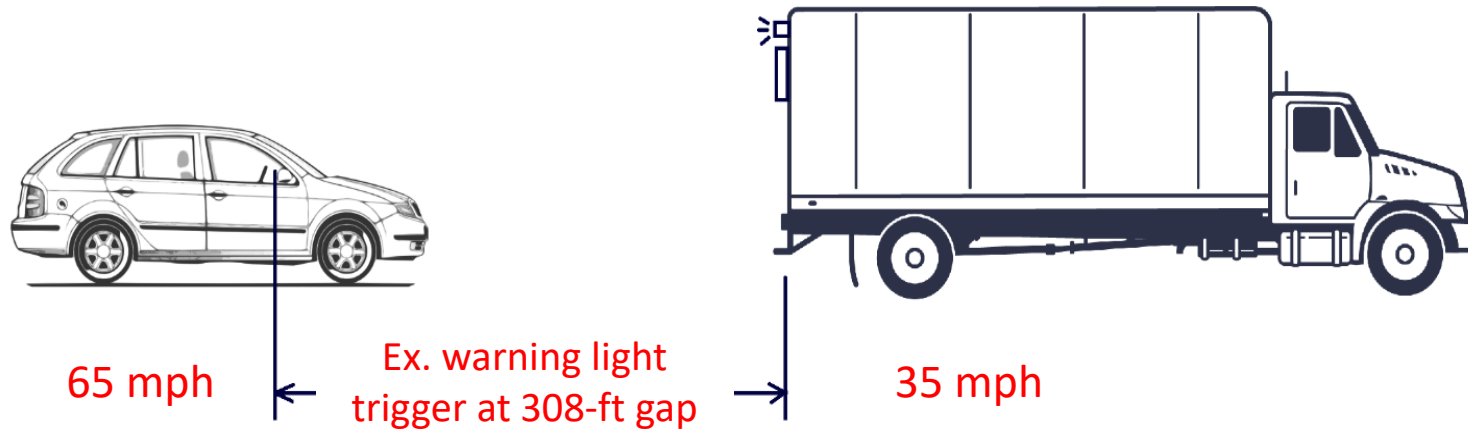
CAMS Object Detection and Tracking

- Under ideal conditions, CAMS can distinguish between vehicles following in the adjacent lane vs. same lane
- CAMS radar isolates and tracks each vehicle, monitoring the time gap with rear of the WMT
- Warning light is only triggered once the time gap threshold is breached
- Warning light turns off after vehicle has backed off or changed lanes

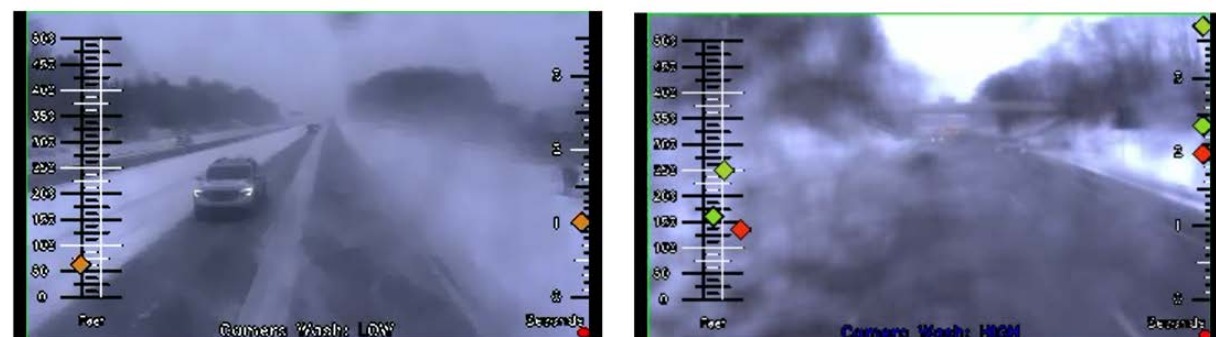


CAMS Warning Light Operation

- Two warning alert patterns are used:
 - 1) solid flash at 7 seconds gap
 - 2) alternating flash at 5 second gap

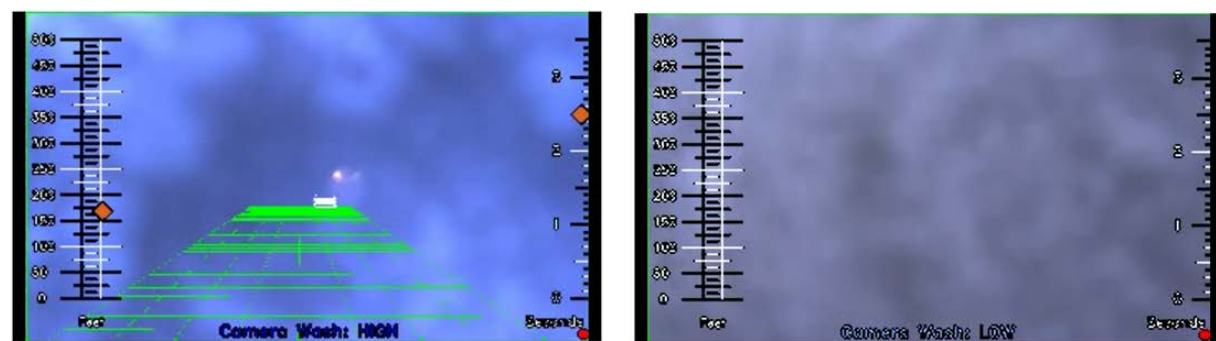


Importance of the Cleaning/Washing System



Clear

Slightly Blocked

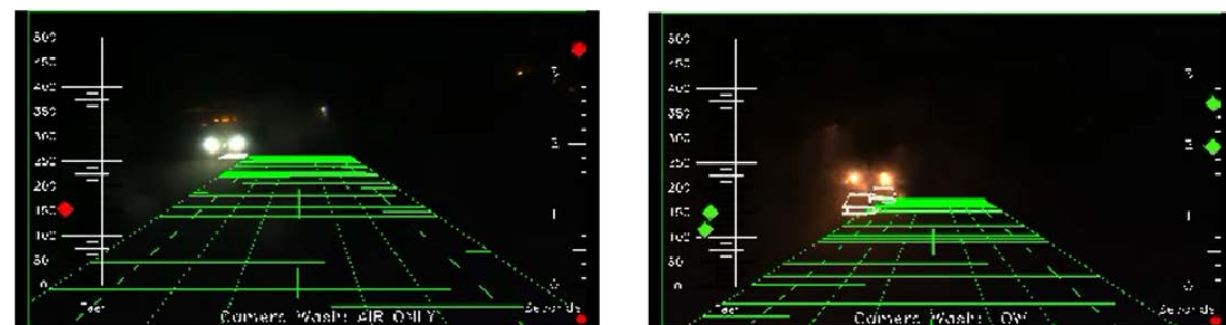


Moderately Blocked

Totally Blocked

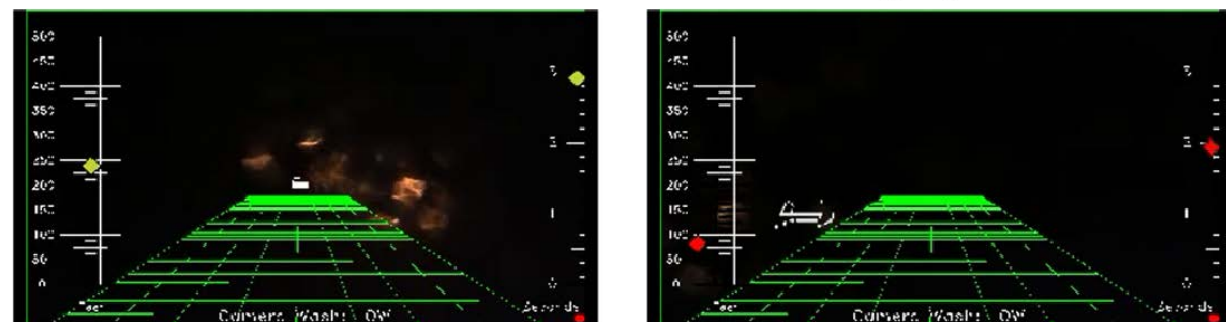
(a)

Daytime



Clear

Slightly Blocked



Moderately Blocked

Totally Blocked

(b)

Nighttime

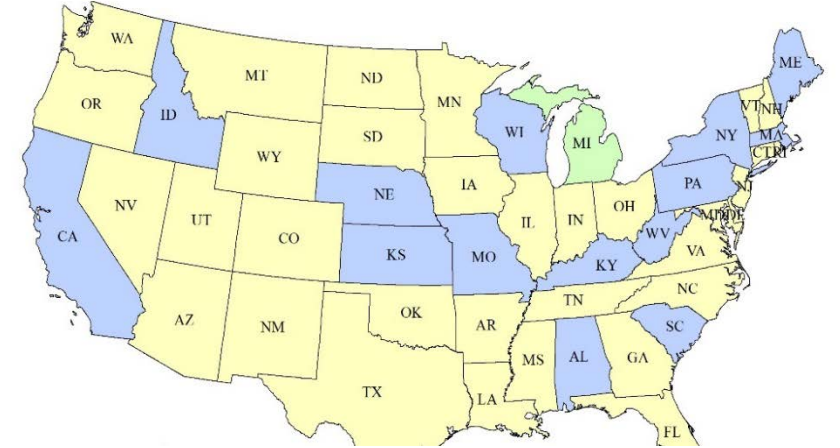
CAMS Evaluation

- Evaluation 1: CAMS Performance During Actual Winter Maintenance Operations
 - Five separate data collection periods on US-23 and I-96 by two MDOT WMTs and one county equipped with CAMS
- Evaluation 2: Driver Behavior in Response to CAMS Warning Light
 - CAMS warning light enabled
 - CAMS warning light disabled - but all other system components working and collecting data
- Evaluation 3: Benefit/Cost Analysis
 - Benefits = savings results from reduction of WMT crashes statewide (\$26,206 per crash – 2012 to 2017)
 - Costs = installation and maintenance costs, statewide CAMS deployment on 800 WMTs in Michigan assuming 5 years life-cycle (\$3.6 million)
 - IF **ALL** WMT Crashes (226) are Eliminated **B/C=1.64 (unrealistic scenario)**
 - IF WMT Crashes (117) with a Potential to be Influenced by CAMS are Eliminated **B/C=0.85 (best case scenario)**
 - IF in-vehicle display and rear camera are eliminate, cost would be reduced increasing B/C
- Evaluation 4: Survey of WMT Drivers

Survey of WMT Drivers and Other Winter Maintenance Staff

Respondents:

- Michigan County Road Agencies (21 responses)
- Nationwide - State DOTs (14 responses)
- MDOT WMT Drivers (6 drivers, including 2 CAMS drivers)



Feedback:

- Potential safety benefits may result from a well designed warning system addressing the tailgating and speed differential between WMT and other vehicles
- CAMS truck drivers did not feel the current system effectively improved driver behavior
- Concerns from all parties about the ability for the cleaning/washing system to keep the radar functional during inclement weather conditions



Conclusions/Recommendations

1. Modify the cleaning/washing system for the CAMS radar/camera housing
2. Use a CAMS warning light color and/or message that is distinct from other WMT warning lights
3. Resolve issues with the inconsistency of the CAMS warning light activation (delay issues, activation from vehicles in adjacent lanes, or no activation at all)
4. Either eliminate in-cabin display (and camera) or modify to include better blind spot coverage (In-vehicle display was distracting)
5. Collect additional behavioral data for vehicles following WMTs
 - a. Small sample sizes during the driver behavior study impeded the ability to draw statistically valid conclusions
 - b. Behavioral analysis may have been impacted by somewhat different weather conditions during data collection for cases with the light enabled vs. disabled
 - c. There seem to be no perceived changes in driver behavior
6. Broader implementation of CAMS is not recommended until these items are addressed
7. CAMS Final Report - November 2018