Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Effectiveness of Green Strobes on Winter Maintenance Vehicles and Equipment

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Green warning lights make winter maintenance trucks more visible

Michigan Department of Transportation (MDOT) winter maintenance vehicles perform critical safety work when clearing snow and ice, but their slower speeds in low-visibility conditions put them at risk for collisions. To make the vehicles easier to see, MDOT began using flashing green lights in 2016 in conjunction with traditional amber warning lights. With a variety of placement options and flash patterns to choose from, MDOT sought to identify the best configuration for maximum visibility. This comprehensive study provided robust data that show the most effective use of amber and green strobes on MDOT's fleet.

PROBLEM

Snowplows and other winter maintenance vehicles travel at reduced speeds to clear snow- and ice-covered highways. The slower speed, combined with low-visibility weather conditions and slippery roads, can increase the vehicles' risk of being hit by motorists. In 2016, a new Michigan law allowed green-colored lights to be used on maintenance vehicles in addition to traditional amber warning strobes. MDOT responded immediately to increase the visibility of its winter maintenance fleet, adding green lights to the amber warning strobes already in place.

Researchers tested an array of light configurations to determine which setup maximizes visibility while minimizing glare.

When placing the lights, MDOT safety and maintenance staff did not have substantive guidance to consult in support of one configuration or flash sequence over

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"MDOT started using green strobes on our winter maintenance trucks based on subjective information and perceptions. Feedback from our workers and the motoring public has been positive, but we wanted supporting data to either confirm or help us adjust our strategy."

Jim Gaus
Project Manager

another. Lights were added to trucks based on staff experience and observations, but with concerns about the lights' brightness, glare and other potential adverse effects, MDOT wanted more data. To investigate optimal use of two-light warning strobes, MDOT engaged researchers to determine the most effective strobe light configurations to increase the visibility of its winter maintenance fleet and improve safety for all Michigan road users.

RESEARCH

First, researchers reviewed existing warning light guidance and publications concerning human visual sensitivity to light colors and flashes. Next, they conducted a survey of state transportation agencies to ascertain the current state of the practice concerning warning lights on public vehicles.

The survey results provided evidence in support of using another color with amber. Based on a review of relevant literature and the state of the practice, researchers designed four human factor tests:

- **Conspicuity test.** Subjects rated how attention-getting each configuration was.
- **Appropriate driving action test.** Subjects stated which driving action they preferred to take when encountering a particular warning light configuration. Choices were *No action, Take foot off accelerator, Apply brake* or *Lane change*.
- **Maximum peripheral detection angle test.** Subjects were asked when they could detect each configuration in their peripheral vision.
- **Glare rating test.** Subjects indicated which light configurations created the worst glare at night.

These tests asked experts and public participants to evaluate the effectiveness of 37 warning light configurations using amber and green strobes. Participants observed stationary and moving test vehicles under a variety of conditions, including both day and night and in adverse weather.

Subjects first evaluated the lights on nonmoving vehicles, assessing them from distances of 450 and 150 feet under clear conditions. Based on the results, researchers devised dynamic tests to simulate actual driving scenarios. Conducted in a controlled environment on a closed track, the tests were performed with participants serving as passengers in a staff-driven vehicle that followed the test vehicle as it displayed different light configurations.

Finally, researchers repeated the conspicuity and glare rating tests on stationary vehicles in snowy conditions.

RESULTS

The test data showed that an additional green flashing light improves the visibility of MDOT's winter maintenance vehicles but can also add glare if not properly configured. To balance these interests, researchers found that a combination of amber lights in a quad flashing pattern (four times per second) and single flashing green lights on the back or top of the vehicle was the most effective warning configuration. The finding confirmed the effectiveness of MDOT's original warning light configuration, which turned out to be nearly identical to the researchers' recommendations.

VALUE

This research provides extensive data about warning light configurations incorporating amber and green strobes, and it offers the guidance that MDOT staff did not have available when they first installed green strobes on MDOT's winter maintenance fleet. The study results firmly support how MDOT uses amber and green warning lights, and the final report provides a resource for Michigan cities and counties seeking guidance on adding green lights to their winter maintenance vehicles. As MDOT continues to use green strobes in upcoming winters, the research results will be a valuable resource in expanding and refining its use of this new safety option.

Research Administration

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This final report is available online at
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