2008-29TS
Published 12-01-08

RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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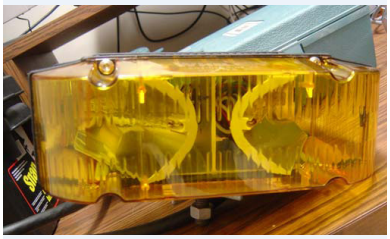
PROJECT COST:
$25,502



The standard emergency lighting currently used on Mn/DOT snowplows consists of an HID strobe light like the one shown here.

LED Emergency Lighting for Snowplows and Other Maintenance Vehicles

What Was the Need?

Mn/DOT maintenance and construction vehicles are required to have emergency lighting to ensure the safety of workers and motorists. The current standard for Mn/DOT snowplows is high-intensity discharge strobe lighting, or HID.

In an effort to reduce maintenance costs, Mn/DOT is exploring the possibility of replacing HID on snowplows with light-emitting diodes because LED-based strobe lighting is more efficient and reliable than HID lighting. However, observation suggests that under certain conditions and from certain angles, LED lighting is less visible than standard HID lighting and so may not be as safe. Further, very little data is available about the effectiveness and safety of using LED lights on snowplows. For Mn/DOT officials to make an informed decision about whether to move to LED lighting on snowplows and other highway maintenance and construction vehicles, they needed to consider the results of comprehensive testing of this new solution.

What Was Our Goal?

The goal of this project was to better understand the effectiveness of LED strobe lights as a replacement for the standard HID strobe lights currently used on Mn/DOT snowplows and to develop a set of specifications for LED-based lighting. This data will allow Mn/DOT to decide whether using LED-based lights on snowplows is a safer alternative, under a variety of conditions, to using the standard HID lighting system.

What Did We Do?

Researchers compared HID and LED lighting technologies using a number of field and laboratory tests, including intensity measurements, optical intensity measurements, visibility testing and light spectrum measurements.

Researchers first performed intensity measurements and field tests to determine the correlation between the optical power output and conspicuity of LED and HID lights. Lab testing included detailed optical measurements of angularity brightness and color. Field tests compared the effectiveness of LED and HID lights, including their perceived brightness at a distance under typical driving conditions.

Researchers then measured optical intensities of LED and HID lights using equipment that enabled semiautomatic intensity measurements at various observation distances and viewing angles typical for drivers. They then conducted visibility testing by recording the minimum distances at which an observer could identify strobes under different weather and driving conditions, including light fog, snow-fog, heavy snow and morning to late-afternoon sun.

Finally, researchers determined color differences in HID and LED strobe lights by taking measurements of the visible light spectrum emitted by them. They also established electrical power output by measuring the DC voltage delivered to the strobes and pulsed current drawn by the lights.

What Did We Learn?

The results of this research suggest that only for some conditions are LED-based lights as conspicuous as the standard HID strobe lights currently used on Mn/DOT snowplows. When viewed from a direction typical of a vehicle approaching the snowplow from the rear, the LED-based lights were just as conspicuous as the standard strobe lights. But

continued

"The research showed that compared with standard HID strobes, the visibility of LED-based strobes is reduced from some viewing angles. More research is needed as to whether these angles affect driver safety."

–Tim Vogt,
Chair, St. Cloud State University Department of Electrical and Computer Engineering

"LED-based strobes should be more cost-effective on snowplows than standard strobes because they last longer and use less current."

–Farideh Amiri,
Maintenance Operations Research Engineer, Mn/DOT Office of Maintenance

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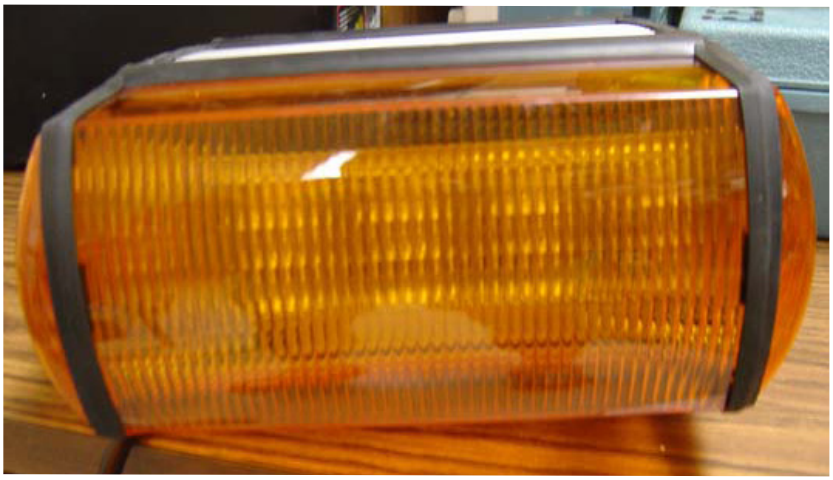

Compared to the standard HID strobe light, LED emergency strobes (above) are not as visible from as many different angles of driver approach, possibly creating safety issues.

because of the strong variation in and correlation between intensity and viewing angle for LED devices, they were less visible than standard HID strobes when approached from a variety of other angles.

Because LED- and HID-based lights were shown to be equally visible under some conditions, it is necessary to determine those conditions that are relevant to safety and effectiveness, and those that are not. With respect to good visibility for vehicles approaching the rear of a snowplow under typical conditions, LED-based systems are probably as effective as HID-based lights as well as being less costly.

What's Next?

By replacing standard HID with LED strobe lights on snowplows and other maintenance and construction vehicles, Mn/DOT could save a considerable amount in maintenance and energy costs. While this study did not show LED lights to be as safe as HID lights in all conditions, it constitutes a first step in analyzing the most significant factor affecting the visibility of LED-based lights: the angle of approach.

LED technology is rapidly evolving, and it would be useful to test the next generation of LED lights for snowplows and other maintenance and construction vehicles. This research should include a more detailed analysis of how the parameters of LED-based lighting systems—intensity, angle, color, timing and power—can be controlled to design LED lenses that automatically correct the angularity problems identified in this study.

This Technical Summary pertains to Report 2008-29, "LED Lighting for Snow Plows and Related Maintenance and Construction Vehicles," published August 2008. The full report can be accessed at http://www.lrrb.org/PDF/200829.pdf.