Project Summary

Development of a standard for light emitting diode (LED) signal lights designed to improve warning signals at grade crossings

This study is part of the **Highway-Railway Grade Crossing Research Program**, an undertaking sponsored by Transport Canada, major Canadian railways, and several provincial authorities. The program is part of Direction 2006, a cooperative initiative with the goal of halving grade crossing and railway trespassing incidents by 2006.

This study examined existing light emitting diode (LED) technology and produced a recommended standard for the use of LEDs to replace incandescent lights currently used as warning signals at highway-railway grade crossings. The proposed standard would result in safer, more effective signals that would be cheaper to install and maintain than those currently in use.

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Background

Traffic stop lights and highway-railway grade crossing signals serve the same function in stopping traffic, but the technology behind each is very different. While both use incandescent lights, grade crossing signals are required to be able to run from a battery backup for a considerable length of time in case of a power outage. This means that to conserve power, railway lights use only 18 watt bulbs instead of the 150 watt bulbs used in traffic lights. To get sufficient light intensity, mirrors and lenses are used to create a focussed beam directed at the motorist. This requires not only a precise alignment of the light bulbs, but a substantial structure to hold them firmly in place.

LED technology is about three times as efficient in producing light from electricity than incandescent technology, and offers substantial advantages in both energy efficiency and light intensity. LEDs also last considerably longer than incandescent bulbs – at least one million hours, compared to an average of 5,000 hours for incandescent lights – and are impervious to shocks.

There are currently about 20,000 LED lights in use at grade crossings across the U.S. Transport Canada has restricted the use of LED signal lights in Canada until a suitable, justifiable standard could be developed.

Objectives

This study had the following objectives:

- Review current LED signal use and any evaluations that may have been completed
- Determine the requirements and concerns of Transport Canada, railways, and other stakeholders
- Evaluate the characteristics of LED signals with regard to luminous intensity and spread, life expectancy, human factors, technical limitations, etc., and compare them with those of incandescent light signals
- Develop a proposed standard based on the evaluation and the requirements of stakeholders
- Develop a plan for field testing an application of LED technology that promises to meet these requirements
- Conduct the field and laboratory tests
- Analyse the data and modify the standard on the basis of the analysis
- Complete the draft standard

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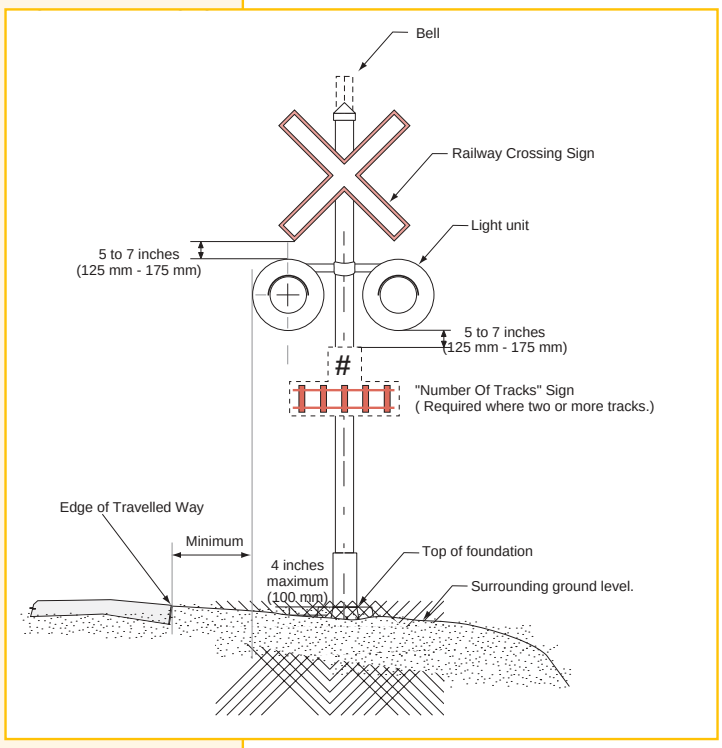

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Findings

To determine the standard that LED technology should be required to meet to be used in grade crossing signals, the researchers consulted widely with railway and regulatory authorities, industry, the scientific community, and traffic and signal light manufacturers. A steering committee with representatives of these stakeholders met throughout the project, and principles were established to guide the development of the new standard. The stakeholders agreed that the standard should:

- Consider driver requirements and human factors, not the capabilities of the technology
- Define a broad beam pattern so alignment is not critical and standard traffic light structures can be used
- Meet or exceed existing grade crossing signal requirements as expressed in the latest recommended specifications for incandescent lights
- Meet or exceed the most demanding high-speed, wide-angle traffic light specifications
- Apply to front, back and overhead lighting to avoid requiring different signal modules for each location
- Be measurable and quantifiable, so that it can be applied throughout the life of the signal
- Be confirmed with laboratory and field testing
- Be the same for 200 mm and 300 mm lights

The characteristics of the red light produced by LEDs were examined to determine how they might affect colour-blind individuals, drivers wearing sunglasses, ageing eyes, and eyes affected by sun glare or fog. LEDs were found to offer two inherent advantages over incandescent lights. They produce a pure red signal that is more conspicuous to the human eye than that produced by an incandescent bulb with a red filter. LEDs can be turned off and on instantly, which allows the number of flashes per minute to be increased dramatically, improving the range at which the flashing lights can be seen. Incandescent lights are limited to about 60 flashes per minute.

A review of driver considerations found that requirements at grade crossings were no different than at traffic intersections, and that there was no reason for standards for the two signalling systems to differ.

Concern that the proposed standard for LEDs would be too high to be met by current technology led to testing and review of several prototypes supplied by manufacturers. Four were selected for laboratory testing. Three met the standard with minor modifications to their power supplies and using lenses designed for traffic lights.

Three field tests conducted with three different focus groups found that LED signal lights with the required intensity easily exceeded the requirements for visible range. In addition, the field tests found the LEDs were superior to traditional incandescent lights.

Conclusion

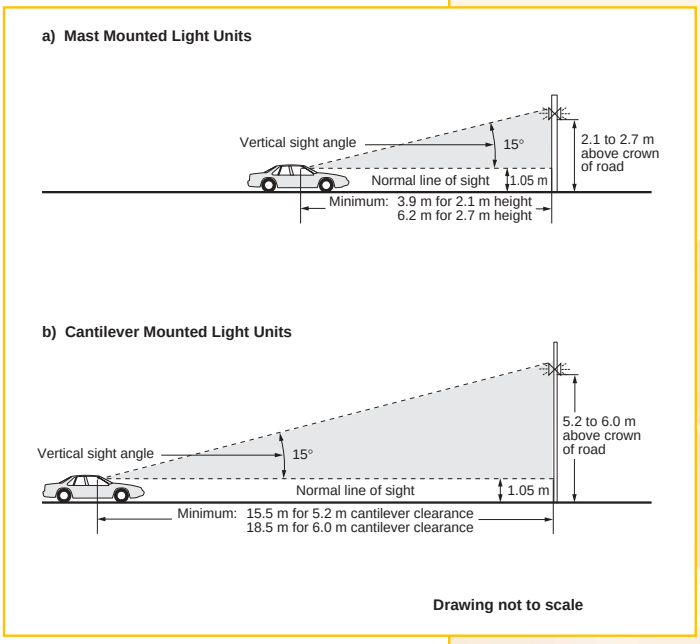
The proposed standard brings railway signal lights into conformity with high-speed, wide-angle traffic light standards in North America and Europe. In addition, the recommended light beam pattern is sufficiently broad that a single LED module design can meet the performance requirements for overhead lights, lights to the side of the road, and "back" lights on the far side of the tracks, which eliminates the need for different designs for each placement. The broad beam also significantly reduces the need for checking signal alignment and allows traffic light structures to be used to mount the signal housings, which will result in cheaper and safer operations.

Recommendations

The project reviewed the standards for both railway crossings and highways, human factors, driver requirements, the scientific literature, and stakeholder comments, and produced a recommended photometric standard for railway grade crossing signal lights, and recommended specifications for environmental, electrical, physical, and mechanical performance.

The key photometric specifications developed in this study are intended to be published in Transport Canada's RTD 10, Road/Railway Grade Crossings, as a national standard. The requirements are intended to remain consistent for many years; once published, they will be difficult to modify or update.

For technical requirements that may change with the advance of technology, the researchers made specific recommendations for amendments to the American Railway Engineering and Maintenance-of-way Association (AREMA) manuals. These proposed changes include technical specifications for mechanical vibration and shock, voltage surge protection, and electromagnetic interference. The researchers also developed a purchase specification to provide further guidance to purchasers, in the event that the AREMA manuals are not updated.



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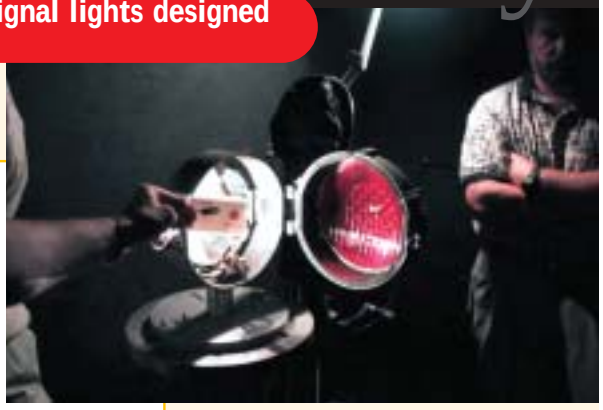

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