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EFFICACY OF INCREASED FLASH RATE OF RAILROAD GATE FLASHERS

SUMMARY

Under the direction of the Federal Railroad Administration's (FRA's) Train Control and Communication Research Division, the Volpe National Transportation Systems Center (Volpe) conducted a study to evaluate the effectiveness of increasing the flash rate of gate-mounted flashers on driver compliance with grade crossing warning devices.

Results from data collected and analyzed during a field-test of the technology in 2023 indicate that gate-mounted rapid flash rate light-emitting diode (LED) flashers reduced grade crossing violations by motorists. The number of violations per grade crossing activation decreased by about 22 percent after the installation of the new flashers. The average time of violation, measured as time elapsed since grade crossing activation, decreased by 18 percent (from 3.4 seconds on average before installation to 2.8 seconds on average post-installation). Results also showed a 35 percent decrease in the violation rate for nighttime grade crossing activations, indicating that the rapid flashers improved the conspicuity of the active warning devices at the grade crossing.

BACKGROUND

Motorists whose visibility is obscured or who are distracted while approaching a rail-highway at-grade crossing may not notice the standard railroad gates and flashing lights. This can lead to unsafe situations such as motorists stopping within the dynamic envelope of the crossing, breaking the descending or horizontal gate, or driving through the crossing and colliding with a train. Figure 1 shows an incident involving a driver violating the crossing gate at the study crossing on Washington Street in Canton, MA (ID# 546 729P), which resulted in a broken gate.

Figure 1. Crossing Gate Violation Example (Crossing ID# 546 729P)

Flashers at active grade crossings flash at a rate of about 1 hertz (Hz), or one flash per second, during a grade crossing activation. In a standard crossing, there are two flashing lights, with each light energized alternately, on and off. The idea of a higher flash rate for grade crossing flashers was developed at Railway Equipment Company (RECO) in Delano, MN. Engineers developed a flashing light activation sequence, similar to that on a police car, that aims to capture the motorist's attention in more quickly and effectively.

The proposed flashing lights aim to increase the flash rate of each light up to 4.5 Hz when the light is energized (for a strobe effect) during the initial phase of the activation. Once the roadway gate descends to a full horizontal position, the flash rate will resume back to about 1 Hz.

The Massachusetts Department of Transportation (MassDOT) received approval

from the Federal Highway Administration (FHWA) for this experiment in 2023, consistent with Section 1A.10 of the Manual of Uniform Traffic Control Devices.

OBJECTIVE

The objective of this study was to examine the effectiveness of increasing the flash rate of gate-mounted grade crossing warning lights on driver compliance with grade crossing warning devices.

METHODS

Researchers used a before and after design to evaluate the effectiveness of the rapid flashers on driver compliance with grade crossing warning devices. Volpe partnered with the Massachusetts Bay Transportation Authority (MBTA) to identify a suitable grade crossing for implementation, collecting before-and-after data, and evaluating the results.

Vehicles were recorded at the subject crossing to measure driver compliance with the grade crossing warning devices. Two main performance measures were used: violation rate and the time of each violation. Violation rate is defined as the number of events per activation in which a driver continues through the grade crossing while the warning devices are activated. The time of violation is defined as the time elapsed between the onset of the activation (when the lights begin flashing) and when the front of the vehicle passing the grade crossing gates.

These two measures were compared before and after the implementation of the rapid flashers at a crossing. For these flashers to be effective, a reduction in violation rate and in the time of violation should be observed.

Data Collection and Analysis: The grade crossing location selected is on Washington Street in Canton, MA (ID# 546 729P). This is a public, at-grade crossing equipped with 8-inch mast-mounted flashers and 4-inch gate-mounted flashers on each of the two approach lanes. It also has pedestrian gates in all four quadrants.

The MBTA is the primary operating railroad using the crossing, with an estimated 28 trains per day on weekdays. There is no weekend commuter rail service. The Canton commuter rail station lies to the west of the crossing on the south side of the tracks, as shown in Figure 2.

Figure 2. Washington Street Grade Crossing (Canton, MA)

The research team collected data via two video cameras connected to a digital video recorder and mounted to a utility pole on the northwest corner of the crossing. Grade crossing violations were classified into three types:

- Type I: Vehicle traversed the crossing while lights were flashing but before gates started descending, within the first four seconds of initial activation.
- Type II: Vehicle traversed the crossing while gates were descending, within the next eight seconds.
- Type III: Vehicle traversed the crossing while gates were horizontal.

RESULTS

Through the successful partnership between Volpe, MassDOT, and MBTA, the data on vehicular grade crossing violations before and after the implementation of the rapid flashers were collected and analyzed as follows:

Pre-Installation (Pre): For the pre-installation period, vehicular movements at the crossing were analyzed for 20 weekdays over a 4-week

period from May 30, 2023 to June 26, 2023. A total of 720 grade crossing activations and 544 vehicle violations were observed; 315 of these violations were Type I, and the remaining 229 violations were Type II. Four Type III violations were observed in this period but were removed from the analysis. Those four events occurred during two late night activations (same night) with no trains present that lasted about 12 minutes each.

Post-Installation (Post): The existing flashers on the roadway gates were replaced with rapid flashers on November 3, 2023. A period of three weeks was allowed to account for the novelty effect of this improvement. The post-installation period consisted of 20 weekdays over a 4-week period from November 27, 2023 to December 22, 2023. A total of 702 grade crossing activations and 415 vehicle violations were observed (298 Type I, 117 Type II, 0 Type III).

Comparative Analysis: Although the difference between the total number of activations in both periods was only about 3 percent, the total number of violations was about 24 percent less in the post period (544 violations pre vs 415 violations post). Violation rates (the number of violations per grade crossing activation) between the two periods were compared. As shown in Table 1, the violation rate decreased from 0.76 violations per activation in the pre-installation period to 0.59 in the post-installation period, a decrease of about 22 percent.

Table 1. Violation Counts and Rates for the Pre and Post Periods

	Count		Violation
Period	Activations	Violations	**Rate**
Pre-Installation	720	544	0.76
Post-Installation	702	415	0.59

Figure 3 shows the violation rates for Type I and Type II violations for both periods. The Type I violation rate decreased by about 5 percent between the pre and post periods, from 0.44 to 0.42 violations per activation. The Type II violation rate showed a more dramatic decrease between the periods, from 0.32 to 0.17 violations per activation (a decrease of about 47 percent).

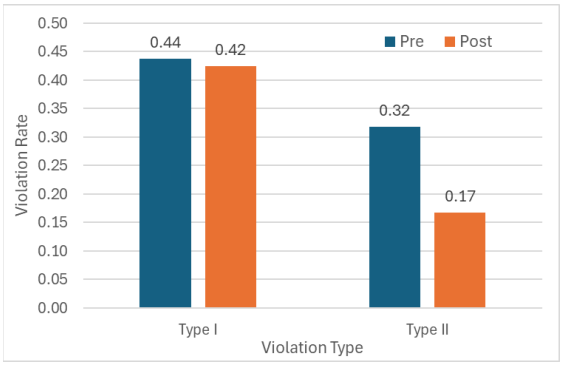

Figure 3. Violation Rates between the Pre and Post Periods

For observed violations, the average time of violation was 3.4 seconds for the pre-installation period. For the post-installation period, the average time of violation had decreased by 18 percent to 2.8 seconds. This means that violations tended to occur earlier in the activation after the rapid flashers' installation.

Figure 4 shows the percentage cumulative distribution of violations by elapsed time since grade crossing activation for both periods. This figure shows that for the post-installation period, fewer violations occurred later into the activation after the installation of the rapid flashers.

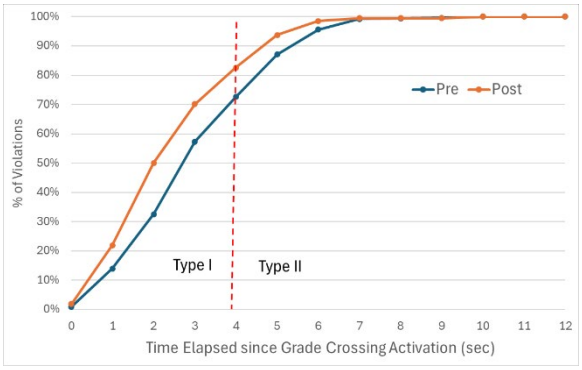

Figure 4. Percentage Cumulative Distribution of Violations by Time Elapsed since Grade Crossing Activation

To account for the day/night seasonal difference between the two periods (May–June vs

November–December), researchers also compared the violation rates for daytime and nighttime separately. As shown in **Table 2**, results for nighttime violations for both periods (8:30PM-5:00AM) showed a significant decrease in violation rates for both violation types (about 35 percent overall). However, due to the very small nighttime sample size, a statistical analysis of the results is not appropriate and therefore results should be interpreted with caution.

Table 2. Nighttime Violation Rates

	Violation Rate per Violation Type	
Period	Type I	Type II
Pre-Installation	0.15 (21 viol. /137 activ.)	0.08 (11 viol. /137 activ.)
Post-Installation	0.10 (12 viol. /120 activ.)	0.05 (6 viol. /120 activ.)

CONCLUSIONS

Results indicate that increasing the flash rate of gate-mounted LED flashers improved driver compliance with the active warning devices at the subject crossing. The overall violation rate decreased by about 22 percent after the installation of the new flashers. The violation rate while the gate was descending (Type II) decreased by about 47 percent. The average time of violation (measured by time elapsed since grade crossing activation) decreased by 18 percent. Overall, results showed a positive safety benefit from this improvement as reflected in the reduction in violation rate and in violations later in the activation period.

FUTURE ACTION

This grade crossing will undergo several additional improvements in the near future, involving changes to the approaching roadway and upgrading the mast-mounted flashers from 8-inch incandescent to 12-inch LEDs. Researchers will continue collecting and analyzing data during and after each of these improvements to assess any additional benefits.

ACKNOWLEDGMENTS

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CONTACT

Francesco Bedini Jacobini
Program Manager
Federal Railroad Administration
Controls & Communication Research Division
1200 New Jersey Avenue, SE
Washington, DC 20590
(202) 493-0800
Francesco.Bedini@dot.gov

Marco DaSilva
General Engineer
Volpe National Transportation Systems Center
Systems Safety and Engineering Division
220 Binney Steet, Cambridge, MA 02142
(617) 494-2246
marco.dasilva@dot.gov

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