TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 0-4749-S

Project 0-4749: Development of an Active Warning Device for School Bus Loading and Unloading Points in Areas of Limited Visibility

Authors: J. L. Carson, A. Holick, E. S. Park, M. Wooldridge, and R. Zimmer

PROJECT SUMMARY REPORT

Active Advance Warning Devices Show Promise for School Bus Zone Safety

The findings contained in this report respond to the three-part problem described below:

1. Children are at greatest risk when in school bus loading or unloading zones. Students are three to four times more likely to be killed while boarding or leaving the bus than while riding the bus.
2. Efforts to improve safety at school bus loading or unloading zones have been focused on increasing school bus conspicuity and enhancing driver guidance. However, none of these efforts are effective (i.e., visible from a distance) if a school bus is stopped in an area of limited visibility.
3. The constant display of the static warning message, SCHOOL BUS STOP AHEAD, combined with the limited presence of the hazard (i.e., the stopped school bus and children), results in rapid motorist desensitization to the risk and a subsequent degradation in safety at school bus loading and unloading zones.

The primary objective of this research project was twofold:

1. to develop an active advance warning device (AAWD) comprising an actuated flashing beacon supplement to a conventional SCHOOL BUS STOP AHEAD (S3-1) sign and
2. to evaluate its effect on driver performance (i.e., reduced speeds, improved vehicle braking activity, reduced erratic maneuvers, etc.) and safety through school bus loading and unloading zones.

Figure 1. AAWD System Developed for School Bus Zones.

Secondary objectives were to summarize AAWD components and costs, develop an activation strategy for the flashing beacon system component, review the liability risk associated with AAWDs (i.e., moving from passive to active warning), review national experience related to AAWDs, and provide guidance regarding potential AAWD specifications and use in Texas.

What We Did...

The AAWD system for use at limited visibility school bus loading and unloading zones was developed to meet state and federal design standards with respect to size, color, illumination rate, etc. The activation system for the flashing beacon component of the AAWD was determined after a critical review of various mechanisms (see Figure 1).

Concurrent with the development of the AAWD system, a review of both published literature and historic case law was conducted to determine potential additional liability risks associated with generally moving from a passive to an active warning device. Case law information was derived from courts in all 50 states using the LexisNexis Legal Research database.

Along with a review of national experience, several field studies in Texas investigated the effects of AAWDs on driver behavior and safety at school bus loading and unloading zones with limited visibility. In general, sites for this investigation were selected with the following characteristics in mind (see Figure 2):

- limited visibility,
- high speed,
- rural environment,
- reasonably high traffic volumes, and
- "simple" environment without distracting stimuli.

Investigations such as this are challenged by external factors (i.e., increased enforcement presence) and the novelty of the experimental device, which may exaggerate the observed effects of the traffic control device under study. To control for these potential errors, this project used a before/after, case/control experiment. Four case sites and two control sites were observed.

Figure 2. Sample Site for AAWD Experiment.

What We Found...

Safety Impacts

Of the 46 published studies reviewed, 37 reported a positive effect (i.e., either a reduction in vehicular speed or a reduction in accidents) resulting from the introduction of AAWDs comprising flashing warning beacons as the, or one of the, system components.

Findings from the local field studies conducted in Texas suggest generally favorable results:

- When considering changes in average vehicle approach speeds measured at both the SCHOOL BUS STOP AHEAD sign and 500 feet upstream of the sign, a statistically significant reduction in average approach speeds was observed (1.0 mph and 2.02 mph respectively) when the flashing beacon was activated.
- Three out of four sites experienced statistically significant speed reductions ranging from 1.18 mph to 3.18 mph when the flashing beacon was activated.
- When a school bus was present at the loading and unloading zone, a statistically significant reduction in vehicle approach speeds was observed (8.62 mph) across all sites at the SCHOOL BUS STOP AHEAD sign when the flashing beacon was activated.
- One out of four sites experienced a statistically significant reduction in average approach speeds (15.08 mph) measured at the SCHOOL BUS STOP AHEAD sign with a bus present at the loading and unloading zone and with the flashing beacon activated.

It is likely that further statistically significant favorable results are precluded by the small sample sizes, particularly when AAWD performance at individual sites is examined. Brake light actuation distances were largely unaffected by the activation of the flashing beacon.

System Components and Costs

The system components for the prototype AAWD developed and tested as part of this project included a SCHOOL BUS STOP AHEAD advance warning sign (S3-1), top- and bottom-mounted flashing beacons, and a flashing beacon activation system. Costs for the final system are estimated to be $2,000 for the S3-1 sign and flashing beacons and $2,600 for the flashing beacon activation system; a single flashing beacon activation system can be used with multiple S3-1 sign and flashing beacon assemblies. These estimates do not include sign installation or ongoing maintenance and operations costs.

Liability Risk

Based on a review of published literature and a review of historic case law, the addition of flashing beacons to the SCHOOL BUS STOP AHEAD (S3-1) sign appears to pose minimal additional liability risk above what is already experienced by transportation departments. With respect to general warning sign use, transportation departments are largely protected from tort liability through discretionary immunity and are further protected by following:

1. state or federal standards and specifications for installations and operations,
2. a logical and systematic decision-making process for selecting appropriate warning devices,
3. a logical and systematic decision-making process for operating active warning devices, and
4. a program of regular inspection and maintenance for warning devices.

Areas of potential liability risk, though not prevalent in the historic case law to date, relate to a transportation department's "jurisdictional responsibility" with respect to establishing, operating, and maintaining school bus loading and unloading zones and the expectation or lack of expectation of a hazard tied to the activation of the flashing beacon (i.e., motorists may rely solely on the flashing beacons as their indication of the hazard [i.e., school bus and children] and may not exercise the same degree of caution when the bus is not present and the beacons are not flashing but children are nonetheless present at the bus stop).

The Researchers Recommend...

Given the generally favorable safety-related impacts (both nationally and locally), the low system cost, and the minimal additional liability risk incurred beyond that of a general warning sign, the active advance warning device system comprising a SCHOOL BUS STOP AHEAD sign (S3-1), flashing beacons, and a flashing beacon activation system is recommended for implementation. Prior to or in conjunction with this implementation, researchers recommend the following activities to ensure that the safety of children and the motoring public is maximized and the Texas Department of Transportation is protected from tort liability:

- Incorporate the AAWD into state standards and specifications.
- Develop a logical and systematic decision-making process for selecting school bus loading and unloading zones equipped with the supplemental flashing beacons (vs. those that are unsigned or signed only with static SCHOOL BUS STOP AHEAD signs).
- Develop a logical and systematic decision-making process for operating the active flashing beacon system component.
- Develop a program of regular inspection and maintenance for the AAWD that includes the general condition of the sign and the functionality of the flashing beacon system component.
- Define the department's "jurisdictional responsibility" with respect to establishing, operating, and maintaining school bus loading and unloading zones.
- Investigate additional or modified signing (i.e., a supplemental plaque) to reflect the presence of children even if the flashing beacons are not activated.
- Periodically evaluate driver behavior at the AAWD sites to ensure that driver desensitization to the warning has not compromised the safety of the site.

If proven to be successful in Texas, this type of AAWD would be easily transferable for application in other states.

For More Details . . .

The research is documented in Report 0-4749-1, *Development and Evaluation of an Active Warning Device for School Bus Loading and Unloading Points in Areas of Limited Visibility*.

Research Supervisor: Jodi L. Carson, TTI, j-carson@tamu.edu, (512) 467-0946

Researchers: Andrew Holick, TTI, a-holick@tamu.edu, (979) 845-5686
Eun Sug Park, TTI, e-park@ttimail.tamu.edu, (979) 845-9942
Richard Zimmer, TTI, d-zimmer@tamu.edu, (979) 845-6388

TxDOT Project Director: Carlos Ibarra, cibarra@dot.state.tx.us, (903) 799-1480

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TxDOT Implementation Status
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The objectives of this research project were: 1) to develop an active advance warning device for school bus stops in areas of limited visibility; and 2) to evaluate the effect of this device on motorist performance and safety in the vicinity of the school bus stop. Three products were required for this project: 1) draft specifications; 2) draft design detail drawings; and 3) draft text for TxDOT manuals and Texas MUTCD (TMUTCD). The first two products are instrumental in the assembly of the active advance warning device for school bus stops in areas of limited visibility. It is recommended that the active advance warning device be installed as needed, after a safety review by the TxDOT district office. Concerning the third product, incorporation of draft text for TxDOT manuals and the TMUTCD will require review and approval by the TxDOT Traffic Operations Division.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 465-7403 or email wodell@dot.state.tx.us.

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Texas Transportation Institute/TTI Communications
The Texas A&M University System
3135 TAMU
College Station, TX 77843-3135