U.S.Department of Transportation
Federal Highway Administration

Advanced Dilemma-Zone Detection System

This summary is one in a series describing Innovative Intersection Safety Treatments. The summaries identify new technologies and techniques to improve intersection safety developed since NCHRP Report 500, Volumes 5 and 12, were published in 2003 and 2004, respectively. These treatments show promise for improving safety but comprehensive effectiveness evaluations are not yet available.

Safe Roads for a Safer Future
Investment in roadway safety saves lives

Purpose

The Advanced Dilemma-Zone Detection system enhances safety at signalized intersections by modifying traffic control signal timing to reduce the number of drivers that may have difficulty deciding whether to stop or proceed during a yellow phase. This may reduce rear-end crashes associated with unsafe stopping and angle crashes due to illegally continuing into the intersection during the red phase.

Alternative Names

Detection-Control System (D-CS), Intelligent Detection-Control System.

Operation

- The Advanced Dilemma-Zone Detection system minimizes the number of vehicles the intersection traffic control signal system exposes to an intersection-approach dilemma zone. This is accomplished by adjusting the start time of the yellow-signal phase either earlier or later, based on observed vehicle locations and speeds.
- Advanced Dilemma-Zone Detection is intended to safely control the major-road approaches to an isolated signalized intersection without creating excessive delay to minor movements.
- Advanced Dilemma-Zone Detection uses comprehensive detection equipment to measure vehicle speeds and flows. Based on the number of vehicles expected to be in the dilemma zone in the immediate future and the number of minor-street vehicles waiting to travel through the intersection, the Advanced Dilemma-Zone Detection system attempts to identify when (1) the fewest passenger cars will be in the dilemma zone, and (2) no heavy vehicles will be in the dilemma zone.
- Advanced Dilemma-Zone Detection uses the speed, location, and length of vehicles to calculate the location of the dilemma zone relative to both vehicle speeds and the intersection approach (i.e., the dilemma zone is dynamic: it occurs farther from the intersection for a faster traveling vehicle than it does for a slower vehicle). Based on this calculation, the system then adjusts the start time of the yellow phase to coincide with the point when the fewest possible vehicles are in their respective projected dilemma zones.

Potential Benefits

The Advanced Dilemma-Zone Detection system has several benefits relative to traditional multiple detector systems, which have upstream detection for vehicles in the dilemma zone but do not take the speed or size of individual vehicles into account. These benefits include:

- Reducing the frequency of red-light violations;
- Reducing the frequency of crashes associated with the traffic signal phase change (for example, rear-end and angle crashes);
- Reducing delay and stop frequency on the major road; and
- Maintaining or reducing overall intersection delay.

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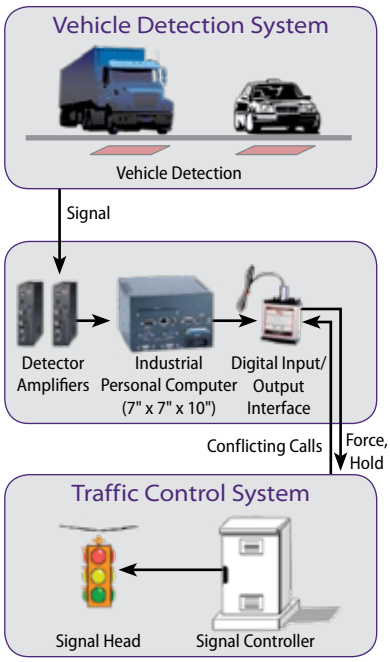

Figure 1: Advanced Dilemma-Zone Detection system components as applied in TxDOT Detection-Control System study referenced in this fact sheet

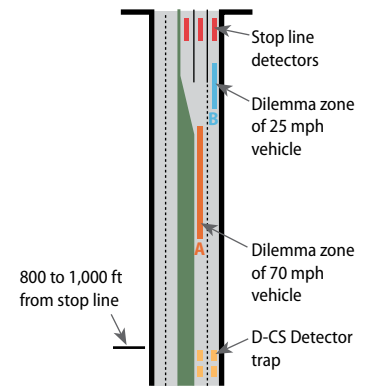

Figure 2: Advanced Dilemma-Zone Detection design as applied in TxDOT Detection-Control System study referenced in this fact sheet

Learn More

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Agency Experience

- An Advanced Dilemma-Zone Detection system was developed for the Texas Department of Transportation (TxDOT) to minimize both delay and crash frequency at rural intersections.
- This system was implemented as part of a study conducted by TxDOT at several intersections using commercially-available equipment in Texas. The evaluation of safety and operational benefits found that the system:
  - Reduced delay by 14 percent;
  - Reduced stop frequency by 9 percent;
  - Reduced red-light violations by 58 percent;
  - Reduced heavy-vehicle red-light violations by 80 percent; and
  - Reduced severe-crash frequency by 39 percent.

FHWA is conducting on-going effectiveness evaluations of the TxDOT study described above, and more complete results are expected in the spring of 2010.

Implementation Considerations

- At intersections with currently installed advance detector loops or cameras, it may be possible to use the existing detector loops and cameras as part of the Advanced Dilemma-Zone Detection implementation.
- Advanced Dilemma-Zone Detection may be most appropriate at high-speed, rural, and isolated intersections.
- Advanced Dilemma-Zone Detection systems are currently available as off-the-shelf products from some signal controller manufacturers.

Manual on Uniform Traffic Control Devices (MUTCD) Specifications

- There are no compliance issues with the MUTCD, as it does not prescribe detection locations for the green phase.

Costs

- Costs vary depending on the extent and type of existing detection infrastructure, but will generally be higher then costs associated with traditional detection systems (i.e., systems with upstream detection for vehicles in the dilemma zone but which do not take the speed or size of individual vehicles into account). Advance loop detectors or video technology, for example, can reduce the amount of necessary capital improvements.

As part of the TxDOT study, the Advanced Dilemma-Zone Detection system was implemented at eight different intersections in Texas. Similar systems may have been installed in other locations. *Zimmerman, K. and J. Bonneson. "In-Service Evaluation of a Detection-Control System for High-Speed Signalized Intersections," FHWA/TX-05/5-4022-01-1, Federal Highway Administration, 2005. Available at http://tti.tamu.edu/documents/5-4022-01-1.pdf.*