Authors: James Bonneson and Karl Zimmerman

PROJECT SUMMARY REPORT

Identifying and Treating Locations with a Red-Light-Running Problem

An examination of the Texas Department of Public Safety crash database revealed that about 37,700 red-light-related crashes occur each year in Texas. Of this number, 121 crashes are fatal. These crashes have a societal cost to Texans of about $2.0 billion annually.

A ranking of red-light-related fatalities on a "per capita" basis indicates that Texas has the fourth highest rate in the nation. Moreover, the cities of Dallas, Corpus Christi, Austin, Houston, and El Paso were specifically noted to have an above-average number of red-light-related crashes (on a "per capita" basis) relative to other U.S. cities with populations over 200,000.

The problem of red-light-running is widespread and growing; its cost to society is significant. A wide range of potential countermeasures to the red-light-running problem exists. These countermeasures are generally divided into two broad categories: engineering countermeasures and enforcement countermeasures. Research has shown that countermeasures in both categories are effective in reducing the frequency of red-light violations.

What We Did...

The objectives of this research project were to: (1) quantify the safety impact of red-light running at intersections in Texas and (2) provide guidelines for identifying truly "problem" intersections and whether enforcement or engineering countermeasures are appropriate. There were six major activities associated with this project:

• Develop a model for predicting the frequency of red-light-related crashes on an intersection approach.

• Develop a model for predicting the frequency of red-light violations on an intersection approach.

• Quantify the effectiveness of an area-wide officer enforcement program that targets intersection traffic control violations.

• Develop a procedure for identifying locations that have the potential for safety improvement (i.e., "problem" locations) through treatment for excessive red-light-related crashes.

• Develop guidelines for identifying viable countermeasures to red-light-related problems.

• Incorporate the findings, procedures, and guidelines in a handbook to assist engineers in treating problem locations.

The model development activities were based on the assembly of crash and violation databases representing numerous intersections in Texas. Statistical techniques appropriate for the analysis of crash data were used to calibrate the crash prediction models. A sensitivity analysis using these models revealed several useful insights about the effect of various factors on the frequency of red-light-related crashes, violations, or both.

What We Found...

The researchers identified numerous findings that can be used to understand or address red-light-related safety problems.

Intersection Red-Light-Related Crash Frequency

A regression model was developed relating crash frequency to various volume, geometric, and traffic control factors. The findings from this development indicate that a decrease in severe red-light-related crashes is associated with the following:

- a decrease in approach leg average annual daily traffic (AADT),
- an increase in yellow duration,
- a decrease in speed limit, and
- a wider intersection.

Figure 1 shows the relationship between yellow duration, approach leg AADT, and crash frequency.

Area-Wide Crash Frequency and Enforcement Effectiveness

A database was assembled for the purpose of evaluating the effectiveness of an officer enforcement program that targets intersection traffic control violations. In this program, the enforcement agency uses a heightened level of enforcement relative to that otherwise employed. The program is sustained for a period of time that can range from several months to one year. The objective of the program is to encourage drivers to be compliant with traffic control laws and more aware of traffic control devices; the overarching goal is to make the road safer, as evidenced by fewer crashes. This type of targeted enforcement is often coupled with a public awareness campaign that is intended to inform drivers and garner public support for the program.

Citywide crash data were assembled for eight Texas cities that participated in the Texas Department of Transportation's
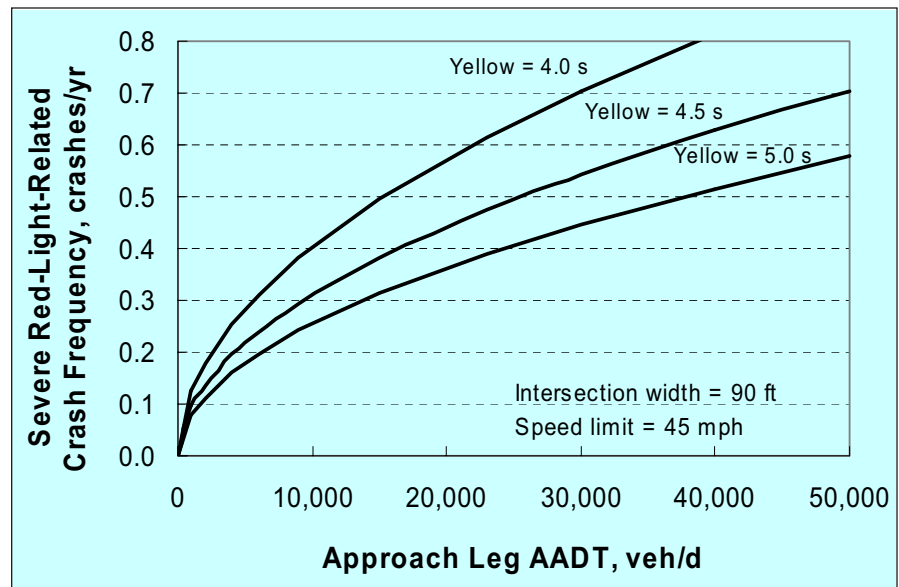

Figure 1. Relationship between Traffic Volume and Red-Light-Related Crashes.

(TxDOT) Intersection Traffic Control-Selective Traffic Enforcement Program (ITC-STEP). A before-after analysis method was used to evaluate the effectiveness of the ITC-STEP at reducing red-light-related crashes. The results of the analysis revealed that the program reduced red-light-related crashes by 6.4 percent during the time of its implementation.

Intersection Red-Light Violation Frequency

A database was assembled for the purpose of evaluating the various factors that are correlated with, or have an effect on, the frequency of red-light violations. In general, a decrease in red-light violation frequency is found to be associated with the following factors:

- a decrease in approach flow rate,
- an increase in yellow duration,
- a decrease in speed,
- a wider intersection,
- a decrease in heavy-vehicle percentage,

- a decrease in volume-to-capacity ratio, and
- the addition of signal head back plates.

An examination of the combined effect of a change in cycle length and volume-to-capacity ratio revealed that red-light violations were at their lowest level when the volume-to-capacity ratio was in the range of 0.6 to 0.7. This range of ratios was found to yield minimal violations, regardless of speed, path length, yellow duration, heavy-vehicle percentage, cycle length, phase duration, or traffic volume. Figure 2 shows the relationship between volume-to-capacity ratio and violation frequency.

Violation Causes and Countermeasures

A database was assembled to examine the characteristics of red-light-related crashes for the purpose of identifying the most appropriate set of countermeasures to use in treating problem locations. The characteristics considered include crash type and the duration

of time the signal indication was red prior to the crash. This latter characteristic is defined herein as "time-into-red."

Based on the findings from the analysis, enforcement efforts are likely to reduce violations occurring primarily in the first few seconds of red and, therefore, should significantly reduce left-turn-opposed crashes. In an indirect manner, these efforts should also reduce some right-angle crashes by encouraging driver compliance with the signal. In contrast, engineering countermeasures are most likely to reduce violations throughout the red and, therefore, reduce both right-angle and left-turn-opposed crashes in somewhat equal proportion.

Increasing the all-red interval is likely to reduce the portion of right-angle crashes that occurs in the first few seconds of red. However, right-angle crashes are relatively infrequent in the first few seconds of red, so increasing the all-red interval may not significantly reduce the total number of right-angle crashes.

Identification of Benefits from Treatment

A procedure was developed for identifying intersections with the potential for red-light-related safety improvement (i.e., "problem" intersections). The application of this procedure identifies intersections that are likely to need some type of safety improvement and for which the treatment is likely to be cost-effective. To this end, the procedure can be used to identify and rank intersections with an above-average frequency of red-light-related crashes or violations.

The Researchers Recommend...

A *Red-Light-Running Handbook* was developed from the research findings. The *Handbook* outlines a process for identifying and treating locations with potential for safety improvement. The objective of the process is to reduce red-light-related crashes. It includes the following steps:

1. Conduct an engineering study to confirm the nature and extent of the problem.

2. Identify and implement viable engineering countermeasures.

3. Evaluate the effectiveness of the implemented countermeasures.

4. If red-light-related problems still exist, consider implementation and evaluation of additional (or other) engineering countermeasures until all viable countermeasures have been tried.

5. If red-light-related problems still exist, consider the implementation of an officer enforcement program that targets intersection traffic control violations and includes a public awareness campaign.

6. If officer enforcement is determined to be unsuccessful or ineffective, then camera enforcement can be considered. If camera enforcement is implemented, it should be accompanied by a public awareness campaign. Also, rear-end crashes should be monitored and remedial action taken if a sustained increase in rear-end crashes is observed.

The *Handbook* provides technical guidance and tools for engineers to use in implementing the process. It also provides quantitative information on the effectiveness of the more promising countermeasures. The analytic procedures in the *Handbook* are implemented in an Excel® spreadsheet. The spreadsheet is available from the report authors.
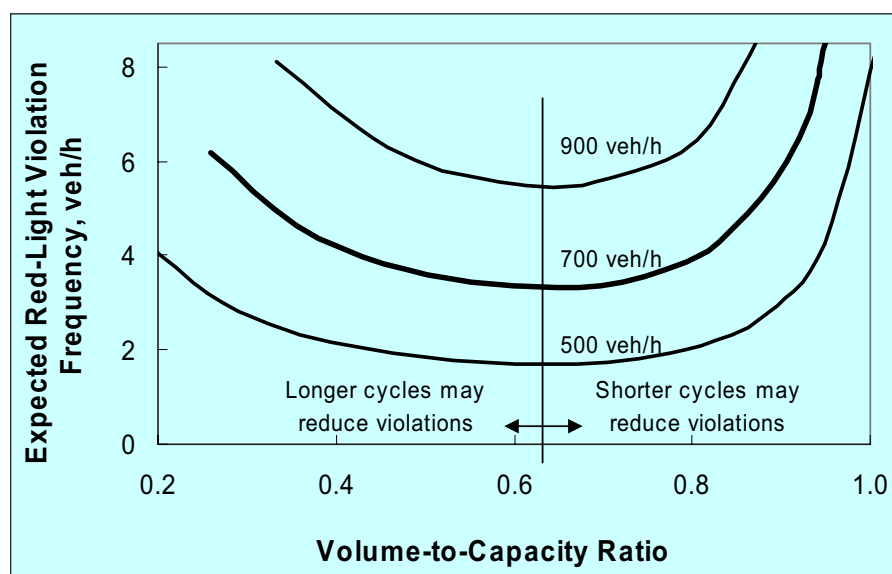

Figure 2. Relationship between Volume-to-Capacity Ratio and Red-Light Violations.

For More Details...

The research is documented in:
- Report 0-4196-1, *Review and Evaluation of Enforcement Issues and Safety Statistics Related to Red-Light-Running*
- Report 0-4196-2, *Development of Guidelines for Identifying and Treating Locations with a Red-Light-Running Problem*
- Report 0-4196-P1, *Red-Light-Running Handbook: An Engineer's Guide to Reducing Red-Light-Related Crashes*

Research Supervisor: James Bonneson, Ph.D., P.E., TTI, j-bonneson@tamu.edu, (979) 845-9906

Key Researchers: Karl Zimmerman, P.E., TTI; Cesar Quiroga, P.E., TTI

TxDOT Project Director: Wade Odell, P.E., wodell@dot.state.tx.us, (512) 465-7403

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The objective of this research project was to quantify the safety impact of red-light running at signalized intersections in Texas and develop guidelines for identifying problem intersections along with their treatments. An important element in identifying intersection treatments was determining whether traffic engineering or law enforcement countermeasures were appropriate. One product was required for this project: a red-light-running handbook. *The Red-Light-Running Handbook: An Engineer's Guide to Reducing Red-Light-Related Crashes* incorporates guidelines for identifying and treating locations where red-light violations present a safety problem. This handbook is being implemented through a series of ten workshops conducted statewide over a two-year period. The focus of this handbook is the use of engineering countermeasures to mitigate problems related to red-light violations, red-light-related crashes, or both. If engineering countermeasures are not effective, law enforcement countermeasures are addressed.

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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