



Project Summary Report 4027-S

Research Project Title: Signalization Countermeasures
to Reduce Red-Light-Running

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Guidelines to Reduce Red-Light-Running

Statistics show that red-light-running is a significant safety problem throughout the United States and Texas. About 20 percent of all intersection crashes can be attributed directly to red-light-running. These crashes are often quite severe because the colliding vehicles hit at right angles to one another. A recent examination of nationwide fatal crash statistics found that Texas ranks fourth highest among the fifty states in terms of the number of red-light-running-related deaths per capita.

Red-light-running countermeasures fall into two broad categories: enforcement countermeasures and engineering countermeasures. Enforcement countermeasures require the use of a police officer or an automated image recorder to identify red-light violators. Engineering countermeasures typically include changes in signal visibility or timing. Using enforcement countermeasures, drivers are encouraged to adhere to the traffic laws through the threat of citation and possible fine. In contrast, engineering

countermeasures improve driver awareness of the signal light or reduce the number of instances in which drivers are put in a position of having to decide whether or not to run the red light.

Studies have shown that countermeasures in both categories are effective in reducing the frequency of red-light-running. However, engineering countermeasures hold greater promise because of the significant resource requirements of officer enforcement and the current legal and political challenges of automated enforcement. Furthermore, engineering countermeasures are within

the direct control of the agency responsible for the signal.

This research project developed guidelines that describe how engineering countermeasures can minimize the frequency of red-light-running and associated crashes at intersections.

What We Did...

A two-year program of development and evaluation produced information engineers can use to reduce red-light-running. During the first year, researchers identified the causes of red-light-running and a range of engineering countermeasures. In addition, they developed a before-after study plan

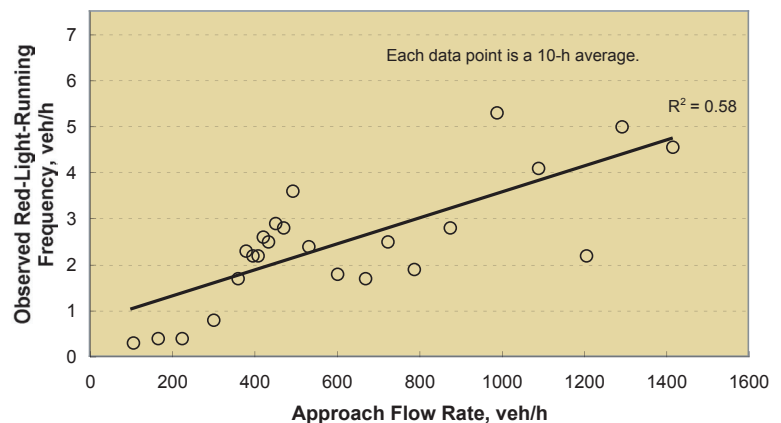


Figure 1. Red-Light-Running Frequency as a Function of Approach Flow Rate.



to evaluate the effectiveness of alternative countermeasures at 10 signalized intersections in Texas. In the second year, several countermeasures were implemented and evaluated through the direct measurement of red-light-running frequency. The research team then compared the observed frequency of red-light-running at each site to its crash history.

One product of this research is a guideline document. The document provides technical guidance for engineers interested in using engineering countermeasures to reduce red-light-running at problem intersections. It also provides tools for evaluating the effectiveness of selected engineering countermeasures.

What We Found ...

The database assembled for this project reflects six hours of data collection at each of 10 intersections. More than 10,018 signal cycles were observed. During these cycles, 586 vehicles entered the intersection after the light changed from yellow to red.

Of the 586 vehicles observed to run the red light, 84 were trucks and 502 were passenger cars. Overall, 0.86 percent of truck drivers violated the red light, and 0.38 percent of passenger car drivers violated the red light. This finding indicates that truck drivers are twice as likely to run a red light as passenger car drivers.

The typical intersection approach experiences from 3.0 to 5.0 red-light-runners per 1000 vehicles and from 5.0 to 10.0 red-light-runners per 100 cycles. Intersections with red-light-running rates in excess of these typical values should be considered for treatment with one or more countermeasures.

There is speculation among engineers that lengthy yellow intervals may be abused by some drivers. Specifically, it is believed that drivers adapt to an increase in the yellow duration and continue to run the red light with the same frequency as before the increase. Analysis indicates that drivers do adapt to an increase in yellow duration; however, the frequency of red-light-running is still reduced. Specifically, a nominal increase of 0.5 to 1.5 seconds of yellow, such that the yellow duration does not exceed 5.5 seconds, was found to decrease the frequency of red-light-running by 50 percent at several intersections. This finding is evidence of the benefit of a properly timed yellow interval, where the interval duration is based on engineering analysis and consideration of traffic conditions, control device visibility, and intersection sight distance.

The researchers examined the relationship between a range of factors and red-light-running frequency. The factors examined include:

- approach flow rate,
- cycle length,
- yellow interval duration,
- heavy-vehicle percentage,
- running speed,
- clearance path length,
- platoon ratio,
- approach grade,
- number of approach lanes,
- light emitting diode (LED) signals,
- use of signal head back plates,
- use of advance detection, and
- signal head mounting.

In general, a decrease in red-light-running is found to be associated with the following:

- a decrease in approach flow rate,
- an increase in yellow duration,
- a decrease in speed,

- an increase in clearance path length (i.e., a wider intersection),
- a decrease in platoon density, and
- the addition of signal head back plates.

The effect of approach flow rate is shown in [Figure 1](#). The coefficient of determination R^2 of 0.58 indicates that flow rate explains about 58 percent of the variability in red-light-running. Most of the remaining systematic variability is explained by the other factors previously noted.

[Table 1](#) summarizes the findings from this research regarding the effectiveness of several engineering countermeasures. The information presented reflects the findings from the before-after studies, the calibration of a red-light-running regression model, and a review of the literature. The effectiveness of each countermeasure is based on the study of red-light-running at 10 intersections in Texas.

Guidelines from this project help the engineer select and evaluate engineering countermeasures to reduce red-light-running. The guidelines are presented in a series of steps that should be followed when an intersection approach is believed to have a red-light-running problem. The steps include:

- gather information through an observational study and site survey,
- confirm the extent of the problem through the computation of the expected frequency of red-light-running for the subject location,
- compute a “ranking index” that indicates whether the site is truly a problem location,
- identify possible red-light-running causes,
- select candidate countermeasures, and



- evaluate countermeasures and select those that will yield a prescribed target level of red-light-running.

If the red-light-running problem still exists after the trial of one or more countermeasures, then the engineer may need to consider some type of enforcement activity. If the problem is deemed to be area-wide, then enforcement coupled with a public awareness campaign may be appropriate.

The Researchers Recommend...

There are a variety of countermeasures available to engineers to treat intersections with excessive red-light-running or red-light-running-related crashes. As is the case with most engineering improvements, proper treatment of the red-light-running problem requires careful diagnosis to ensure that a problem truly exists. This diagnosis requires a site survey to collect data that quantify the frequency of red-light-running and associated crashes. The survey should also identify

conditions that may contribute to the occurrence of red-light-running.

Thereafter, if the frequency is determined to be excessive, one or more engineering countermeasures should be evaluated for applicability and effectiveness. The most promising countermeasures should then be implemented and a follow-up evaluation conducted to determine whether red-light-running and related crashes have been reduced. The guidelines provided in the appendix of Report 4027-2 describe this process, and they can be used to reduce red-light-running at most intersections.

Table 1. Engineering Countermeasures to Red-Light-Running.

Countermeasure Category	Specific Countermeasure	Countermeasure Effectiveness ¹
Signal Operation	Increase the yellow interval duration	-50 to -70 %
	Provide green-extension (advance detection)	-45 to -65 %
	Improve signal coordination	Varies ²
	Improve signal operation (increase cycle length 20 s)	-15 to -25 % ³
Motorist Information	Improve sight distance	--
	Improve visibility of signal (12-inch lens, add heads)	--
	Improve visibility of signal with yellow LEDs	-13 %
	Increase conspicuity of signal with back plates	-25 %
	Add advance warning signs without flashers	--
Physical Improvement	Add advance warning signs with active flashers	-29 to -67 %
	Remove unneeded signals	--
	Add capacity with additional traffic lanes	--
	Flatten sharp curves	--

Note:

1 -Negative values indicate a reduction in the frequency of red-light-running. "--": not addressed in this research.

2 -Red-light-running frequency is likely to increase with improved coordination; however, this increase may be offset by the larger cycle length typically required for good progression.

3 -Reductions associated with an increase in cycle length may not be realized if motorist delay increases significantly.



For More Details . . .

The research is documented in Report 4027-2, *Engineering Countermeasures to Reduce Red-Light-Running*.

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This research project described how engineering countermeasures can be used to minimize the frequency of red-light-running and associated crashes at intersections. One product was required for this project: a guideline document to describe cost-effective procedures for minimizing red-light-running. The guideline document was submitted as an inclusion in research Report 4027-2. This functional document is currently being used in a follow-on research project, 0-4196, which examines the effectiveness of engineering countermeasures versus law enforcement to minimize red-light-running. If the developed guidelines are an effective tool for minimizing red-light-running and crashes at intersections, it is recommended that this information be made available to agencies outside of TxDOT for their use.

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