Evaluation of Strobe Lights in Red Lens of Traffic Signals

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Strobe lights are used as a supplement to the red lens to draw the attention of the driver to a traffic signal. Strobe lights have been used in situations in which (a) the signal is unexpected, (b) the signal may be difficult to see, and (c) there is an accident problem or potential accident problem. The Barlo strobe light, a horizontal bar positioned across the middle of the red lens with about 60 flashes of white light per minute, was used at all of the sites. A study was undertaken to evaluate the effectiveness of the strobe light in the red lens of traffic signals and, if appropriate, to recommend guidelines for the use of strobe lights. Only applications of the Barlo strobe light were studied. The use of strobe lights by the Virginia Department of Transportation was examined and accident analyses were performed. On the basis of the trend analysis, there was no consistent evidence that strobe lights are effective in reducing accidents. The limitations of the analyses were identified in the study. There is no basis for recommending the use of strobe lights unless there are other bona fide measures of effectiveness that can be used to justify their installation.

Strobe lights have been used as a supplement to the red lens to draw the attention of drivers to a traffic signal. Strobe lights have been used in situations in which (a) the signal is unexpected, (b) the signal may be difficult to see, and (c) there is an accident problem or potential accident problem. Specific applications of the strobe light include

1. Isolated, high-speed, rural intersections,
2. First signalized intersection into an urbanized area following travel on an extended road section without a signal,
3. First signalized intersection following a transition from a grade-separated or limited-access highway to an at-grade highway with intersections, and
4. Where the background lighting and signs (visual noise) are a problem.

There have been limited applications of strobe lights in the red indication in the United States. Consequently, few studies have been conducted that evaluate the effectiveness of strobe lights. The limited study results that are available are inconsistent and inconclusive (*1*). In many cases, especially in North Carolina, strobe lights are included among multiple safety improvements at intersections, making it impossible to determine the effectiveness of the strobe lights. A similar situation exists at new signal installations with strobe lights.

In June 1987, there were three intersections with strobe lights in two Virginia Department of Transportation (VDOT) districts. In April 1994, there were 22 intersections with strobe lights in six VDOT districts. Apparently, the interest in and popularity of strobe lights have increased in Virginia. The Barlo strobe light, a horizontal bar positioned across the middle of the red lens with about 60 flashes of white light per minute, was used at all of the sites.

According to FHWA (*2*), there is insufficient evidence to support the inclusion of strobe lights in the *Manual on Uniform Traffic Control Devices (MUTCD)* (VDOT, unpublished data, 1985). Other concerns about the strobe light include whether (a) it distracts the drivers from other traffic control devices and other vehicles, and (b) its attention-getting value diminishes with time. There is a need for an evaluation of the use of strobe lights in the red lens of traffic signals.

OBJECTIVES AND SCOPE

The objectives of this study were to evaluate the effectiveness of the strobe light in the red lens of the traffic signals and, if appropriate, to recommend guidelines for the application of strobe lights. Only applications of the Barlo strobe light were studied.

METHODS

Two activities were conducted to accomplish the study objectives:

1. Data collection. A questionnaire survey was sent to the nine VDOT district traffic engineers to compile information on strobe light use, including an inventory of strobe light installations, maintenance experiences, and reasons for installing the strobe. Accident data were collected for selected sites.
2. Data analysis and evaluation. The collected data were summarized and analyzed to assess the use and performance of strobe lights. The evaluation plan for the strobe lights focused on a trend analysis of accidents.

RESULTS AND DISCUSSION

VDOT District Traffic Engineers Survey Results

There are 22 intersections with strobe lights in the seven districts that responded to the survey. Most of the strobe lights (19 of 22, or 86 percent) are in the western part of the state. At 17 intersections (77 percent), the Barlo strobe light is in the red signal indicator over the left through lane. This position was selected on the basis of the notion that the strobe light would be detected at a greater distance in the left through lane signal because horizontal curves and possi-

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bly foliage on the right shoulder might block the view of the right through lane. At four intersections in one western district, strobe lights are in the red signal indicator over both through lanes. It is suspected that two strobe lights were used to enhance the visibility of these devices. In an eastern district, the strobe light is in a separate red signal head next to the traffic signal over the right lane. Staff from this district had observed this arrangement in North Carolina and the city of Virginia Beach. At 18 intersections, strobe lights were installed on both directions of the major roadway; at four intersections these devices were needed in only one direction. Strobe lights were installed on all approaches at only one intersection.

At nine intersections, the strobe lights were installed with a new traffic signal; at seven intersections, strobe lights were installed less than 12 months after a signal installation. Of the remaining six intersections, five of them had a traffic signal in place at least 3 years before the strobe light was installed.

Reasons for installing the strobe lights included one or more of the following: (a) high truck volumes and high speed, (b) accident experience, (c) road geometrics, especially grades (downgrade), horizontal curves, and other features resulting in limited sight distance, and (d) an isolated intersection where a signal is unexpected.

Maintenance of the strobe lights has not been a problem in general. At least three districts initially had problems. In one district, the problem of a strobe light exploding because it failed to release stored energy was solved by using a strobe from a different manufacturer. In another district, the number of failures with the control circuits decreased after several discussions with the supplier and manufacturer. A third district had problems with a transformer exploding when the side street strobe lights were flashing; these strobes were removed to solve the problem. One district noted that any malfunction is usually caused by the power pack, which is relatively expensive (about $110). It costs about $765 for a red signal head with a Barlo strobe light. The annual preventive maintenance routine typically includes cleaning the explosion guards, lenses, and reflector, replacing the incandescent lamp, and inspecting the seals for leaks that could result in water damage. Extreme care must be taken because of the high voltage of the strobe apparatus.

When asked when strobe lights should be used, the responses were (a) isolated intersections, (b) limited sight distance, (c) high speed, and (d) one or more of the following: poor alignment, curves, or grades. One potential concern was that many requests would be made for strobe lights. However, the district offices have received few requests for strobe lights. There were 0 to 3 requests for strobe lights during a 3-year period.

Some potential uses of strobe lights suggested by district personnel include (a) use with a hazardous indication beacon for a warning sign, (b) school flashing lights, and (c) emergency vehicles. In a western district, a strobe light in an amber lens has been installed above a sign warning of "trucks crossing highway 800 ft" (245 m) near a truck stop on an arterial (the flashing lights are actuated); there is limited sight distance [less than 180 m (600 ft)] southbound because of an upgrade.

Accident Analysis and Evaluation

A review of accident trends of the six sites with 3 years of accident data before and after the strobe light installation was performed. Rear-end, angle, and total accidents that involved at least one vehicle on the strobe light approaches were examined.

Traffic and geometric data on the sites are listed in Table 1. All of the six sites had a four-lane divided highway as a main approach with strobe lights. Sites 1, 4, and 5 intersect with a two-lane road. Sites 2 and 6 intersect with a four-lane divided road on one side and two lanes on the other side; Site 3 intersects with a four-lane divided road. Site 4 is the only T-intersection.

Before-and-after accident data are presented in Table 2 for six sites. The percentage changes in accidents are discussed next. For rear-end accidents, there was no change at four sites, and an increase of 100 percent or more at two sites. Three sites had a decrease between 38 and 75 percent in angle accidents, whereas there was an increase of 25 and 400 percent at two sites, and no change at one site. For total accidents, one site had no change, one had a 5 percent increase, two sites had an increase of at least 80 percent, and two had a decrease of at least 25 percent. The accident experience at Site 5 is identical for both periods, and the number of accidents is the lowest of all the sites. The finding that two sites had an increase in accidents, two sites had a decrease, and two sites had little or no change suggests no conclusion or no consistent impact as a result of using the strobe lights. Additional review produced some explanations for the findings, however.

TABLE 1 Study-Site Traffic and Geometric Data

Site	No. Strobe Lights Per Approach	+ or T	Major Route		Minor Route	
			Speed Limit kph (mph)	Estimated ADT	Speed Limit kph (mph)	Estimated ADT
1	1	+	66 45	11,000	66 45	6,300
2	1	+	80 55	21,000	80 55	11,000
3	2	+	59 40	9,000	59 40	4,400
4	2	T	66 45	14,200	66 45	1,100
5	2	+	80 55	9,400	66 45	2,500
6	1	+	66 45	11,000	66 45	2,400

Note-- Sites 1, 2, and 6 are each in a different district. Sites 3-5 are in the same district.

TABLE 2 Summary of Accident Data

	REAR END ACCIDENTS				ANGLE ACCIDENTS				TOTAL			
			DIFFERENCE				DIFFERENCE				DIFFERENCE	
SITE	BEFORE	AFTER	NO.	%	BEFORE	AFTER	NO.	%	BEFORE	AFTER	NO.	%
1	4	4	0	0	13	8	-5	-38	19	20	1	5
2	2	7	5	250	1	5	4	400	3	15	12	400
3	4	4	0	0	8	3	-5	-63	13	7	-6	-46
4	6	6	0	0	4	1	-3	-75	12	9	-3	-25
5	0	0	0	0	1	1	0	0	2	2	0	0
6	3	6	3	100	12	15	3	25	15	28	13	87

Sites 1, 2, and 6 have one strobe light per approach, whereas Sites 3 through 5 have two per approach. Both sites that had an increase in rear-end and angle accidents had one strobe light per approach. For total accidents, two sites with one strobe light had an increase of more than 80 percent whereas two sites with two lights per approach had a decrease of at least 25 percent.

Although the sample size is too small to conclude definitively, the use of two strobe lights per intersection appears to be more effective than one strobe light per approach. It seems logical that if two strobe lights reduced accidents, then one strobe would also reduce accidents, possibly to a lesser degree. Because accidents tended to increase at sites with one strobe light, it appears that factors other than number of strobe lights may be influencing the accident experience. The study sites were further examined to determine what factors other than the strobe lights may have contributed to the accident experience.

Sites 1, 3, and 5 are in rural areas with no distinguishing features. Site 2 is in an industrial area with a high volume of trucks. The side street that is a primary arterial is being widened from two to four lanes. Subsequently, the intersection is being rebuilt to include dual left-turn lanes from mainline in one direction and a sweeping right turn lane in the opposing direction. The additional capacity should help to reduce some of the accidents. Site 4 was once the first signal inbound near a town. Around the time the strobe light was installed, a new signal was installed about 670 m (2,200 ft) in advance of Site 4; therefore, it is no longer the first signal. Also, a right turn lane was added to the mainline. It is likely that these changes influenced the lower accident frequency at Site 4. Site 6 has one leg of the side street for access to a shopping mall with heavy traffic, and the opposing side street approach has light traffic. In May 1994, two traffic signal changes were made to improve operations and safety at the intersection: the exclusive/permissive left-turn signal phasing on the mainline was replaced with an exclusive left-turn phase, and split phases replaced a shared phase for the two side street approaches. Such factors that led to the improvements likely contributed to the accident experience. Also, it is unclear whether there is a benefit for installing two strobes per approach compared with one per approach.

Limitations of the Analysis

Strobe lights flash only when the red signals in which they are housed are on. Ideally, there should have been some means to ensure that the accidents under review involved a vehicle traveling on an approach when the strobe light was flashing. Unfortunately, there was no reliable item on the accident report form to provide this information. The item, "driver action," which includes "disregard for the stop-go signal/ran the red light," is potentially useful. However, the majority of accidents under review had "driver inattention," a catchall description with little value, as the driver action. Although a copy of the actual accident reports completed by the police may have been helpful in determining driver action, the reports for most of the accidents were more than 5 years old and not readily available. An alternative measure of effectiveness, field observations of red signal violators and driver reaction as they approach the red signal, was not pursued because of resource and time constraints.

The strobe lights were installed at locations with potential safety problems. These sites may have a propensity for higher-than-normal accidents. The strobe light sites were not selected randomly but because of their accident history or potential for accidents. Statistical analysis of the accidents was not reported because a much larger sample size would be needed to obtain useful results.

Other Issues

A western district requested some guidelines on when to remove strobe lights. There was some concern about liability in the event of an accident after removal. In the author's opinion, the lack of evidence that strobe lights are effective in reducing accidents on the basis of the accident analysis can be used as justification for the removal of strobe lights.

On the basis of comments from some Department of Traffic Engineering (DTE) staff, in some areas, motorists and VDOT personnel perceive strobe lights as effective in improving safety at an intersection. For example, DTE staff from one district commented that the strobe lights were especially useful at dawn and dusk and at other times of reduced visibility. Clearly, the effectiveness of the strobe lights has not been demonstrated in this study. If other bona fide measures of effectiveness can be identified, then they should be considered.

At the October 1993 meeting of the Traffic Research Advisory Committee of the Virginia Transportation Research Council, the number one research priority was noncompliance with traffic control devices. Driver noncompliance, such as running red traffic signals, is increasingly common. Willful, defiant behavior is not likely to be affected by the presence of a strobe light. This type of behavior may be a contributing factor to the lack of effectiveness of the strobe light.

Alternatives to a Strobe Light

Three of the four applications for the use of strobe lights listed in the introduction involve conditions under which a traffic signal may not be expected, i.e., isolated rural intersections or the first signal after an extended road section without traffic signals. An alternative method in the MUTCD to alert motorists to a traffic signal ahead is to use the signal-ahead warning sign (W3-3). Hazard identification beacons (flashing yellow lights) should supplement the sign to increase its attention-getting value. An alternative to the fourth application of strobe lights, conditions where visual noise is a problem, is the use of a back-plate to increase the signal target value.

One of the four reasons for installing a strobe light given in the VDOT DTE survey was road geometrics that limit sight distance. The use of "prepare to stop when flashing" warning signs is an alternative. One district is testing this alternative. No additional alternatives other than the signal ahead and "prepare to stop when flashing" warning signs come to mind for the two reasons noted in the DTE survey results but not previously addressed: high truck volume and high speeds, and accident experience.

CONCLUSIONS

VDOT DTE Survey

1. VDOT has 22 intersections with strobe lights; this is up from 3 intersections in 1987. Nineteen (86 percent) of these are in the western part of the state and have the Barlo strobe in the red signal over the left through lane.

2. Strobe lights are used primarily for (a) high truck volumes and high speed, (b) accident experience, (c) road geometrics, especially grades (downgrade), horizontal curves, and other features that result in limited sight distance, and (d) isolated intersections where a signal is unexpected.

3. There have been few requests for strobe lights recently. The cost of a red signal head with a Barlo strobe light is about $765.

Accident Analysis

1. On the basis of the trend analysis of the six study sites, there was no evidence that strobe lights are consistently effective in reducing accidents. It is unclear whether two strobe lights per approach are more effective than one strobe light per approach. The limitations of the analysis were identified in the study.

2. There is no basis for recommending use of strobe lights unless there are other bona fide measures of effectiveness that justify their installation. The findings can be used as justification for removal of the strobe lights.

ACKNOWLEDGMENTS

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REFERENCES

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