

# Removal of Signal Flashing Mode During Late-Night/Early-Morning Operation

This case study is one in a series documenting successful intersection safety treatments and the crash reductions that were experienced. Traffic engineers and other transportation professionals can use the information contained in this case study to answer the following questions:

- What is an inexpensive treatment option to reduce crashes, particularly right-angle crashes (many with injuries), during late-night/early-morning hours?
- How many crashes did the treatment reduce?
- Are there any implementation issues associated with this treatment, and if so, how can they be overcome?



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## Introduction

Operating traffic control signals in the flashing mode can be an efficient form of signal operation when traffic volumes are low by reducing delay, fuel consumption, vehicle emissions, and the use of electricity. As such, programming traffic signals to operate in a flashing mode is typically limited to late-night/early-morning hours<sup>1</sup>. Use of a flashing yellow signal indication on the major street approaches and a flashing red signal indication on the minor street approaches is the standard practice for most intersections with adequate sight distance. Results of field studies, however, have indicated that crash rates may increase around traffic signals using flashing operations during late-night/early-morning conditions<sup>2</sup>[7].

## Objective

The following case study showcases a successful and effective low-cost strategy that measurably improved safety at eight signalized intersections in Winston-Salem, NC. The treatment consisted of removing the flashing operation from traffic signals during late-night/early-morning hours.

**“...use of flashing signal operation requires careful application and additional monitoring. We have found that it is better to have positive control rather than leaving the driver to decide when it is safe to proceed into the intersection.”**

*Stan Polanis*

*Director of Transportation,  
City of Winston-Salem, NC*

## Treatment Summary

All the intersection examples used in this report are from Winston-Salem, NC. Existing intersection treatments met minimum MUTCD requirements. The city changed the traffic signal operations at the intersections from flashing mode to steady (stop-and-go) mode during late-night/early-morning hours.

## Evaluation Methodology

This case study examines eight intersections in Winston-Salem, NC, with high incidences of right-angle crashes (many with injuries) during late-night/early-morning hours. Crash reductions were based on a review of “before and after” data from these intersections during a minimum of approximately six years, between 1997–2007<sup>3</sup>. (The “before” and “after” observation periods ranged between 35-51 months, depending on the intersection). Right-angle crashes occurring at the intersections both before and after the changes during late-night/early-morning hours were targeted. In addition, total crashes and injury crashes were also examined and compared.

<sup>1</sup> 2009 MUTCD, Section 4D.28 to Section 4D.31

<sup>2</sup> Source: S.F. Polanis, “Right-Angle Crashes and Late-Night/Early-Morning Flashing Operation: 19 Case Studies,” ITE Journal, April 2002. Note that one possible exception to this is very low-volume conditions such as those where the major street volume is less than 200 vehicles per hour or the ratio of the two-way volume for the major versus minor streets is greater than 3 to 1.

<sup>3</sup> Note that crash reductions in this report reflect the percent reduction per year based on the difference between the total number of “before” and “after” crashes.”

## Results

**Problem:** Eight urban intersections with traffic signals operated in the flashing mode for late-night/early-morning operations were experiencing high crash rates, particularly right-angle crashes (many with injuries). Previous studies suggested a higher risk of this type of crash associated with traffic signals operating in flashing mode during the late-night/early-morning hours.

**Solution:** The city sought to reduce right-angle crashes by removing the flashing operation from traffic signals and returning to normal (steady) signal operations during late-night/early morning hours.

Table 1 summarizes the “before and after” crash analysis at the treated intersections. Following the table is a brief discussion of the results at each intersection. (Note that targeted right-angle crashes shown in the table occurred during the late-night/early-morning hours. Total and injury crashes shown may have occurred at any time of day or night).

Locations	Implementation Date	Before				After				Percent Reduction In Crashes/Year		
		Months	Total Crashes	Injury Crashes	Right-Angle Crashes	Months	Total Crashes	Injury Crashes	Right-Angle Crashes	Total Crashes	Injury Crashes	Right-Angle Crashes
Indiana Ave. and Patterson Ave.	May-01	45	31	11	4	45	22	4	1	29%	63.6%	75%
Sprague St. and Vargrave St.	Oct-01	46	32	10	4	46	26	5	1	18.8%	50%	75%
Hawthorne Rd. and Miller St.	Oct-01	35	31	11	3	35	15	0	0	51.6%	100%	100%
Martin Luther King Dr. and Waughtown St.	Mar-02	40	57	11	8	40	38	7	0	33.3%	36.4%	100%
Country Club Rd. and Westview Dr.	Apr-02	51	16	7	4	51	16	4	1	0	42.9%	75%
Marshall St. and Salem Ave.	Apr-02	39	8	4	3	37	6	1	0	20.9%	73.6%	100%
Sixth St. and Trade St.	Jul-02	37	7	4	3	37	4	0	0	42.9%	100%	100%
Third St. and Metropolitan Dr.	May-04	36	16	10	7	36	9	6	1	43.8%	40%	85.7%
<b>TOTAL</b>		<b>329</b>	<b>198</b>	<b>68</b>	<b>36</b>	<b>327</b>	<b>136</b>	<b>27</b>	<b>4</b>	<b>30.9%</b>	<b>60.1%</b>	<b>88.8%</b>

Table 1: Summary of crash reductions after removal of signal flashing mode during late-night/early-morning operation

- Indiana Avenue and Patterson Avenue**

Indiana Avenue has three eastbound lanes and two westbound lanes. Patterson Avenue is a two-lane street carrying north-south traffic. The speed limit on both roads is 35 mph. The intersection served a total entering annual daily traffic (ADT) of approximately 6,700 during the “before” period, and 8,400 in the “after” period. The flashing operation during late-night/early-morning hours was removed from the traffic signals on May 31, 2001. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 29 percent, reduced injury crashes by 63.6 percent per year and reduced the targeted right-angle crashes by 75 percent per year.**
- Sprague Street and Vargrave Street**

Both of these streets have an approach speed of 35 mph with one lane in each direction. The intersection served a total entering ADT of approximately 11,000 during the “before” period, and 12,000 in the “after” period. The flashing operation during late-night/early-morning hours was removed from the traffic signals on October 29, 2001. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 18.8 percent, reduced injury crashes by 50 percent per year and reduced the targeted right-angle crashes by 75 percent per year.**
- Hawthorne Road and Miller Street**

Miller Street runs north-south and carries one lane of traffic in each direction, while Hawthorne Road carries east-west and carries two lanes of traffic in each direction. The speed limit on both streets is 35 mph. The intersection served a total entering ADT of approximately 12,000 during the “before” period, and 12,000 in the “after” period. Late-night/early-morning flashing operations were removed from the traffic signals on October 30, 2001. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 51.6 percent. Injury crashes and the targeted right-angle crashes were eliminated (from eleven and three, respectively, in the “before” period).**
- Martin Luther King Jr. Drive and Waughtown Street**

Martin Luther King Jr. Drive and Waughtown Street both have two lanes in each direction with a posted speed limit of 35 mph. The intersection served a total entering ADT of approximately 10,000 during the “before” period, and 9,200 in the “after” period. Flashing operations were removed from the traffic signals on March 14, 2002. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 33.3 percent and reduced injury crashes by 36.4 percent per year. The targeted right-angle crashes were eliminated (from eight in the “before” period).**
- Country Club Road and Westview Drive**

Country Club Road has a speed limit of 35 mph with two lanes in each direction. Westview Drive has one lane in each direction, with a speed limit of 30 mph on the northbound approach and speed limit of 35 mph on the southbound approach. The intersection served a total entering ADT of approximately 13,000 during the “before” period, and 12,000 in the “after” period. Late-night/early-morning flashing operations were removed from the traffic signals on April 10, 2002. **After the return to steady operations during late-night/early-morning hours, injury crashes decreased by 42.9 percent per year and the targeted right-angle crashes decreased by 75 percent per year (total crashes remained the same).**
- Marshall Street and Salem Avenue**

Both streets have one lane in each direction and a posted speed limit of 35 mph. The intersection served a total entering ADT of approximately 3,700 during the “before” period, and 2,700 in the “after” period. Late-night/early-morning flashing operations were removed on April 10, 2002. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 20.9 percent, reduced injury crashes by 73.6 percent per year. The targeted right-angle crashes were eliminated (from three in the “before” period).**
- Sixth Street and Trade Street**

Sixth Street runs east-west and carries one lane of traffic each direction. On-street parking is permitted on Trade Street, which also has one lane in each direction. The speed limit on both roads is 35 mph. The intersection served a total entering ADT of approximately 6,100 during the “before” period, and 6,000 in the “after” period. Late-night/early-morning flashing operations were removed from the traffic signals on July 02, 2002. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 42.9 percent and injury and the targeted right-angle crashes were eliminated (from four and three, respectively, in the “before” period).**
- Third Street and Metropolitan Drive**

Third Street has two lanes in each direction, while Metropolitan Drive is one way street with two lanes. The speed limit on both streets is 35 mph. The intersection served a total entering ADT of approximately 3,500 during the “before” period, and 3,000 in the “after” period. Late-night/early-morning flashing operations were removed from the traffic signals on May 26, 2004. **After the return to steady operations during late-night/early-morning hours, this intersection experienced a crash reduction of 43.8 percent, reduced injury crashes by 40 percent per year and reduced the targeted right-angle crashes by 85.7 percent per year.**

The removal of the late-night/early-morning flashing mode cumulatively reduced total crashes by 30.9 percent, injury crashes by 60.1 percent, and right-angle crashes by 88.8 percent. Fatal crashes were eliminated at four intersections.



Photo by Ron Steafer (used with permission).



Photo by Vaughan W. Inman, Ph.D. (used with permission).

## Discussion

### Implementation Issues

The city experienced no implementation issues with this countermeasure.

### Cost

The costs for changing the traffic signals from flashing mode to normal mode were low: approximately \$500 per intersection.

### Time Frame

The removal of the flashing operations took less than four hours per intersection. The city also conducted public outreach 30 days prior to removal.

### Effectiveness

Removing the late-night/early-morning flashing mode at these urban intersections was effective at reducing total crashes, injury crashes, and right-angle crashes, and in some cases eliminated injury or right-angle crashes between the “before” and “after” analysis periods. The National Cooperative Highway Research Program (NCHRP) conducted an Empirical Bayes analysis of the Winston-Salem Study which is detailed in its report on Accident Modification Factors for Traffic Engineering and ITS Improvements[8]. The NCHRP results indicated that late-night/early-morning angle crashes were reduced by approximately 34 percent and this was significant at the 10% significance level. These reductions are substantially lower than the 88.8 percent reduction presented in this case study based on simple “before and after” analysis of the treated intersections. However both studies (the NCHRP report and the “before and after” analysis) confirm that removal of flashing operations during late-night/early-morning hours reduces crashes.

### Summary of Results

**Overall, the removal of the late-night/early-morning flashing mode from eight urban intersections in Winston-Salem, NC cumulatively reduced total crashes by 30.9 percent, injury crashes by 60.1 percent, and right-angle crashes by 88.8 percent.** At four of the eight intersections, right-angle crashes at night were eliminated between the “before” and “after” periods. The reductions in crashes achieved by the treatments exceed the overall crash reduction factors of 75 percent for right-angle crashes and 29 percent for overall crashes mentioned in the Desktop Reference for Crash Reduction Factors (September 2007), published by the United States Department of Transportation (USDOT) FHWA[2].

## References

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- 8) Accident Modification Factors for Traffic Engineering and ITS Improvements, NCHRP Report 617, 2008.

## For More Information

### Ed Rice

Intersection Safety Team Leader,  
FHWA Office of Safety

202.366.9064

ed.rice@dot.gov

### Stanley F. Polanis

Director of Transportation,  
City of Winston-Salem, NC

336.747.6867

stanp@cityofws.org



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