MIDWEST SMART WORK ZONE DEPLOYMENT INITIATIVE

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Report Title

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SpeedGuard Radar Speed Reporting System

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Supplemental Notes

Abstract

The SpeedGuard radar speed reporting system is a speed monitoring display which informs drivers of their speeds and thereby encourages them to slow down if they are traveling above the speed limit. The objective of the system is to reduce the speed of traffic and increase speed limit compliance. Statistically significant reductions in speeds and improvements in the uniformity of speeds were observed in both passenger cars and non-passenger cars after the deployment of the SpeedGuard system. The 85th-percentile speed, upper limit of the pace, and mean of the highest 15 percent of speeds were reduced by 4 or 5 mph and dropped to or below the 55-mph speed limit. The percentages of passenger cars and non-passenger cars complying with the 55-mph speed limit increased 17 and 15 points to 91 and 90 percent, respectively. The system proved to be effect at reducing speeds and increasing speed uniformity in the study context. It should be noted that data collection included only 7 hours of data after system deployment, and no data was available with respect to the persistence of the speed reductions farther downstream.

NEBRASKA

Three technologies were evaluated in Nebraska. They were the following:

- SpeedGuard Radar Speed Reporting System provided by Speed Measurement Laboratories, Inc.;
- Portable Traffic Management System provided by Brown Traffic Products, Inc.; and
- ADAPTIR Traffic Control System provided by the Scientex Corporation.

The technologies were deployed in a work zone on I-80 between Lincoln and Omaha in the vicinity of the Highway 63 interchange near Greenwood as shown in Figure 5-1. The work zone was for an interstate reconstruction project which involved the closing of one roadway for reconstruction and head-to-head operation on the other roadway. The 1998 average daily traffic volume on this section of I-80 was approximately 38,000 vehicles per day, of which 21 percent were trucks. The normal speed limit on I-80 is 75 mph, the speed limit in the work zone was 55 mph.

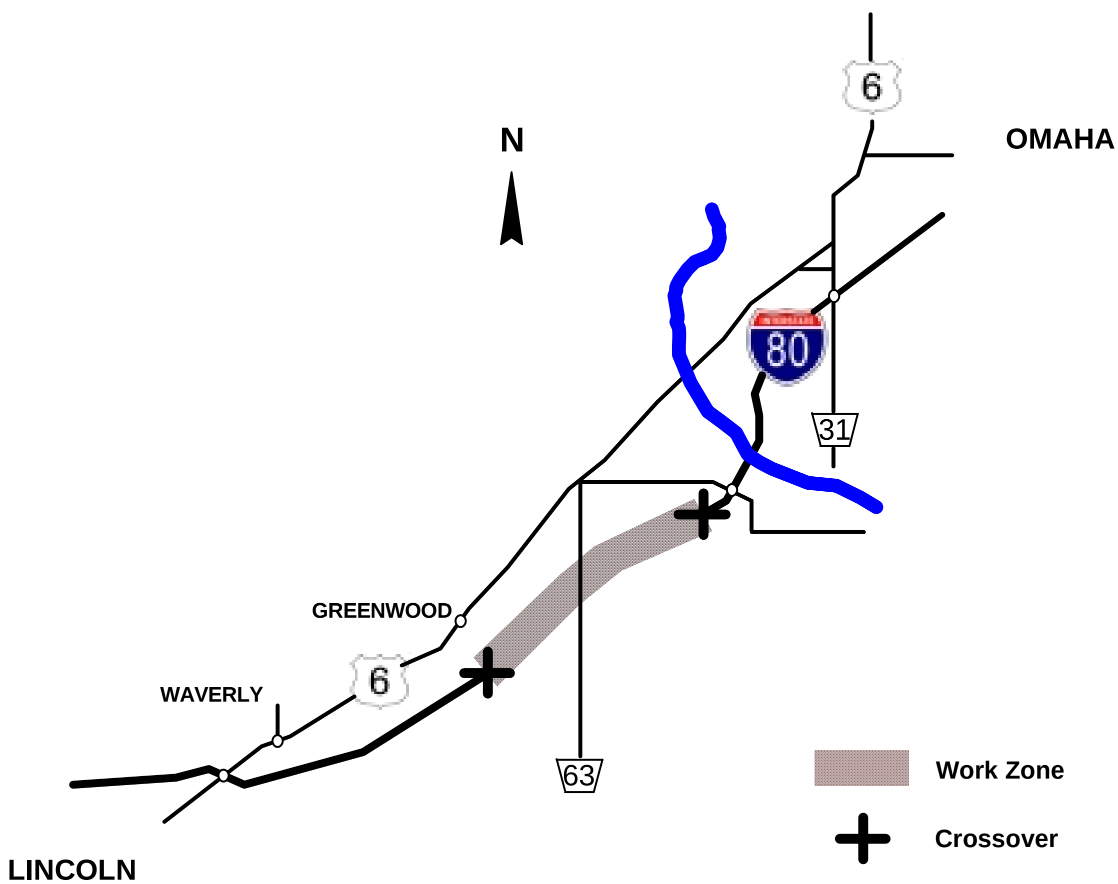

FIGURE 5-1 Location of work zone where technologies evaluated in Nebraska were deployed.

SPEEDGUARD RADAR SPEED REPORTING SYSTEM

Description

The SpeedGuard radar speed reporting system is a speed monitoring display which informs drivers of their speeds and thereby encourages them to slow down if they are traveling above the speed limit. The objective of the system is to reduce the speed of traffic and increase speed limit compliance.

The SpeedGuard radar speed reporting system is a portable, self-contained trailer unit, shown in Figure 5-2. It is equipped with radar to measure the speeds of approaching vehicles. The vehicle speeds are displayed on a panel with 24-inch LED numerals. The unit is equipped with a photocell for automatically controlling the brightness of the display. The system is powered by three 12 Vdc heavy duty marine batteries rated for 168 hours (one week) of use.

The message YOUR SPEED is mounted on the trailer beneath the variable speed display. A speed limit sign can be mounted on a rack above the display. The rack can be lowered for transport.

Speedguard is a product of Applied Concepts, Inc., 730 F. Avenue, Suite 200, Plano, Texas 75074, PH: 972-398-3750, FX: 972-398-3751, Email: sales@a-concepts.com. It was provided for evaluation by Speed Measurement Laboratories, Inc., 2300 Harvest Glen, Fort Worth, Texas 76108, PH: 817-560-9318, FX: 817-244-7630, Email: speedy3@speedlabs.com, www.speedlabs.com.

FIGURE 5-2 SpeedGuard radar speed reporting system.

Study Site

The study site for the evaluation of the SpeedGuard system was located on the westbound approach to the work zone in Figure 5-1. On this approach, the left lane was closed, reducing the two westbound lanes of I-80 to one lane. The SpeedGuard system was deployed about 1,000 feet in advance of the lane closure taper. The layout of the study site is shown in Figure 5-3.

The traffic control plan was the typical traffic control plan for an interstate construction crossover in Nebraska. The following sequence of signs was located on each side of the roadway:

1. ROAD WORK 2 MILES sign;
2. FINES FOR SPEEDING DOUBLED IN WORK ZONES sign about 7,200 feet before the lane closure taper;
3. SPEED LIMIT 75 sign with FINES DOUBLE sign plate about 6,200 feet before the lane closure taper;
4. LEFT LANE CLOSED 1 MILE sign about 5,600 feet before the lane closure taper;
5. REDUCED SPEED AHEAD sign about 4,600 feet before the lane closure taper;
6. SPEED LIMIT 65 sign with FINES DOUBLE sign plate about 4,100 feet before the lane closure taper;
7. DO NOT PASS sign about 3,600 feet before the lane closure taper;
8. LEFT LANE CLOSED ½ MILE sign about 3,100 feet before the lane closure taper;
9. REDUCED SPEED AHEAD sign about 2,000 feet before the lane closure taper;
10. Symbolic “lane reduction on the left” transition sign about 1,500 feet before the lane closure taper; and
11. SPEED LIMIT 55 sign with FINES DOUBLE sign plate about 1,000 feet before the lane closure taper.

In addition to the signs, there were two flashing arrow panels in the median at the outside edge of the left shoulder. One arrow panel was located about 5,100 feet in advance of the lane closure taper and the other arrow panel was located at the beginning of the lane closure taper.

The lane closure taper was 900 feet long. It was delineated by reflectorized plastic drums spaced at 50-foot intervals and monodirectional yellow raised pavement markers at 5-foot centers.

The SpeedGuard system was placed at the outside edge of the left shoulder as shown in Figure 5-4. It was located about 250 feet in advance of the SPEED LIMIT 55 sign, or about 1,250 feet before the lane closure taper.

Data Collection

Traffic speeds were measured before and after the deployment of the SpeedGuard system. The speed data were collected with the Nu-Metrics NC-97 traffic counter/classifier. The unit can measure and record the speed and lengths of vehicles passing over it. Six of these units were installed in the center of each traffic lane at distances of 500, 1,000, and 1,500 feet in advance of the lane closure taper, as illustrated in Figure 5-3.

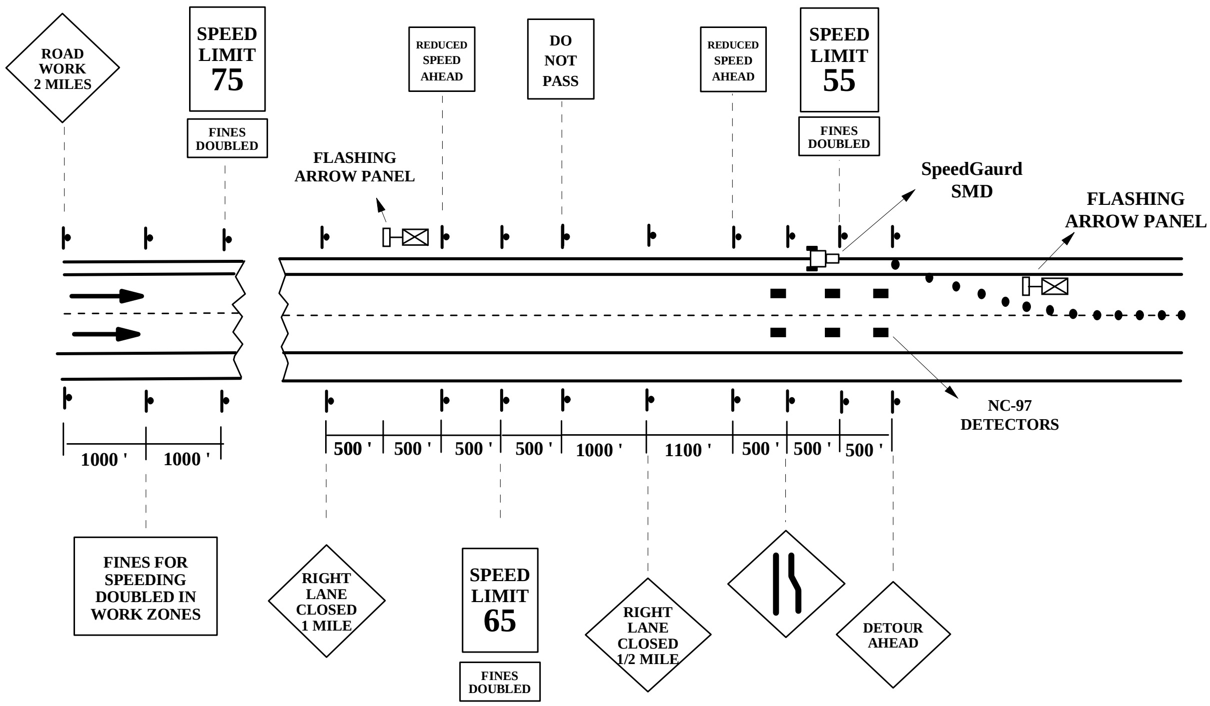

FIGURE 5-3 Layout of SpeedGuard system study site.

FIGURE 5-4 SpeedGuard system deployment.

Even with the traffic control provided by the NDOR, the installation and removal of the Nu-Metrics NC-97 traffic counter/classifier units was difficult because of the high volume and speed of traffic at this location. Therefore, in order to minimize the risk to NDOR and research personnel, the units remained in place throughout the before and after studies. The units were installed early in the morning of Wednesday, August 18, 1999, and removed early in the morning of Monday, August 23, 1999. They were programed to begin recording data at noon on Wednesday, August 18 and stop recording about midnight on Saturday, August 21. The goal was to obtain at least 24 hours of data before and after the deployment of the SpeedGuard system.

The before study period began at 12:15 pm on Wednesday, August 18, and ended at 1:45 pm on Thursday, August 19, when the SpeedGuard system was deployed. The after study period began at 2:00 pm on Thursday, August 19 and was to have lasted until 2:00 pm the following day. However, after being in operation for only 7 hours, the SpeedGuard system malfunctioned and was removed the next morning. Therefore, data collected between noon on Friday, August 20 and 9:00 pm on Saturday, August 21, when the SpeedGuard system was not present, were combined with the before study data. Thus, 58 hours of before study data and only 7 hours of after study data were collected.

In order for the Nu-Metrics NC-97 traffic counter/classifier units to operate continuously throughout the duration of the before and after studies under high traffic volumes, it was not possible for the units to store each vehicle speed measured without exceeding their storage capacity. Therefore, the units were programed to store the distribution of vehicle speeds measured during each 15-minute interval. For the purpose of this evaluation, the speeds were stored in 14 speed bins, or speed intervals. The speed bins and their speed ranges are shown in Table 5-1.

TABLE 5-1 Nu-Metrics NC-97 traffic counter/classifier speed bins.

Bin	Speed Range (mph)	Bin	Speed Range (mph)
1	< 20	8	60 - 65
2	20 - 30	9	65 - 70
3	30 - 40	10	70 - 75
4	40 - 45	11	75 - 80
5	45 - 50	12	80 - 90
6	50 - 55	13	90 - 100
7	55 - 60	14	> 100

Two sets of length bins were used, one for passenger cars and one for non-passenger cars. Measured vehicle lengths of 20 feet or less were assumed to be passenger cars. Measured vehicle lengths greater than 20 feet were assumed to be non-passenger cars.

Data Analysis

The speed distributions recorded by the Nu-Metrics NC-97 traffic counter/classifier units for each 15-minute period during the before and after studies were examined to identify periods of congested flow conditions. These periods were defined as 15-minute periods with average speeds below 35 mph. Since vehicle speeds during congested flow conditions are influenced primarily by the density of traffic, or interaction among vehicles, only the data for the periods of uncongested flow were included in the analysis. The data for the periods of the uncongested flow were then sorted into the categories of daytime and nighttime. Thus, four sets of uncongested flow data were analyzed: passenger cars, daytime; non-passenger cars, daytime; passenger cars, nighttime; and non-passenger cars, nighttime.

In reviewing files from each of the six Nu-Metrics NC-97 traffic counter/classifier units, it was discovered that the two units located at 1,000 feet in advance of the lane closure taper had malfunctioned and no useful data could be retrieved from them. Consequently, before and after speed data were only available from the other four units located at 500 and 1,500 feet in advance of the lane closure taper. The data collected from the two units at the same location were combined for the purposes of the analysis.

The following speed parameters were computed from the 15-minute, speed distribution data collected at each distance in advance of the lane closure taper during the before and after studies:

- mean speed,
- standard deviation,
- 85th-percentile speed,
- 10-mph pace,
- percentage of speeds within the pace,
- percentage complying with the speed limit, and
- mean of highest 15 percent of speeds.

The statistical significance of the differences in these speed parameters before and after the deployment of the SpeedGuard system was determined. The t test was used to evaluate the differences between the before and after values of the mean speed, 10-mph pace, and mean of highest 15 percent of speeds. An analysis of covariance was also conducted to account for the effects of traffic volume in the comparison of mean speeds. The binomial test was used to evaluate the statistical significance of differences between the before and after values of the 85th-percentile speed, percentage of speeds within the pace, and percentage complying with the speed limit. The F test was used to check for statistically significant differences between the before and after values of the standard deviation of the speed distribution.

Results

The speed parameter values computed from the daytime and nighttime data are shown in Tables 5-2 and 5-3, respectively. The location 1,500 feet before the taper was about 250 feet in advance of the SpeedGuard system, where the speed limit was 65 mph. The location 500 feet in advance of the taper was about 750 feet downstream of the SpeedGuard system, where the speed limit was 55 mph. In each table, the speed parameter values for passenger cars and non-passenger cars are shown separately.

The daytime speed parameter values shown in Table 5-2 indicate deployment of the SpeedGuard system resulted in lower, more uniform speeds. At 500 feet before the taper, statistically significant reductions in speeds and improvements in the uniformity of speeds were experienced by both passenger cars and non-passenger cars after the deployment of the SpeedGuard system. The 85^{th}-percentile speed, upper limit of the pace, and mean of the highest 15 percent of speeds were reduced by 4 or 5 mph and dropped to or below the 55-mph speed limit. The percentages of passenger cars and non-passenger cars complying with the 55-mph speed limit increased 17 and 15 points to 91 and 90 percent, respectively. Similar trends occurred at 1,500 feet before the taper, but there were few statistically significant differences at this location.

The nighttime speed parameter values shown in Table 5-3 also indicate that deployment of the SpeedGuard system resulted in lower, more uniform speeds. At 500 feet before the taper, statistically significant reductions in speeds and improvements in the uniformity of speeds were experienced by both passenger cars and non-passenger cars after the deployment of the SpeedGuard system. These differences were comparable to those observed in the daytime. However, at 1,500 feet before the taper, more statistically significant differences were observed in the nighttime. The reductions in the mean speed, 85^{th}-percentile speed, upper limit of the pace, and mean of the highest 15 percent of speeds were about 2 to 4 mph larger in the nighttime than in the daytime. This increased effectiveness is attributed to the greater visibility of the SpeedGuard display at night.

Conclusion

The SpeedGuard system was found to be effective in lowering speeds and increasing the uniformity of speeds. At 500 feet in advance of the lane closure taper, which was 750 feet downstream from the SpeedGuard system, the 85^{th}-percentile speed, upper limit of the pace, and mean of the highest 15 percent of speeds were reduced significantly ($\alpha = 0.05$) by about 5 mph, which lowered the values of these parameters to, or below, the speed limit. Its effects on passenger car and truck speeds were similar, increasing speed limit compliance to 90 percent or more. At this location, it was equally effective day and night. However, at 1,500 feet before the taper, which was 250 feet in advance of its location, its effects were greater at night because of its greater nighttime visibility.

Although the SpeedGuard system was effective, it should be noted that its performance was only measured during the first 7 hours of its deployment. After 7 hours of operation, the system malfunctioned and could not be observed any longer. Consequently, the period of time that its effectiveness can be sustained beyond 7 hours was not observed. Also, the extent of its effectiveness beyond 750 feet downstream was not observed. Because the SpeedGuard was found to be effective, at least in the short term, additional studies should be conducted to evaluate the temporal and spacial limits of its effects.

TABLE 5-2 Daytime before and after speed parameter values for SpeedGuard system.

Speed Parameter	1,500 ft Before Taper [a]		500 ft Before Taper [b]	
	Before	After	Before	After
Passenger Cars				
Mean Speed (mph)	58.0	57.4	50.7	48.0
Standard Deviation (mph)	12.5	10.2	11.7	9.1
85th-Percentile Speed (mph)	65.4	64.0	57.4	52.6
10-mph Pace	57-67	55-65	49-59	45-55
Within in 10-mph Pace (%)	50	45	48	52
Speed Limit Compliance (%)	84	88	74	91
Mean Speed of Highest 15 % (mph)	69.0	69.0	60.0	55.0
Sample Size	39,333	5,335	31,838	5,348
Non-Passenger Cars				
Mean Speed (mph)	60.1	58.9	52.2	49.3
Standard Deviation (mph)	8.8	7.6	8.7	7.5
85th-Percentile Speed (mph)	65.0	63.6	57.0	52.9
10-mph Pace	57-67	55-65	50-60	46-56
Within in 10-mph Pace (%)	55	50	55	55
Speed Limit Compliance (%)	85	88	75	90
Mean Speed of Highest 15 % (mph)	68.6	68.8	59.6	54.7
Sample Size	6,765	762	6,637	856

[a] 250 feet in advance of the SpeedGuard system, where the speed limit is 65 mph.

[b] 750 feet downstream of the SpeedGuard system, where the speed limit is 55 mph.

(shaded) Difference between before and after values is significant ($\alpha = 0.05$).

TABLE 5-3 Nighttime before and after speed parameter values for SpeedGuard system.

Speed Parameter	1,500 ft Before Taper [a]		500 ft Before Taper [b]	
	Before	After	Before	After
Passenger Cars				
Mean Speed (mph)	59.4	55.6	53.3	49.5
Standard Deviation (mph)	9.1	8.9	7.8	6.3
85th-Percentile Speed (mph)	65.0	61.9	57.6	52.8
10-mph Pace	56-66	52-62	48-58	45-55
Within in 10-mph Pace (%)	49	43	57	58
Speed Limit Compliance (%)	85	93	73	90
Mean Speed of Highest 15 % (mph)	69.1	65.1	60.3	55.0
Sample Size	10,134	701	9,503	815
Non-Passenger Cars				
Mean Speed (mph)	61.3	57.4	54.2	49.9
Standard Deviation (mph)	5.8	7.9	5.3	5.5
85th-Percentile Speed (mph)	64.9	62.6	57.3	52.4
10-mph Pace	57-67	53-63	50-60	45-55
Within in 10-mph Pace (%)	58	51	60	61
Speed Limit Compliance (%)	85	91	72	93
Mean Speed of Highest 15 % (mph)	68.6	65.2	59.5	54.5
Sample Size	2,355	135	2,821	182

[a] 250 feet in advance of the SpeedGuard system, where the speed limit is 65 mph.

[b] 750 feet downstream of the SpeedGuard system, where the speed limit is 55 mph.

[shaded box] Difference between before and after values is significant (α = 0.05).