

## PROJECT PROGRESS REPORT

216	Visibility of Traffic Signal Displays for Aging and Color Deficient Drivers	Ed Miska
Project Number	Project Title	Project Chairman
Sept 1993	Mar 1994	Sept 2001
Project Submission Date	Project Acceptance Date	Progress Report Date
5		Sept 2001
Progress Report Number		Est. Completion Date

	<b>Project Status:</b>	<b>% Completed</b>	
		<i>Last Report</i>	<i>This Report</i>
1.	<b>Project Study Group</b>	<b>100%</b>	<b>100%</b>
2.	<b>Project Work Plan</b>	<b>100%</b>	<b>100%</b>
3.	<b>Project Research Study</b>	<b>100%</b>	<b>100%</b>
4.	<b>Project Alternatives</b>	<b>100%</b>	<b>100%</b>
5.	<b>Evaluation of Alternatives</b>	<b>100%</b>	<b>100%</b>
6.	<b>Draft Report</b>	<b>100%</b>	<b>100%</b>
7.	<b>Final Report</b>	<b>50%</b>	<b>100%</b>
8.	<b>Impact Statement</b>	<b>0%</b>	<b>100%</b>
9.	<b>Educational Materials</b>	<b>n/a</b>	<b>n/a</b>

## FINAL REPORT

Project Title: VISIBILITY OF TRAFFIC SIGNAL DISPLAYS FOR  
AGING AND COLOUR DEFICIENT DRIVERS

DATE: SEPTEMBER 6, 2001

### 1. Problem Description (Motivation):

Old age drivers and drivers with color vision deficiencies show difficulties in recognizing traffic signal colors. Research has indicated that the response time of these drivers is significantly longer than the normal population. The project designed to address the problem has evolved into two phases. Phase 1 of this project was to investigate the impact of improved signal head design (i.e., larger lenses, larger backboard and a reflective border) on the safety performance of all drivers. Phase 2 has evolved as an extension to Phase 1, increasing the conspicuity of the reflective border using standard backboards with 3M yellow diamond grade reflective tape at the along the outer edge.

### 2. Scope, Objectives, and Results:

#### Phase 1: New Signal Design

Phase 1 of this project was to field test and review a new signal design consisting of 3 - 300mm signal lenses and a backboard with an additional 75mm reflective border. The objective was to determine if the new signal design caused a reduction in driver's reaction times, resulting in a reduction in traffic accidents at signalized intersections. The new signal design is expected to be effective in reducing rear-end accidents and, to a lesser degree, right angle and other miscellaneous intersection accident types. Ten intersections on major highway corridors in Burnaby, Maple Ridge, and Saanich were selected as test sites. The installation of the new traffic signals was completed on April 1, 1994. A safety performance evaluation of the effectiveness of the new signals was completed in 1996 and again in 1997. The results of Phase 1 of this project are as follows:

- ◆ A simple before and after analysis of safety performance was completed for the test sites. The results of this analysis indicated a 32% reduction in total accidents and a 21% reduction in severe accidents (injury and fatal).
- ◆ A more detailed subsequent safety study which utilized the empirical bayes analysis technique, resulted in a reduction of 24% in the total number of accidents at the test sites and a 16% reduction in injury and fatal accidents.
- ◆ Details of this study have been published at the 77<sup>th</sup> Annual Meeting of the TRB (Jan 11<sup>th</sup> – 15<sup>th</sup>, 1998), Paper No. 980206, authored by Sayed et al..
- ◆ The results of this study contributed to the new standard signal design in BC, consisting of 3 - 300 mm lenses, rather than the 300 - 200 -200 mm design, used previous to this study.

Phase 2: New Signal Backboard Design

A new and related project was initiated by ICBC in the summer of 1998, which has been referred to as Phase 2. The project entitled, Safety Benefits of Improved Signal Backboard Visibility, aims to study the road safety performance impacts of highly reflective tape on signal head backboards. In September 1998, 3M diamond grade VIP reflective tape was placed on the outer edge of the backboards on the signals heads of six intersections located along McKenzie Avenue Expressway between the Patricia Bay Highway and the Trans Canada Highway in Saanich BC. The progress on this phase of the project is described below.

- ◆ Installation of the reflective board occurred in the fall of 1998, with 6 signal locations being fabricated and installed with the modified signal head border, located near Victoria BC.
- ◆ The Saanich Police Department collected the accident data for the study, including three-year period before and after the installation date. The data included nighttime accidents only.
- ◆ A simple before and after safety analysis was undertaken with the results indicating that the aggregate collision frequency was reduced from the before to after periods. The MoTH report also indicated that the proportion of collision types did change and thus, had a positive impact on the test corridor albeit that the sample size was small.

#### 4. Project Results

This NCUTC Project (Project 216) has been continuing and evolving for over seven years with several reports generated to summarize the results. Four reports have been generated including the following:

- 1) Visibility of Traffic Signal Displays for Aging and Color Vision Deficient Drivers  
MoTH: Highway Safety Branch Report
- 2) Post-Improvement Economic Evaluation of the New Signal Head Design  
ICBC: Road Improvement Program
- 3) Safety Evaluation of Alternative Signal Head Design (TRB – Sayed et al.)  
UBC Dept. of Civil Engineering with ICBC and MoTH
- 4) Diamond Grade Tape on Signal Backboards on McKenzie Ave. Expressway  
MoTH: Highway Safety Branch Report

Based on the results presented in these reports, the B.C. Ministry of Transportation has partnered with ICBC on a multi-year program to upgrade all primary signal displays to 300 mm lenses with yellow backboards with 3M VIP Diamond Grade reflective sheeting. As well, a number of B.C. municipalities have started using a reflective tape boarder around backboards. While the majority of applications have been of yellow tape on yellow backboards, there have been

applications of white tape on black backboards. None of the municipalities stated that they had done before and after studies.

## 5. IMPACT ASSESSMENT

The installation of reflective tape on backboards reduced night-time crashes at intersections resulting in a safety benefit. The cost of applying this treatment at new installations or as a retrofit is minimal (limited to four strips of tape per backboard and several minutes of staff time) when combined with regular signal construction or maintenance activities. The costs to retrofit a backboard with reflective tape for BC MoT \$34.15. Hence for a large BC MoT intersection backboards for through movements and protected left turns (total of 12 backboards) the cost is \$410. As backboard use in various agencies is dependent on local policy it is not possible to estimate the cross Canada however the BC costs should be representative since most of the cost is the tape itself.

## 6. RECOMMENDATION

It is recommended that the *MUTCD Section B3.2.3 Backboards* be amended by the addition of the following:

**The night-time visibility (conspicuousness) of traffic control signals may be enhanced by adding up to a 75 mm border of yellow prismatic retro-reflective sheeting, conforming to ASTM D4956-01 Type IX, around the outside edge of the backboard.**

Submitted By: \_\_\_\_\_  
(signature)

Ed Miska P.Eng., PTOE  
(Please print name)

B.C. MoT.  
(representing)

Accepted

Rejected

Returned for Revision

Project Number (if accepted): 216

Project Chair: Ed Miska, P.Eng., PTOE

**APPENDIX A**

**Effectiveness of Diamond Grade Yellow Tape on Signal Backboard  
Preliminary Assessment of the McKenzie Corridor  
(Revised September 2001)**

**Effectiveness of Diamond Grade Yellow Tape on Signal Backboard  
Preliminary Assessment of the McKenzie Corridor  
(Revised September 2001)**

BACKGROUND

In September of 1998, diamond grade yellow tape was placed along the outer edge of the backboards of signal heads at all signalized intersections along McKenzie Avenue from the Patricia Bay Highway to the Trans Canada Highway in Saanich. This was done in an attempt to frame the signal heads and make them more visible to motorists with the intent of improving intersection safety at night. The type of accident that is likely to benefit from the improvement is rear end accidents.

Location

The location of the study was along McKenzie Avenue from the Patricia Bay Highway to the Trans Canada Highway. There were six intersections in the study area. The intersections involved were:

- Route 17 Northbound Off-Ramp at McKenzie Avenue (Douglas Street and McKenzie Avenue)
- Route 17 Southbound Off-Ramp at McKenzie Avenue
- Glanford Avenue and McKenzie Avenue
- Carey Road and McKenzie Avenue
- West Burnside Road and McKenzie Avenue
- Highway 1 and McKenzie Avenue/Admirals Road

Data

The accident data used in the study was obtained from the Saanich Police Department. One year of nighttime accident data was supplied for the before improvement period and 3 years for the after improvement period. The before improvement period is from October 1997 to September 1998 and the after improvement period is from October 1998 to July 2001. Nighttime accidents were determined by the Saanich Police Department and were based on the time of day and the month in which they occurred. Only accidents that occurred during the following periods of time were considered nighttime accidents:

<i>Month</i>	<i>Time</i>
January to March	1700-0800
April to June	2000-0500
July to September	2100-0500
October to December	1700-0800

Summary of Results

The two tables below summarize the findings. The first table lists the before and after accidents by intersection and the second table lists the accidents by primary accident types.

**Table 1: Total Night Accidents by Intersection**

Intersection	Before Improvement (Oct 1997 to Sept 1998)	1 <sup>st</sup> year after Improvement (Oct 1998 to Sept 1999)	2 <sup>nd</sup> year after Improvement (Oct 1999 to Sept 2000)	3 <sup>rd</sup> year after Improvement (Oct 2000 to Jul 2001)
Rte 17 N/B Off-Ramp (Douglas Street and McKenzie Avenue)	1	1	1	0
Rte 17 S/B Off-Ramp at McKenzie Avenue	0	0	0	0
Glanford Avenue and McKenzie Avenue	1	1	2	0
Carey Road and McKenzie Avenue	3	5	0	3
West Burnside Road and McKenzie Avenue	3	2	0	0
Highway 1 and McKenzie Avenue/Admirals Road	6	5	2	0
<b>Total</b>	<b>14</b>	<b>14</b>	<b>5</b>	<b>3</b>

**Table 2: Total Night Accidents by Primary Accident Type**

Primary Accident Type	Before Improvement (Oct 1997 to Sept 1998)	1 <sup>st</sup> year after Improvement (Oct 1998 to Sept 1999)	2 <sup>nd</sup> year after Improvement (Oct 1999 to Sept 2000)	3 <sup>rd</sup> year after Improvement (Oct 2000 to Jul 2001)
Intersection 90	1	3	0	1
Left Turn	3	1	1	0
Right Turn	1	1	0	0
Rear End	7	2	3	0
Overtaking	0	1	0	0
Off Road	0	1	1	1
Unknown	2	5	0	1
<b>Total</b>	<b>14</b>	<b>14</b>	<b>5</b>	<b>3</b>

The total number of accidents the year after the improvement was the same as the previous year, but the second year after the improvement showed a reduction in accidents from 14 to 5 and the third year shows a reduction to 3. When looking at the primary causes of the accidents a significant improvement can be seen in rear end accidents. In the year prior to the improvements there were 7 rear end accidents, 2 in the year after the improvement, 3 in the 2<sup>nd</sup> year, and 0 in the 3<sup>rd</sup> year.

The traffic volume along the corridor has remained relatively consistent from 1998-2001. The following table details the traffic volume for the 4 years.

**Table 3: Traffic Volume for 1998-2001**

Year	AADT
1998	22,730
1999	23,184
2000	23,648
2001	24,120

**Police Opinion**

Sponsored by the  
Transportation Association of Canada  
and  
Institute of Transportation Engineers (Canada)

Sous l'edite de:  
l'Association des Transports du Canada  
et  
l'Institut des Ingenieurs des Transports (Canada)

The Saanich Police Department did not notice any differences in terms of safety or motorist behavior as a result of the improvements.

**Benefit/Cost Calculation**

Cost Calculation

Cost of Tape	\$30.60 / backboard
Cost of Labour	\$3.55 / backboard
Maximum number of backboards / signalized intersection	12
Number of signalized intersection in BC	530
Material Cost for all signalized intersections in BC	\$194,616
Labour Cost for all signalized intersections in BC	\$ 22,578
Taxes	\$ 15,204
<b><i>Total Material and Labour Cost</i></b>	\$232,398
<b><i>Total Material and Labour Cost / Year (Assuming 10 year service)</i></b>	<b>\$ 23,240</b>

Benefits

Accident Type	Total Accidents	ARF (%)	ICBC Collision Costs	Estimated Savings / Year
Fatal	1	30	\$282,000	\$7,050
Injury	188	30	\$44,000	\$206,800
PDO	192	30	\$5,000	\$24,000
<b>Total</b>				<b>\$237,850</b>

Notes

1. Accident data from 1987 to 1998 (12 years)
2. Accident data only for nighttime, straight-ahead rear end accidents occurring at signalized intersections from Highway 1 to 101.
3. Although a 70% reduction in rear end accidents was seen in this preliminary study, only a 30% reduction was used for the benefit-cost analysis to account for the uncertainty in the results due to the short period of analysis.
4. ARF = Accident Reduction Factor

**Benefit/Cost Ratio = 10**

Conclusion

Feedback from the Saanich Police Department indicated that no differences in driver behavior were noticed before and after the improvement in backboard visibility. The accident totals between the year before and the year after the application of the tape to the backboard were the same, but decreased the following years.

A reduction was seen in rear end accidents from the year before the initiation of the improvement in all years following the improvement. Rear end accidents decreased from seven before the improvement to only two, three and none in the years after. This is an encouraging sign since rear end accidents are the primary accident type that should benefit the most from the improvement. Other accident types such as



left/right turn accidents are caused primarily due to a judgment error in determining a suitable gap and the use of diamond grade tape on the signal backboard would not affect the judgement of the motorist. Since the sample size is small, it is not possible to have a statistically significant result. Now that the Ministry has adopted the reflective borders as a standard for backboards there will shortly be a much larger sample size for analysis.

Another benefit of using reflective tape is that during a power failure the reflective tape will still frame the signal and drivers will be more likely to recognize the situation and treat the intersection as a four way stop.

## Recommendations

The use of using diamond grade yellow tape at signalized intersections appears to have a safety benefit at minimal cost albeit that the results are based on a small sample size. However due to the low cost involved (\$34/ backboard or for the largest BC MoT intersection with 12 backboards \$410) and based on the reduction in rear end accidents seen along the McKenzie corridor, it is recommended that the Ministry apply diamond grade tape to all signal backboards. The application of the diamond grade tape should be incorporated into the maintenance of the signal heads and should be applied at the same time that the signal bulbs are replaced. The use of fluorescent diamond grade tape should also be considered as it may have the added benefit of reducing accidents in the daytime as well as at night.