THE IMPACT OF HIGHWAY SAFETY FLARES ON DRIVER BEHAVIOR

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(2003-2005 presented at TRB 2006)

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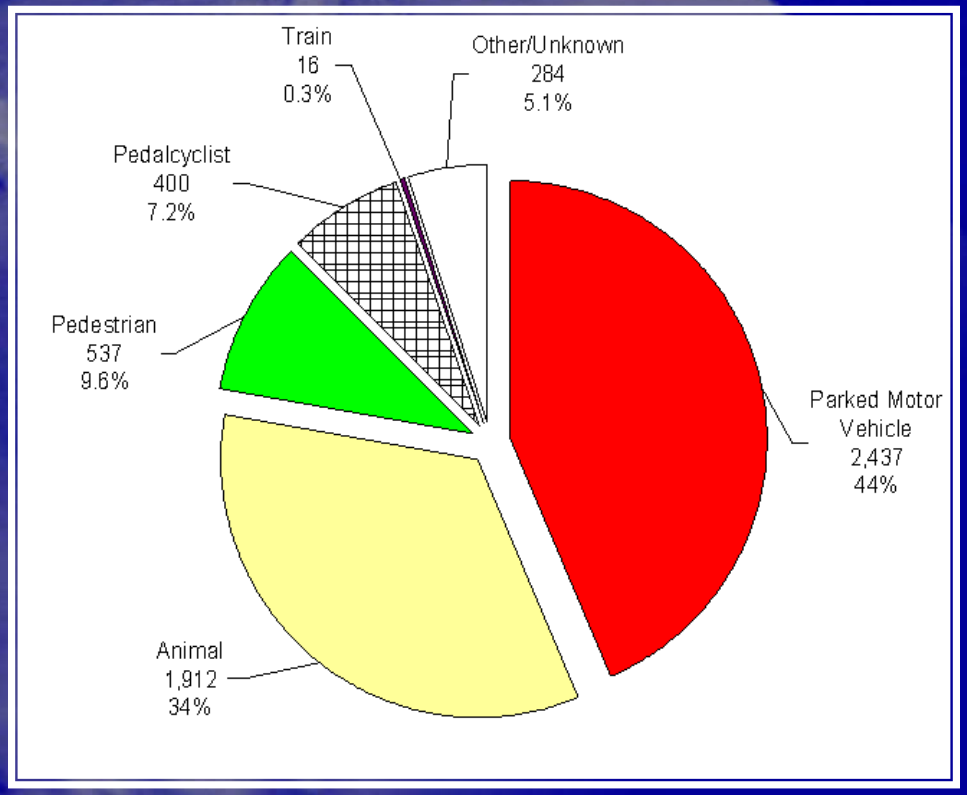
Introduction

Crashes Involving Collisions with Parked/disabled Motor Vehicles



PDMV crashes are the most frequent type of collision with non-fixed objects.

Every year (as of 2005):

- **507** people are killed.
- **30,000** people are injured.
- **350,000** PDMV crashes occur.

Introduction

Safety Measures Aimed at Reducing Crashes involving Collisions with Parked/Disabled Vehicles on Highway Shoulders

Source: www.orionsignals.com

Introduction

Purpose of Flare Deployment

- Warn approaching traffic of unusual road hazard.
- Mark the location of the traffic incident scene.
- Prompt a safe response from passing traffic.

CREATE A SAFETY ZONE
Around the Emergency Event

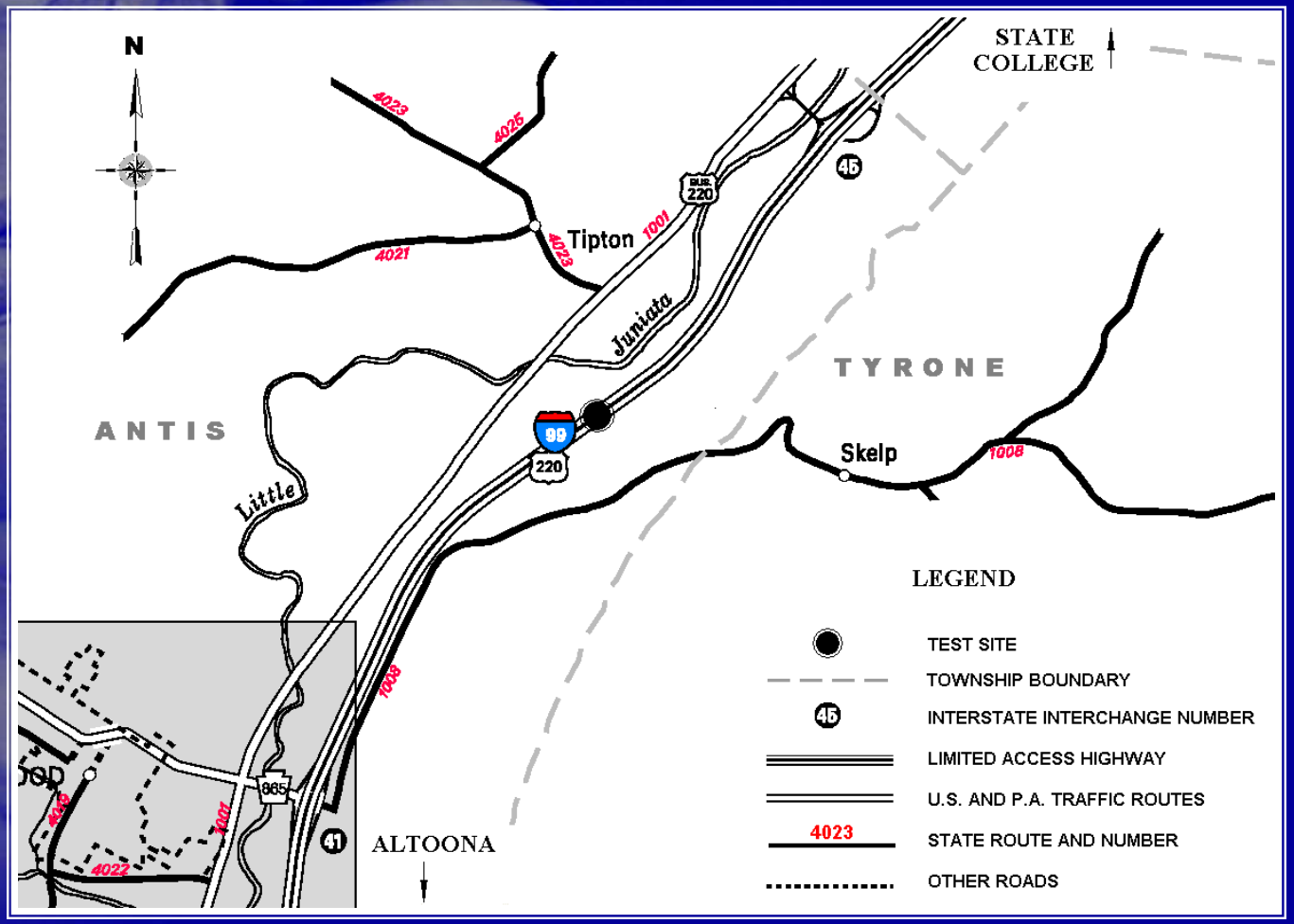
Introduction

Additional research and more uniform guidance is needed for safe and effective flare deployment

- Number of flares to deploy
- Distance between flares
- Flare deployment pattern
- Location of the leading flare
- Added safety benefit of using flares in combination with police car's light bars

Method

Site Selection: Blair County, Pennsylvania



Method

Data Collection Equipment

a) Roadway sensors (pneumatic tubes)

b) Automatic traffic recorder

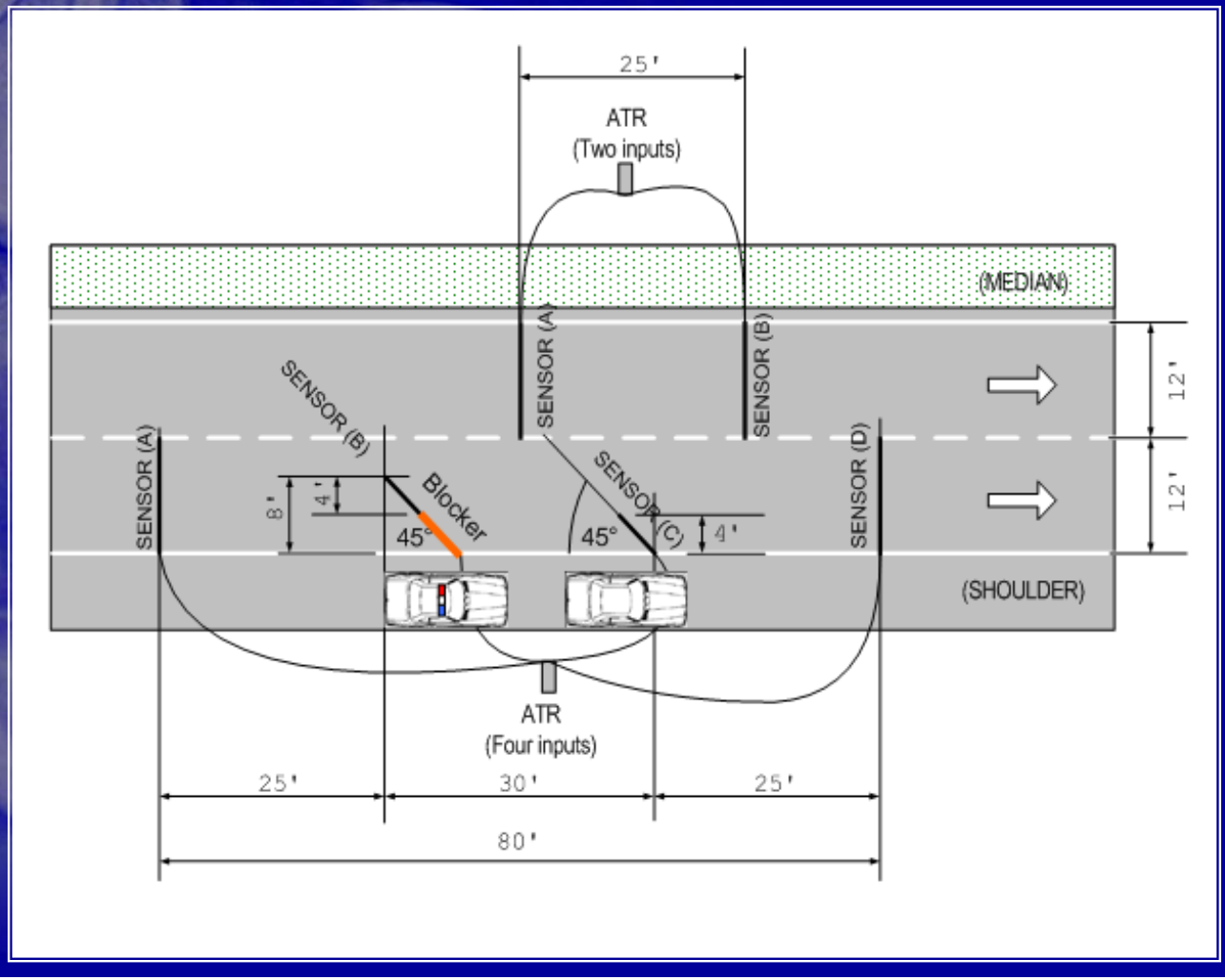
c) Export utility software (TraxproPSU)

d) Excel® programmed worksheets

Method

Method

Data Collection Equipment: Final Configuration

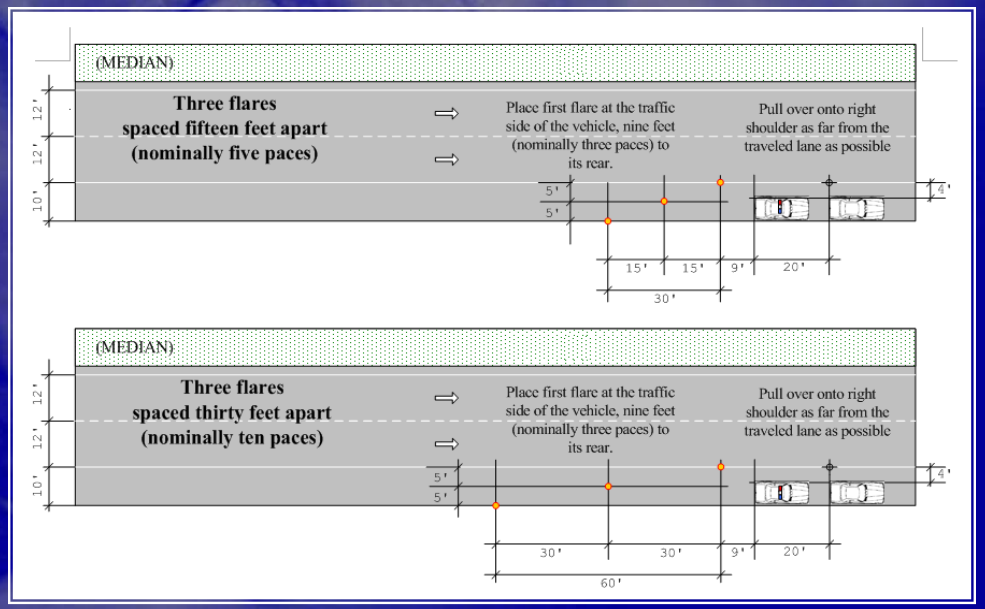


Method

Base Flare Configurations Tested

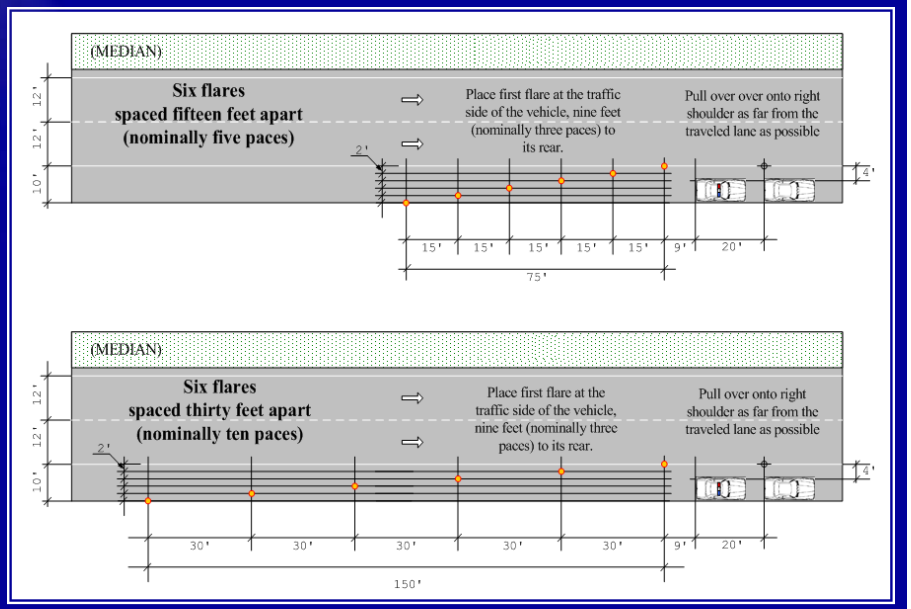
Three flares

Five and Ten paces apart



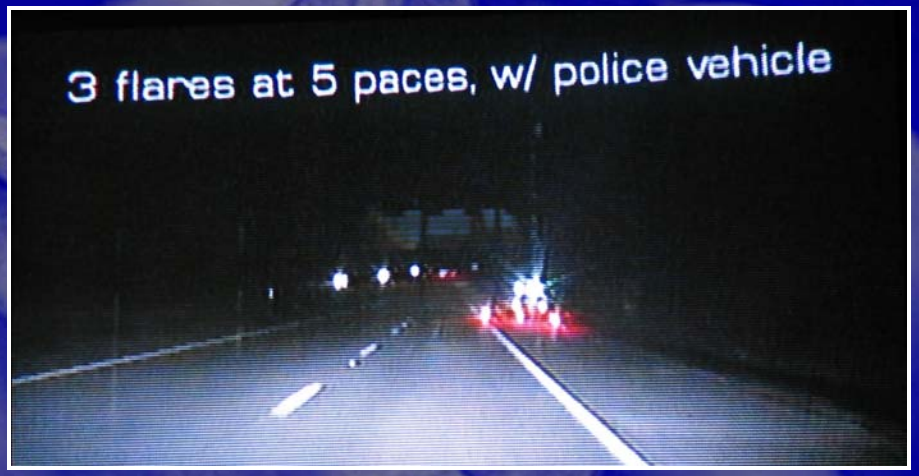
Six flares

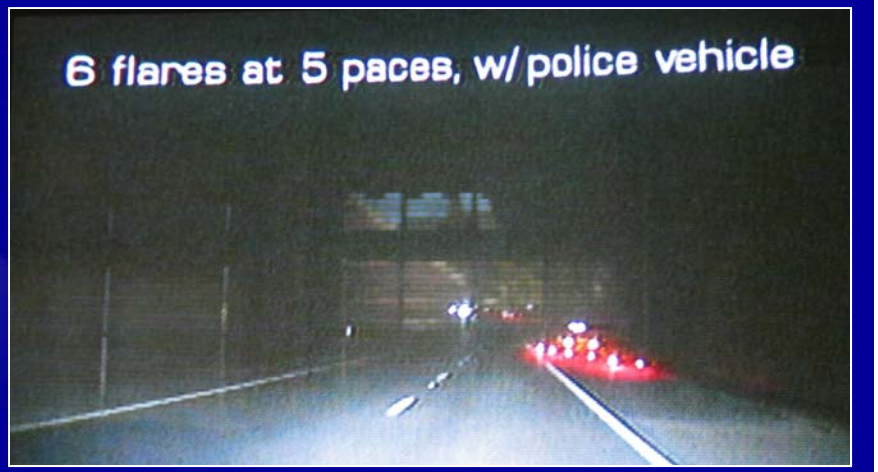
Five and Ten paces apart

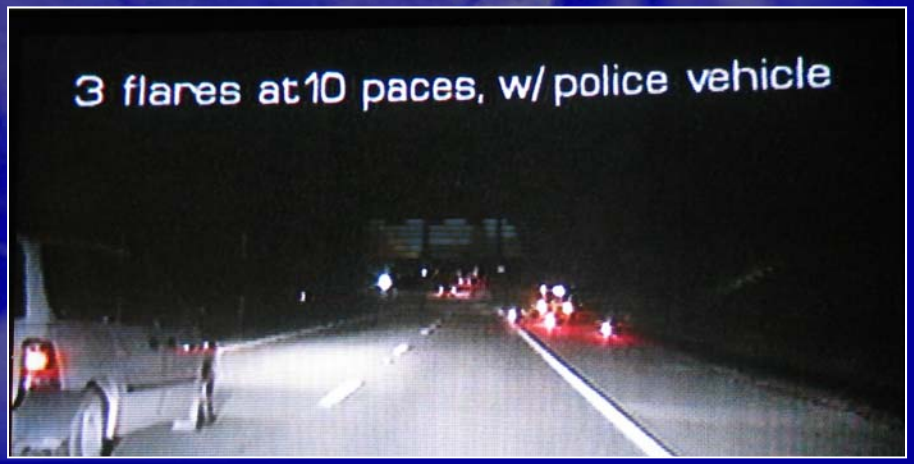


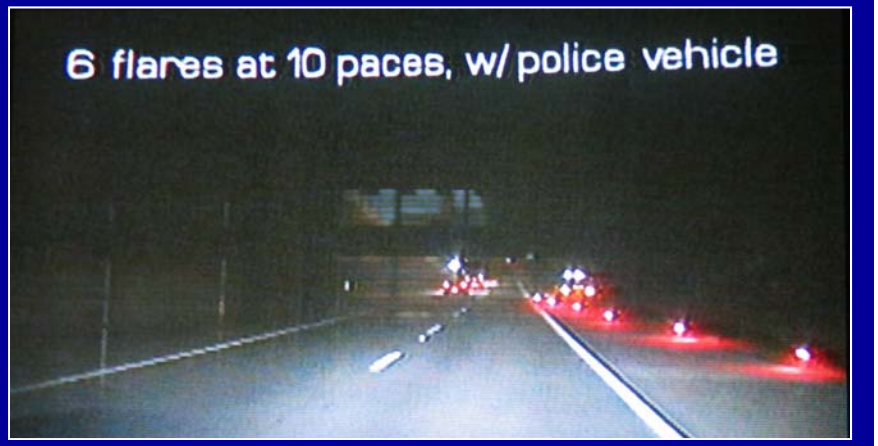
Method

Base Flare Configurations Tested









Method

Roadway Scenarios Tested

Road Scenario	Treatment	Description
(a) Police Car + Flares	A	3 flares @ 5 paces
	B	3 flares @ 10 paces
	C	6 flares @ 5 paces
	D	6 flares @ 10 paces
(c) Police Car Only	E	No flares deployed
(b) Disabled + Flares	F	3 flares @ 5 paces
	G	3 flares @ 10 paces
	H	6 flares @ 5 paces
	I	6 flares @ 10 paces
(d) Baseline	None	Normal conditions

Measures of Effectiveness / Dependent Variables

No.	Variable	Type of Variable	Unit	Description	Range of Values
1	Spot Speed[7]	Continuous	mph	Positive real numbers	0 - 120 mph
2	Lane Changing[8]	Categorical, Binomial	Percentage	[Right, Left]	0 - 100 percent
3	Lateral Placement[9]	Continuous	Inches	Positive real numbers	0 - 96 inches
3a.	Lane Straddling[10]	Categorical, Binomial	Percentage	[Yes, No]	0 - 100 percent

Data Collection Schedule and Order of Testing

GROUP	DAY	DATE	APPROXIMATE START TIME (P.M)								
			8:00	8:35	9:10	9:45	10:20	10:55	11:30	12:05	12:40
EXPERIMENTAL GROUP	Monday	10/20/03	A	E	D	F	C	H	B	G	I
	Tuesday	10/21/03	B	G	A	E	D	I	C	H	F
	Wednesday	10/22/03	C	H	B	G	A	F	E	I	D
	Thursday	10/23/03	D	I	C	H	B	G	A	F	E
CONTROL GROUP	Monday	10/27/03	No treatment applied (baseline condition)								
	Tuesday	10/28/03	No treatment applied (baseline condition)								
	Wednesday	10/29/03	No treatment applied (baseline condition)								
	Thursday	10/30/03	No treatment applied (baseline condition)								

Method

Statistical Analysis Techniques

- ANOVA, Bonferroni, and two-sample t-tests were used for analyses of **continuous variables**.
- Contingency tables, Chi-square tests, and the Marascuilo procedure were used for analyses of **categorical variables**.
- Conventional 0.05 level of significance was used for hypotheses testing.
- Minitab® and Excel® used for the computations.

Results

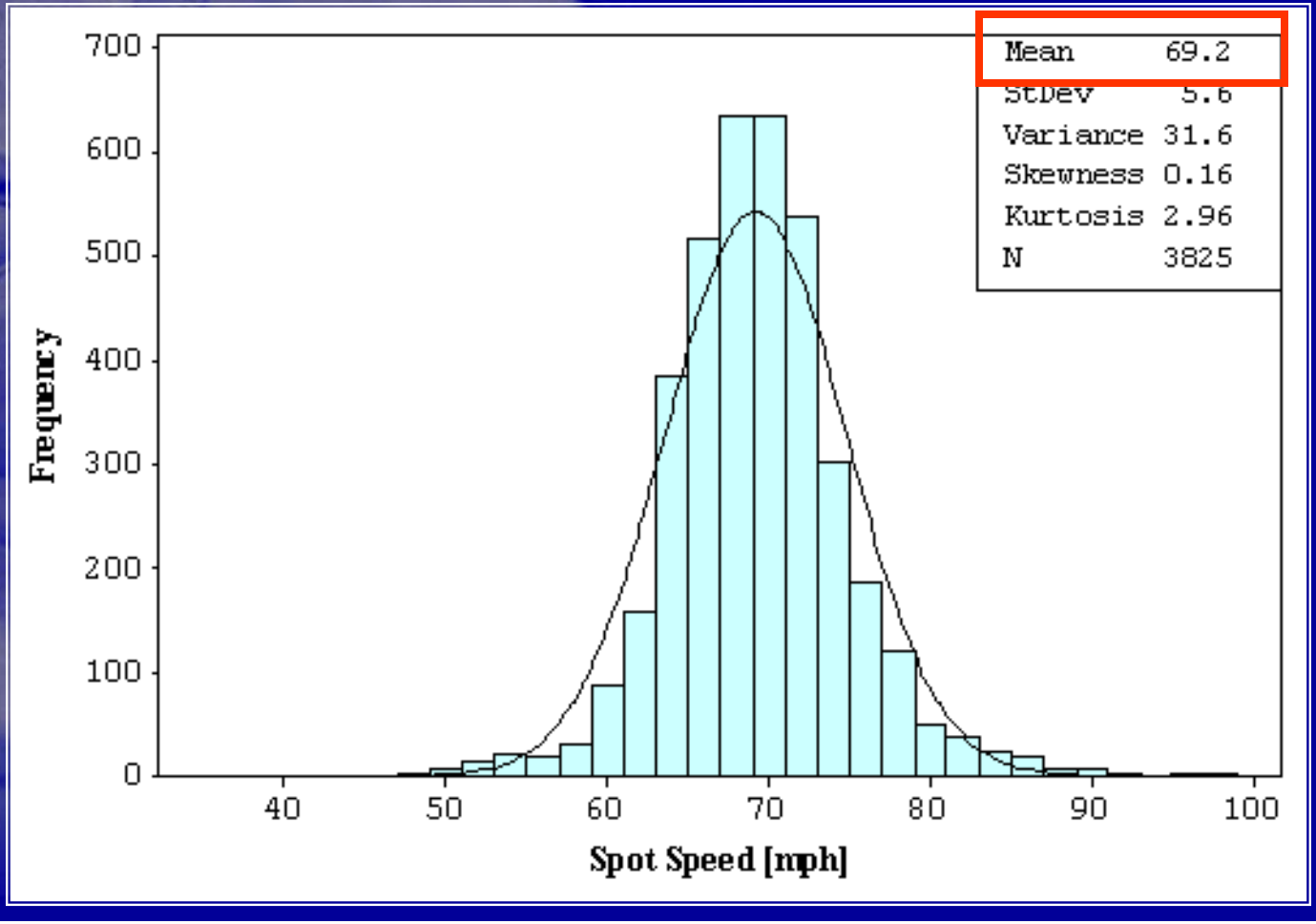
Sample Size

Treatment	Measures of Effectiveness								
	Spot Speeds			Lane Changing			Lateral Placement [LP] and Lane Straddling [LS]		
	Lane		Total	Lane		Total	Right Lane		Total
	Left	Right		Left	Right		[LP]	[LS]	
A	431	17	448	329	17	346	15	2	17
B	452	18	470	255	18	273	16	2	18
C	544	14	558	315	14	329	10	4	14
D	432	25	457	386	25	411	17	8	25
E	271	22	293	206	22	228	19	3	22
F	211	10	221	137	10	147	4	6	10
G	392	37	429	260	37	297	20	17	37
H	370	38	408	239	38	277	25	13	38
I	256	37	293	208	37	245	30	7	37
Sub-Total	**3,359**	**218**	**3,577**	**2,335**	**218**	**2,553**	**156**	**62**	**218**
None(*)	529	3,296	3,825	529	3,296	3,825	3,274	22	3,296
Total	**3,888**	**3,514**	**7,402**	**2,864**	**3,514**	**6,378**	**3,430**	**84**	**3,514**

(*) None = No treatment applied (baseline conditions).

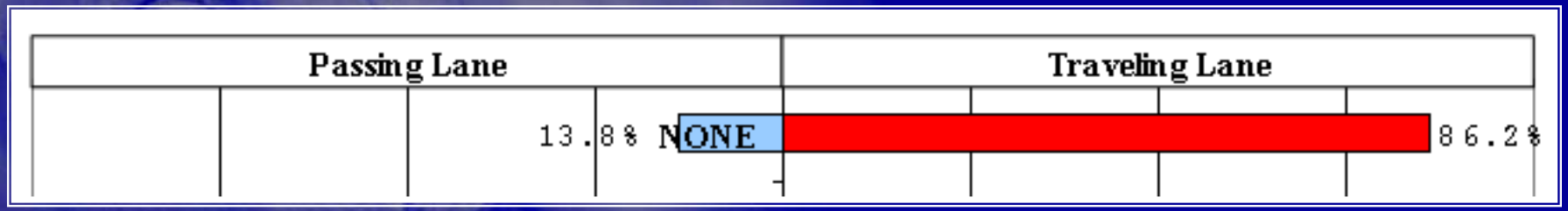
Results

Histogram (with normal curve) of Spot Speeds (Baseline Condition)



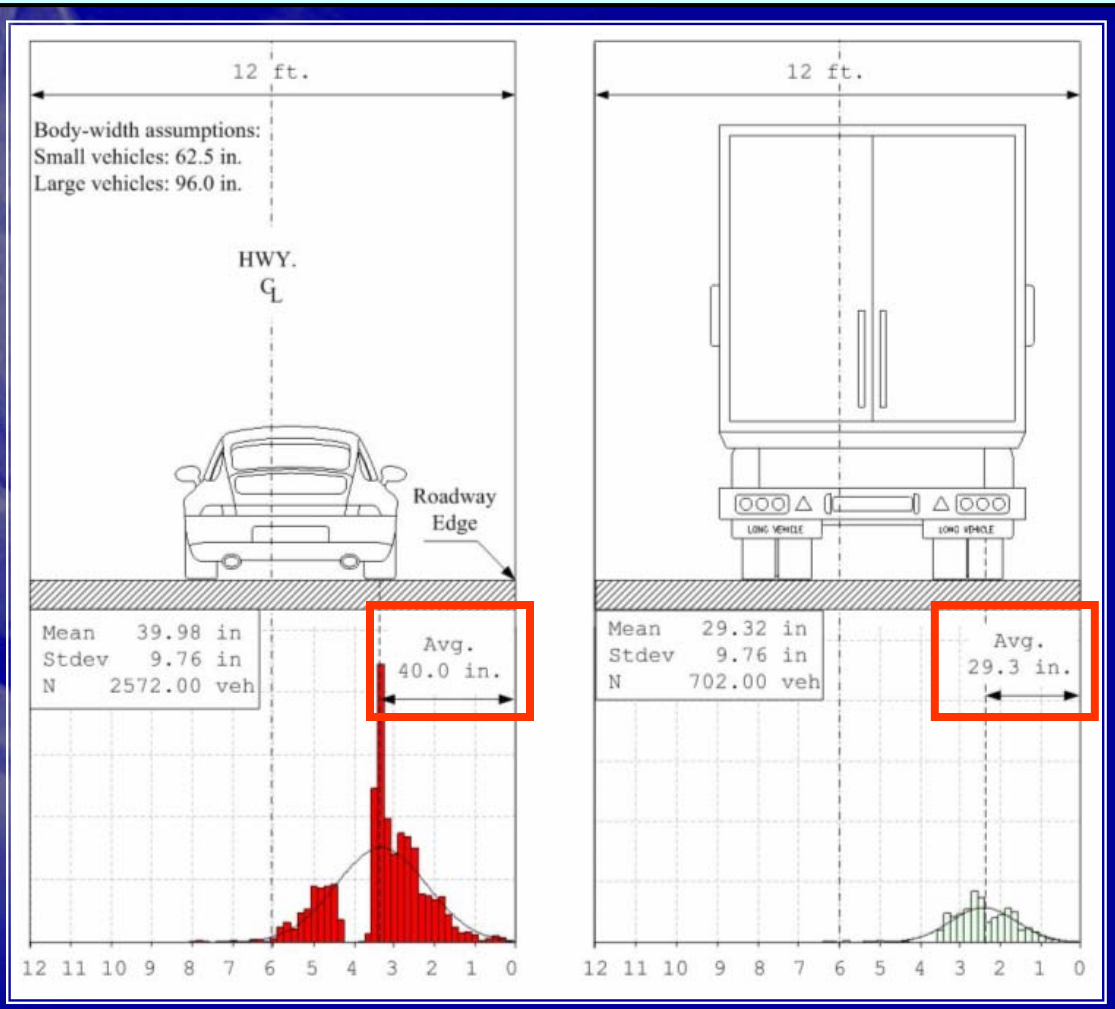
Results

Lane Distribution
(Baseline Condition)



Results

Lateral Placement (Baseline Condition)

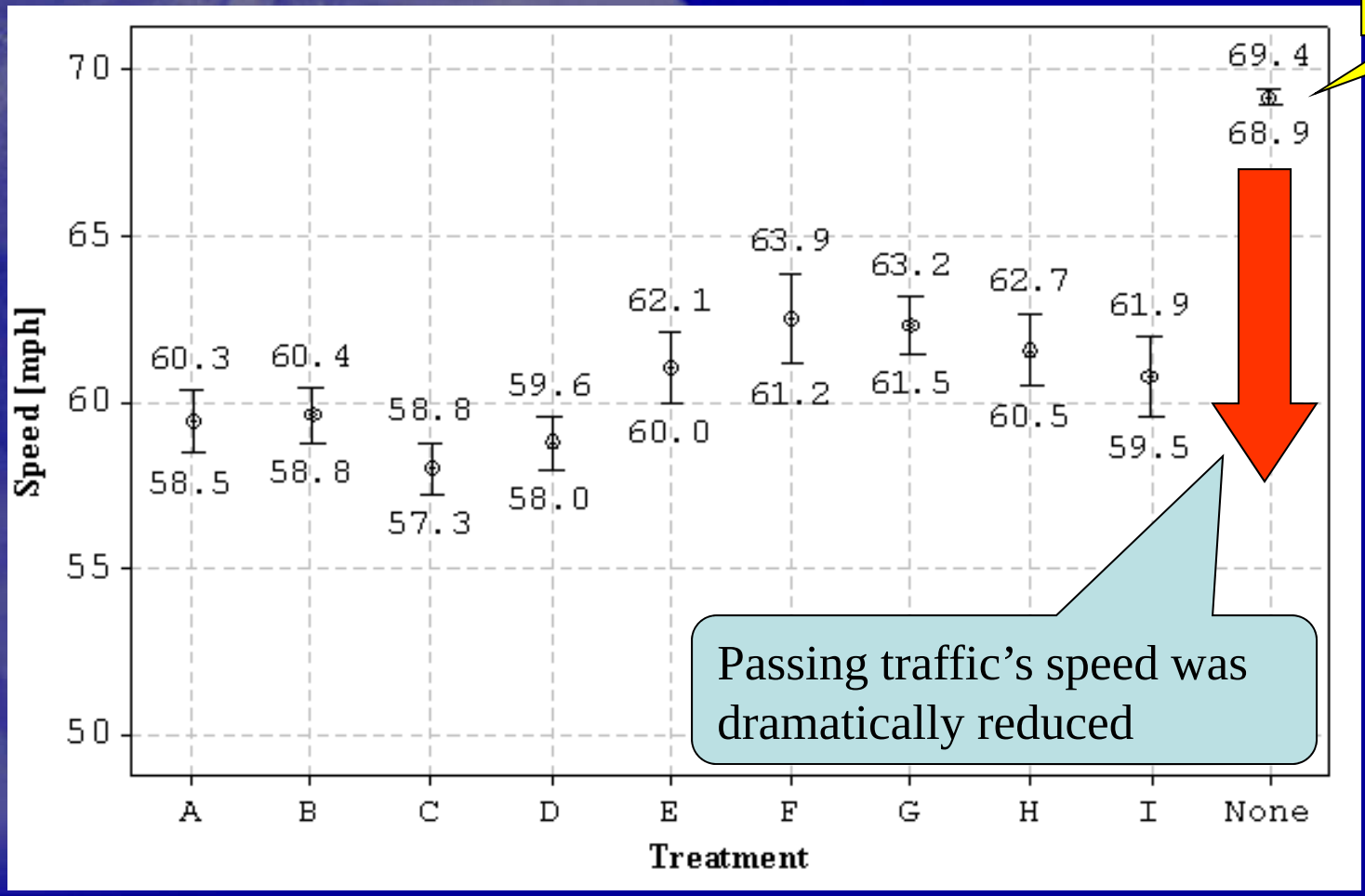


Results

…. What happened when treatments were in place?

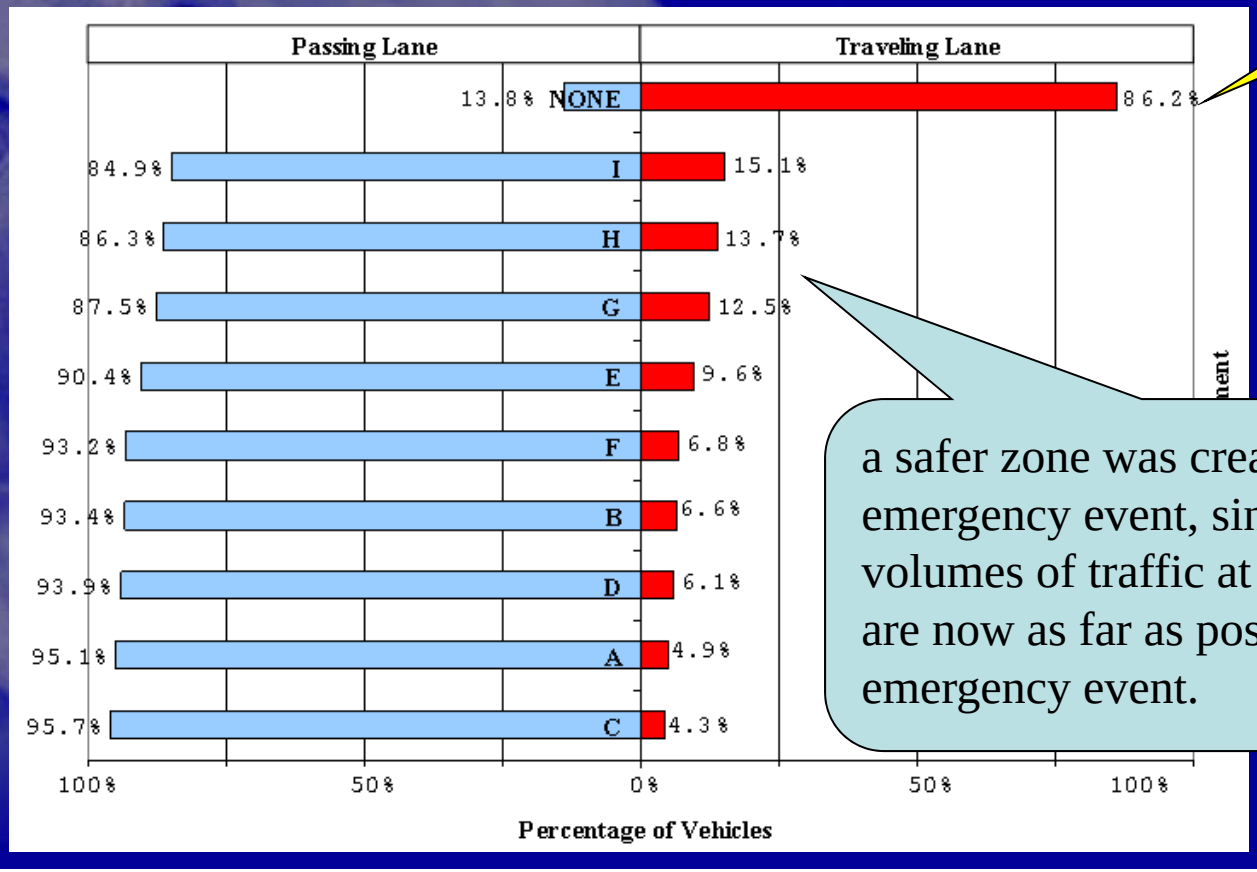
Results

Spot Speed (Experimental Conditions)



Results

Lane Distribution (Experimental Conditions)

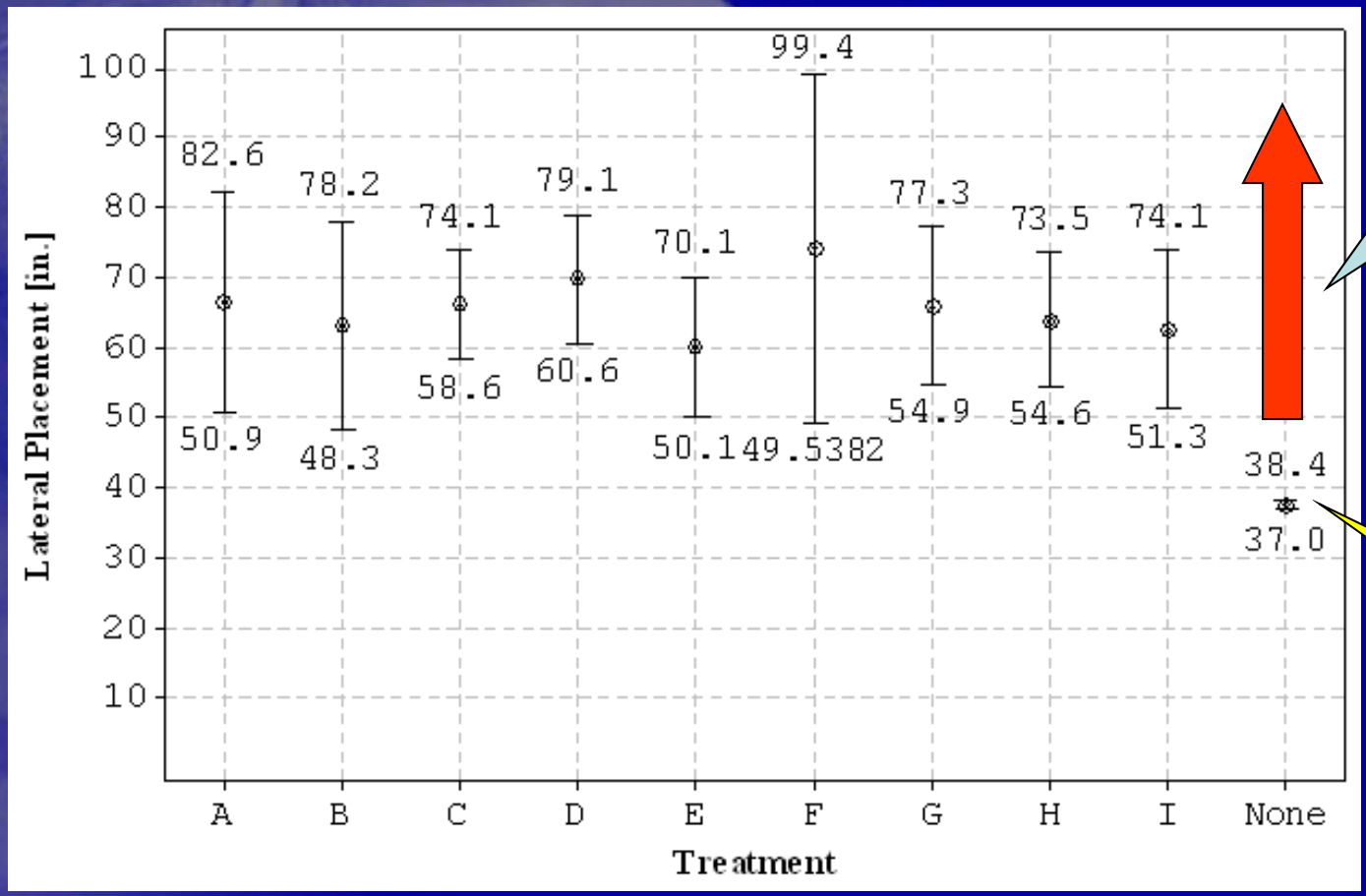


Baseline

a safer zone was created around the emergency event, since high volumes of traffic at high speeds are now as far as possible from the emergency event.

Results

Lateral Placement (Experimental Conditions)

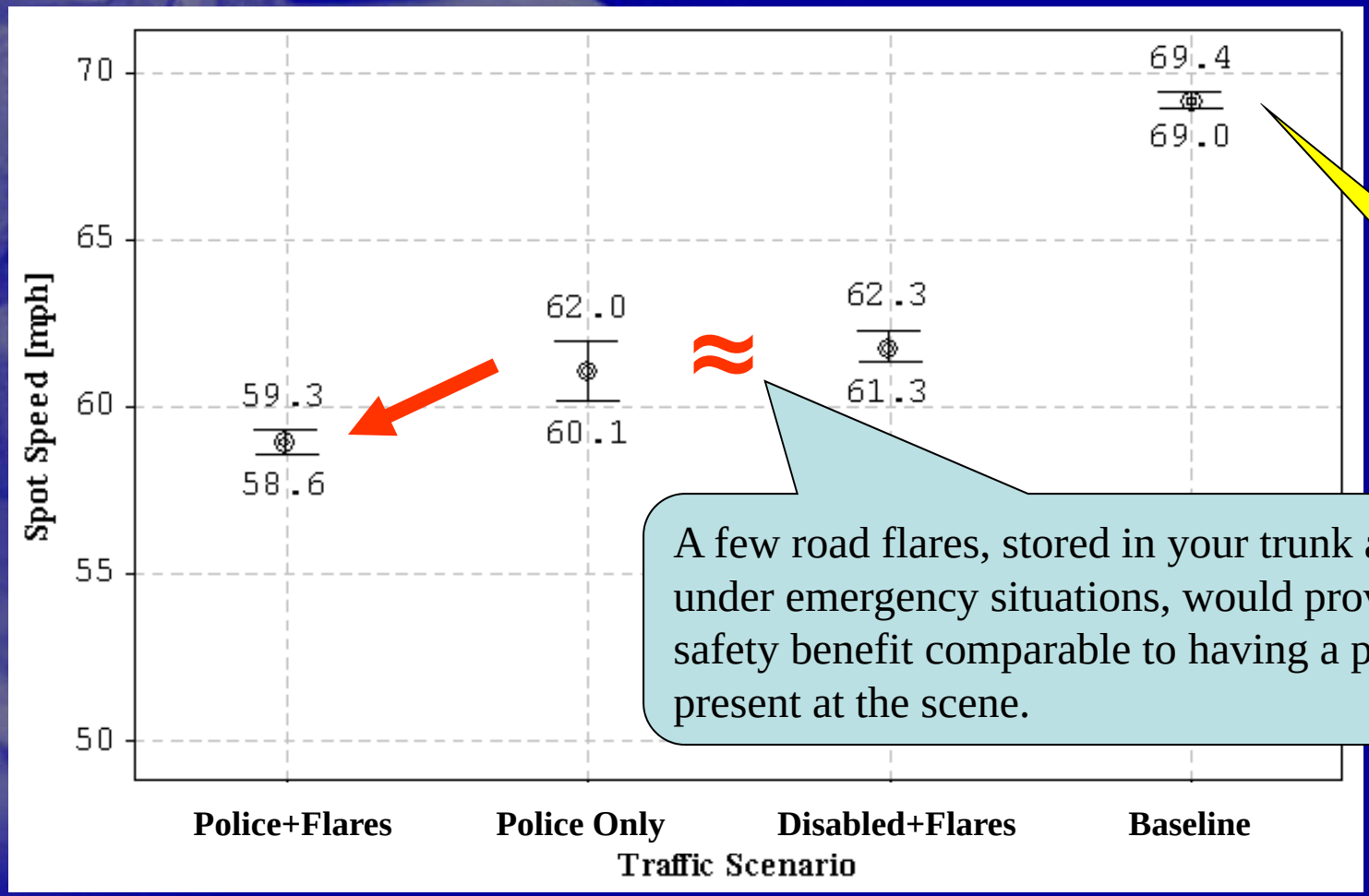


Lateral separation significantly increased.

Baseline

Results

Analysis by Traffic Scenario - Speed

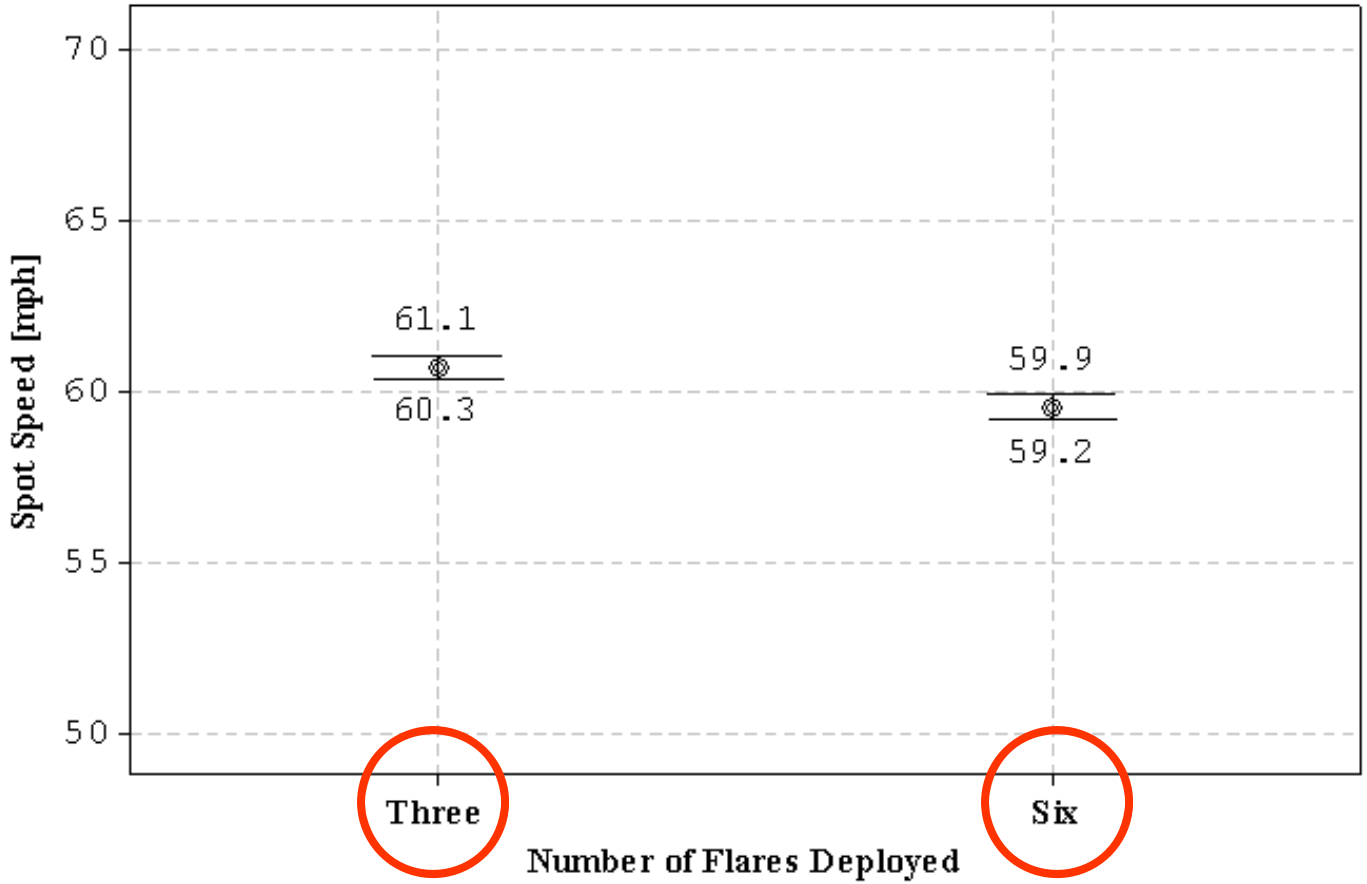


Baseline

A few road flares, stored in your trunk and used under emergency situations, would provide a safety benefit comparable to having a patrol car present at the scene.

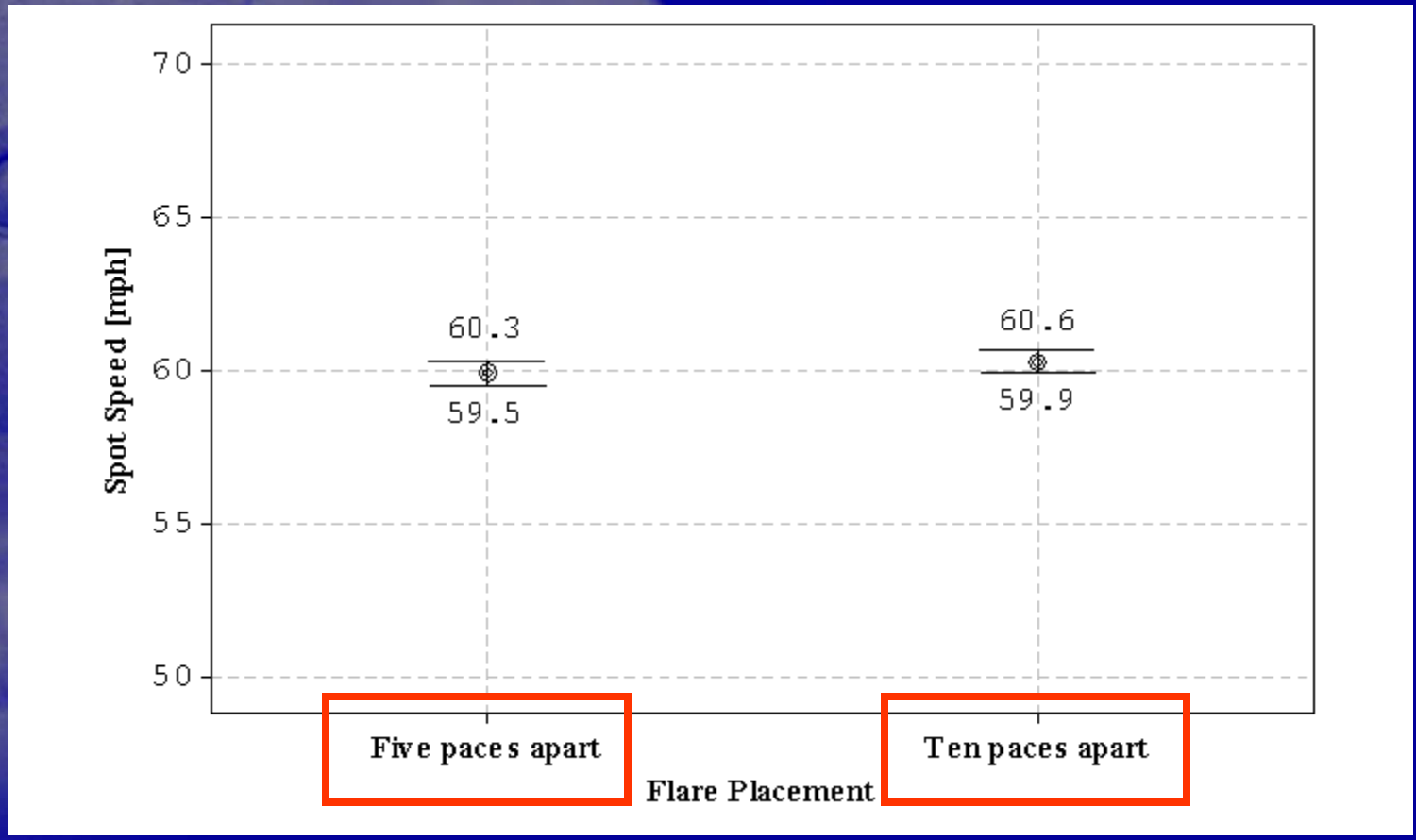
Results

Flare Number - Speed
Three Flares vs. Six Flares



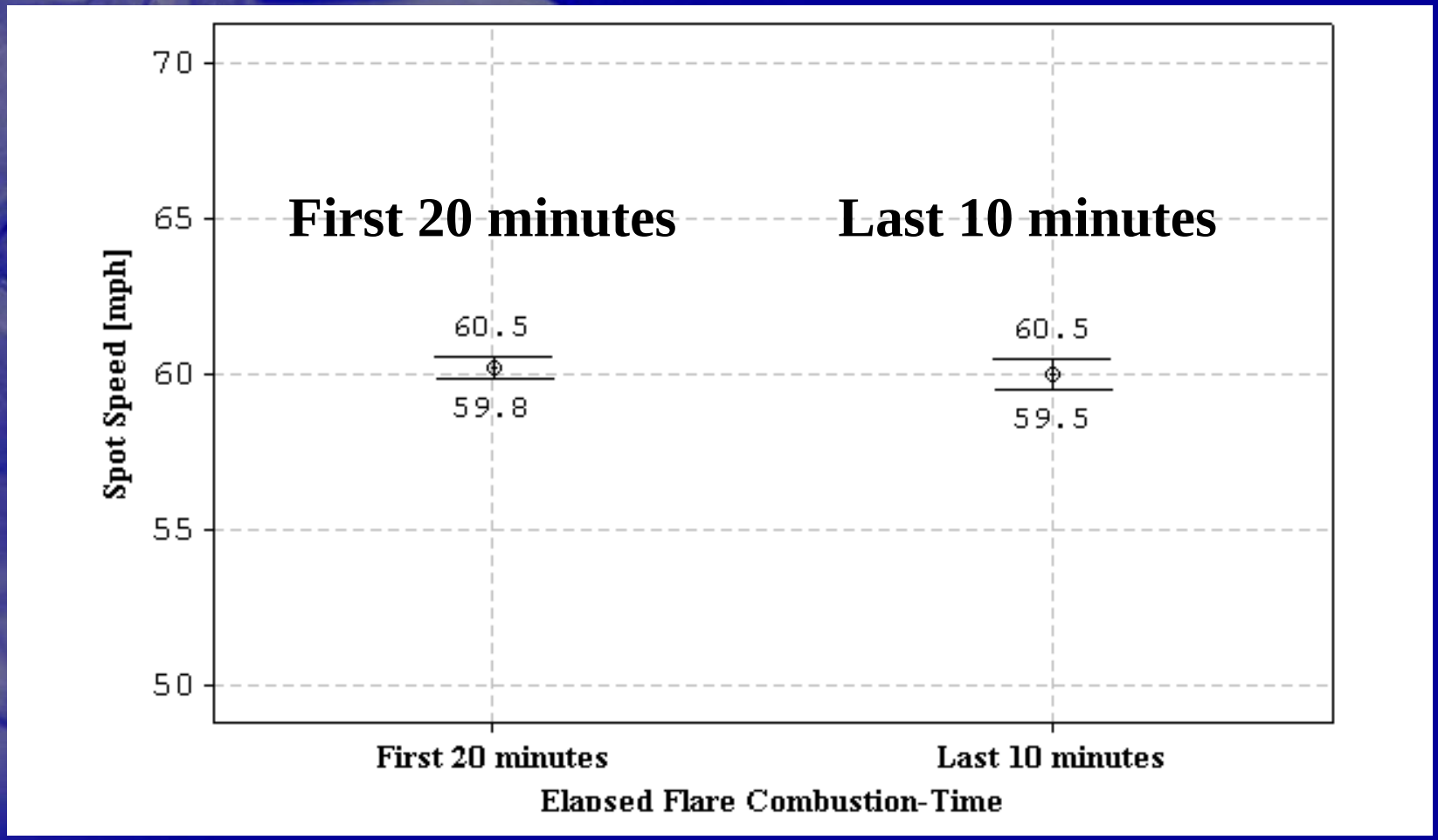
Results

Flare Placement - Speed
Five Paces vs. Ten Paces



Results

Flare Performance as a Function of Elapsed Combustion Time



Conclusions & Recommendations

Road flares significantly enhance the safety around a traffic emergency event and their use is highly recommended for both personal vehicle operators and road safety professionals as a supplement to their flashing light bars.

(Before the 2009 “Steer Clear” law.)