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RAILROAD GRADE CROSSING PASSIVE SIGNING STUDY

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INTERIM REPORT

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16. Abstract

More than three-fourths of the 219,000 public railroad grade crossings nationwide are equipped with passive warning signs only. A two-phase study is now underway to develop improved passive signing for use at these grade crossings. This study is a pool-funded effort involving 25 states, the Federal Railroad Administration and the Federal Highway Administration. This report describes seven signing configurations (at-crossing sign and advance warning signs) tested in two states during Phase I of the study, the test sites, the types of data collected, the experimental variables, the analysis procedure, and the results of Phase I. Upon completion of Phase II, which involves nationwide testing, a final report will be written making recommendations on what signs should be adopted for driver warning at railroad grade crossings.

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PREFACE

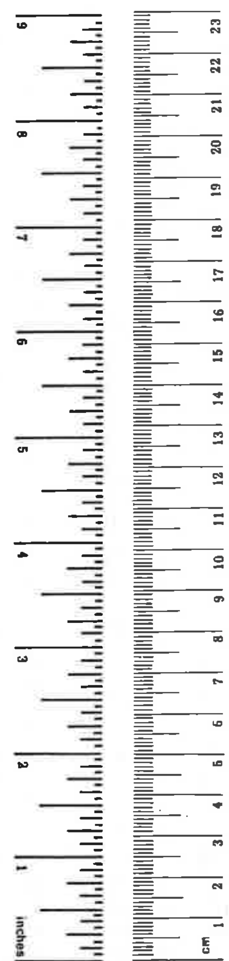
More than three-fourths of the 219,000 nationwide public grade crossings are instrumented with passive signs only. A two-phase study is now underway to develop improved signings for grade crossings. This study is jointly funded by 25 States, the Federal Railroad Administration and the Federal Highway Administration. This report describes the seven signing configurations (at-crossing sign and advance warning signs) tested in two States during Phase I of the study, the test sites, the types of data collected, the experiment variables, the data collection, reduction and analysis procedures, and the results of Phase I.

The authors express deep appreciation to a number of individuals who provided valuable and necessary support in the conduct of the experiment and report writing: Maurice Lanman who participated in the design of the experiment and managed the data collection activities at the Maine Facility; Patricia Brown who participated in the data reduction and analysis; and William Murphy, William Moloney, George Hallenborg, Norman Deserres, James Reardon, Peter Palermo, William Kemper and Grant Paul who collected the data at the sites in Ohio and Kentucky.

METRIC CONVERSION FACTORS

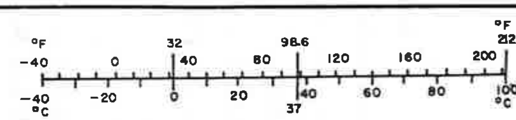
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

This interim report describes the first phase of a two-phase study to evaluate the effectiveness of seven new passive signing configurations in warning drivers of potential hazards of railroad grade crossings. In the interest of greater safety to motorists, this study was undertaken because more than three-fourths of the 219,000 public grade crossings nationwide are protected by passive signs only, the existing signing configuration has not been changed for many years, and it was hypothesized that introducing new signing at railroad grade crossings would be an effective method of improving safety at the crossings. The seven signing configurations were selected by a program advisory committee formed at the initial stages of this program. The committee consists of representatives of 25 participating states (see Appendix E), who are supporting this pool-funded effort, the Federal Railroad Administration, the Federal Highway Administration and the Association of American Railroads.

The purpose of Phase I was to determine on a limited scale whether any of the new signs showed promise of being more effective than the existing (base) sign configuration. Furthermore, Phase I was intended to determine the important experiment variables. The purposes of Phase II will be to test and verify the effectiveness of the "best" signs, as determined from Phase I on a national level while treating only the most important variables.

Phase I involved five test sites in Ohio and one test site in Maine. Before and after data were collected at each site so that relative improvements of the new signs could be determined. The performance data consisted of driver head movement (i.e., looking for a train) and vehicle speed profiles. In this experiment, head movement was taken to be the prime indicator of sign effectiveness because it is the most direct indication of driver response to the signs.

The only major significant finding of Phase I of the study was that the new signs in Ohio averaged an increment of 19 percent more head movement than the base sign (99 percent significant). Two signing configurations showed the most effectiveness in terms of head movement but not significantly with respect to the other new signs. Furthermore, there were no significant differences between the signs, including the base sign, in terms of the speed profiles.

The Maine data appeared to be strongly influenced by a seasonal trend and other extraneous effects making a determination of the most effective sign(s) quite difficult. In general, the Maine data did not show the strong indications of effectiveness (in terms of head movement) for all new signs as was the case for the Ohio data. Also, there were only a few indications of effectiveness (not significant) for the two signs that showed the most effectiveness in Ohio.

The following groups of drivers showed significantly more head movement, more speed reduction, and less speed near the crossing than their counter-parts:

1) required-stop vehicles;
2) female drivers;
3) drivers with passengers;
4) out-of-state drivers.

As could be expected, vehicles that approached the crossings at speeds less than 45 mph showed more head movement, less speed reduction and less speed near the crossing than vehicles that approached the crossing at speeds greater than 45 mph.

Since Phase I showed indications of effectiveness for the new signs (i.e., more head movement) the program advisory committee decided on December 3, 1975 to continue the railroad passive signing study into Phase II with further testing of three signing configurations at 18 new sites nationally.

1. INTRODUCTION

There are about 219,000 public railroad grade crossings in the United States with an additional 37,500 grade intersections separated by structures. Of these public railroad grade crossings, 50,370 are protected by "active" devices which provide the driver with a positive indication of the approach of a train (e.g., signals and/or gates). The remaining 168,630 public crossings and an additional 142,000 private crossings have some type of "passive" warning.

Static signs and markings constitute the usual form of passive warning. These inform the motorist of the existence and location of a crossing, but the driver must determine whether a train is approaching and whether it is safe to cross by looking up and down the tracks.

With more than three-fourths of the public grade crossings nation-wide equipped only with passive signs, it is most important that both the approach and at-the-crossing signs be effective. Furthermore, at the 70,000 or more crossings with two or fewer trains per day and 500 or fewer vehicles per day, economic justification for "active" devices does not appear possible. This study thus evaluated the relative effectiveness of seven new passive signing configurations and the existing passive configuration to warn drivers of the potential hazard of railroad grade crossings.

The Department of Transportation is also engaged in other programs to improve safety at railroad grade crossings. In FY 75 the DOT expended $129 million out of a total of $148 million to construct 112 grade separation structures nationally. The average cost per structure varied from about $500,000 at rural sites to over $2,000,000 at urban sites. In addition, research and development efforts are underway to improve active warning devices including "Constant Warning Time Devices," "Off-Track Train Detection Devices," "Active Advance Warning Signals" and "Improved Gate Arm Mechanism Study."

Due to the high cost of constructing structures and the relatively high costs of installing, maintaining and operating active warning devices, the majority of railroad grade crossings will continue to be equipped only with signs and markings which provide "passive" warning to drivers to proceed with caution.

This study on passive signing is a cooperative effort among 25 state highway agencies, the Federal Railroad Administration and the Federal Highway Administration. Each of these agencies have contributed funds for the conduct of the study. In addition, the States are providing sites for testing the new signs.

2. OBJECTIVE

The objective of this program was to experimentally determine the effectiveness of seven new passive signing configurations in warning drivers of the potential hazards at railroad grade crossings. The seven signing configurations were selected by a program advisory committee that was formed at the initial stages of this program. Since the existing signing configuration has not been changed for many years other then the angle of the crossbuck which was changed on the 1971 MUTLD, the program was initiated to determine the driver's attention, conveying the information needed for correct response, and presenting the information clearly and unambiguously. The experiment assumed that this behavior would be manifested in measurable performance parameters used in this report and described below.

Phase I of the study involved five test sites in Ohio and one test site in Maine. Before- and after- data were collected at each site so that relative improvements provided by the new signs could be determined. The results of Phase I are reported herein.

Phase II will expand the study to 18 new sites nationally testing and verifying the most effective signs (as determined from Phase I). The program will result in recommendations on what sign or signs should be adopted for driver warning at railroad grade crossings.

3. EXPERIMENT DESIGN

Experiments were conducted at five sites in Ohio and one in Maine. The five sites in Ohio were selected to provide information on site-to-site effects. In addition, these sites served as the primary sites from which major findings of sign effectiveness were determined. The site in Maine served as a control in the total experimentation providing information on "novelty" (learning) effect, sample size, seasonal, directional and weather effects.

Manual and electronic data consisting of independent and dependent variables were collected at each test site. The dependent variables were reduced to measures of effectiveness and analyzed for each major independent variable (data category). Standard statistical tests were applied to the data to determine the effectiveness of the new sign configurations.

3.1 SIGN CONFIGURATIONS

Seven new passive sign configurations plus the existing (base) configuration were evaluated during Phase I. These signs are described in Appendix A together with the sign selection procedures.

3.2 SITE DESCRIPTION

Descriptions of the five test sites in Ohio and the one in Maine are given in Appendix B. Each site had the following general characteristics:

a) Two-lane, two-way rural roadway with a high speed limit (greater than 45 MPH) preceding the crossing.

b) Average Daily Traffic (ADT) between 1,000 and 4,000.

c) Two - four trains per day.

d) Sight distance restrictions in at least one quadrant.

3.3 EXPERIMENTAL VARIABLES

During the course of the experiments both dependent and independent variables were measured or recorded manually for each vehicle as it traversed the test area.

3.3.1 Independent Variables

The independent variables were those that essentially remained constant for each vehicle. The independent variables considered in this experiment include:

a) site (5-Ohio, 1-Maine)

b) time of day (day-night)

c) vehicle type (car-other)

d) license plate (in-state, out-of-state)

e) driver (male, female)

f) passenger in vehicle (yes, no)

g) required-stop vehicle (yes, no)

Required-stop vehicles were:

1) motor vehicles carrying passengers for hire;

2) school buses carrying any school child;

3) vehicles carrying explosive or flammable materials.

h) approach speed>45 m.p.h. (yes, no)

i) train expected (yes, no)

A train was expected for a given vehicle if it arrived at the crossing within one hour of that vehicle.

j) weather (good, bad)

(Bad weather for purpose of this study was defined as rain, snow, fog or wet roadway conditions.)

Night data were not collected at the Maine site and bad weather data were not collected at the Ohio sites. Independent variables c-i are also referred t as driver groupings in this report.

3.3.2 Dependent Variables

The dependent variables in this experiment were head movement, speed profile and headway. Head movement was collected visually and recorded manually, while speed profile and headway were collected electronically. The dependent variables were transformed into the following measures of effectiveness

a) Head Movement

This measure was defined as driver head movement within the measurement zone as observed by the manual data collector. Data collectors were instructed to indicate head movement only when they were certain that the driver looked for a train. This was an important measure providing not only an indication of the attentiveness and safety orientation of the driver but also a direct and positive indication of the driver seeing and reacting to a particular sign configuration.

b) Speed Reduction

Speed reduction was defined as maximum speed minus minimum speed (based on sensed speeds) in the measurement zone when maximum speed occurs first, zero otherwise. The measurement zones were 600 feet to the crossing for the Ohio sites and 800 feet westbound and 1,000 feet eastbound to the crossing for the Maine site.

This measure provided an indication of whether or not the driver reacted to the sign configuration by slowing down in the measurement zone. This measure together with measure c speed near crossing provided a concise representation of the vehicle's speed profile. In general, large values of speed reduction implied more effectiveness.

c) Speed Near Crossing

This was the average speed (based on the sensed speeds) of the vehicle within 200 feet of the crossing on the approach side. This measure, in addition to providing information on the relative safety aspects between signs and sites directly, together with measure b speed reduction, provided information on the vehicle's speed profile near the crossing. Since advance warning signs were located approximately 300 to 600 feet from the crossing, reaction to the advance warning signs was expected to occur before the driver was "near the crossing." In general, smaller values of this measure implied more effectiveness.

d) RMS Deceleration

This was the root mean square deceleration of the vehicle within the measurement zone. This measure provided an indication of the smoothness of the speed profile and, hence an indication of the vehicle/vehicle accident potential as a result of driver reaction to a particular sign configuration. Larger values of this measure implied a less safe sign configuration. That is, larger values tended to indicate stronger braking for short periods during the approach rather than smooth braking for longer periods of time.

e) Headway Reduction Ratio

Headway reduction ratio was defined as the maximum (time) headway minus minimum headway (based on the sensed headways) all divided by the minimum headway. Headways were computed within the measurement zone and were with respect to the previous vehicle. Vehicles with minimum headways greater than six seconds were excluded from the computation. The ratio accounted for headway changes and weighted short headway vehicles more heavily. This measure provided an indication of rear-end accident potential due to dangerous headway reductions as a result of driver reaction to a particular sign configuration. Larger values implied less safe configurations.

f) Time in Hazard Zone

A vehicle was defined as being in the hazard zone if its speed at any point exceeded that required to make a comfortable stop 15 feet before the tracks.

A comfortable stop assumed a driver perception-reaction time of 2.5 seconds and a constant deceleration of 8.55 feet/sec.^{2} (See Reference 1). The speed vs. distance for a comfortable stop is shown in Figure 1.

In general, this study assumed that the more time spent in the hazard zone for a particular sign configuration, the less effective the sign.

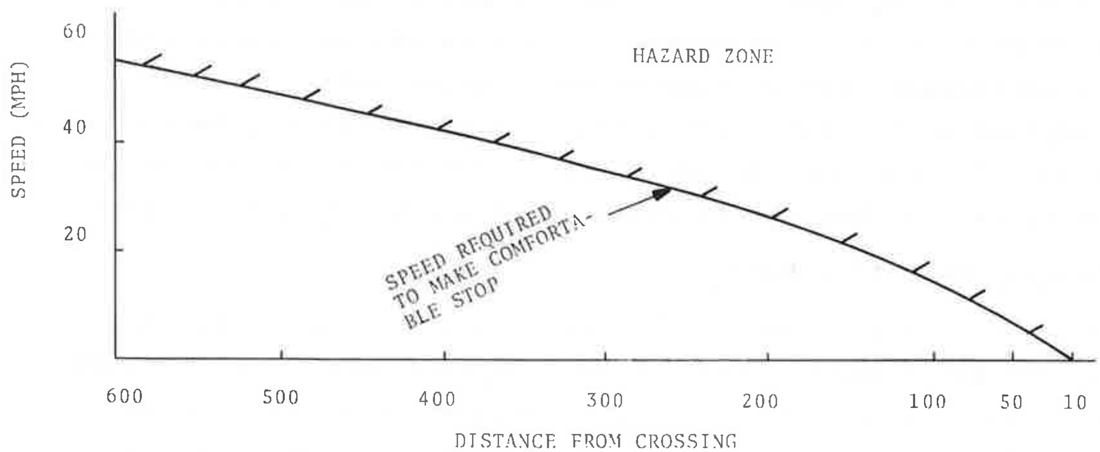

FIGURE 1, SPEED VS. DISTANCE FOR COMFORTABLE STOP

g) Stopped

This measure indicated whether or not a vehicle stopped before the tracks (observed visually, recorded manually). It was intended for two different types of evaluation in the analysis. First, for those vehicles required to stop, it provided an indication of relative compliance. Second, for those vehicles not required to stop, it provided an indication of adverse reaction (i.e., misinterpretation of sign configuration).

Note: This measure was subsequently eliminated from the analysis because of the paucity of required-stop vehicles and vehicles that actually stopped at the crossing when the data were being collected.

3.4 DATA COLLECTION & TEST SCHEDULE

3.4.1 Ohio Sites

Electronic and manual data were collected on only one side of the crossing at the Ohio sites. (The data collection side at each site is indicated in Figures B-1 through B-5). The electronic data provided speed-profile information and were obtained using a data-acquistion system housed in a mobile van. The mobile van, shown in Figure 2, was parked off the side of the road about 100-200 feet from the crossing. (The exact location of the van at each site during the tests is also shown in Figures B-1 through B-5). Although the van was visible to the passing motorists, it did not seem to affect the driver's behavior to the various sign configurations. It was an unmarked recreational vehicle and due to the rural characteristics of the sites, most of the passing motorists paid little or no attention to its presence. Attempting to conceal the van was out of the question because of its size and lack of adequate obstructions.

A schematic of the sensor locations and field equipment set-up is shown in Figure 3. The measurement zone for each test site in Ohio was approximately 600 feet (i.e., from the first sensor to the crossing). The sensors (pressure-sensitive coaxial cables) were laid across the lane of the roadway on the approach side of the crossing and were activated by each axle of each vehicle. The activation times of each sensor were stored on magnetic tape located in the van for subsequent data reduction and analysis. The first two sensors located at approximately 600 feet from the crossing were separated by only four feet to provide axle-to-axle length and spot speed information. Spot speeds were thus measurable at each of the remaining sensor locations. The spacings of the cables were selected in order to obtain maximum data concerning driver reaction to the given sign configuration and to obtain measures of vehicle parameters at approximately regular time intervals as the vehicle decelerated. The sensors were taped to the roadway, using camouflage tape, and because of their small size (1/8-inch diameter) were very difficult to detect by the passing motorist.

Manual data were collected on a clipboard by an observer located in the van. The manual data consisted of vehicle crossing time, vehicle type, passenger/no passenger, in-state/out-of-state vehicle, male/female driver, driver looked for train/did not look, vehicle stopped at crossing/did not stop, and train crossing time (whenever it occurred during the data collection period). A sample of a manual

FIGURE 2. MOBILE VAN

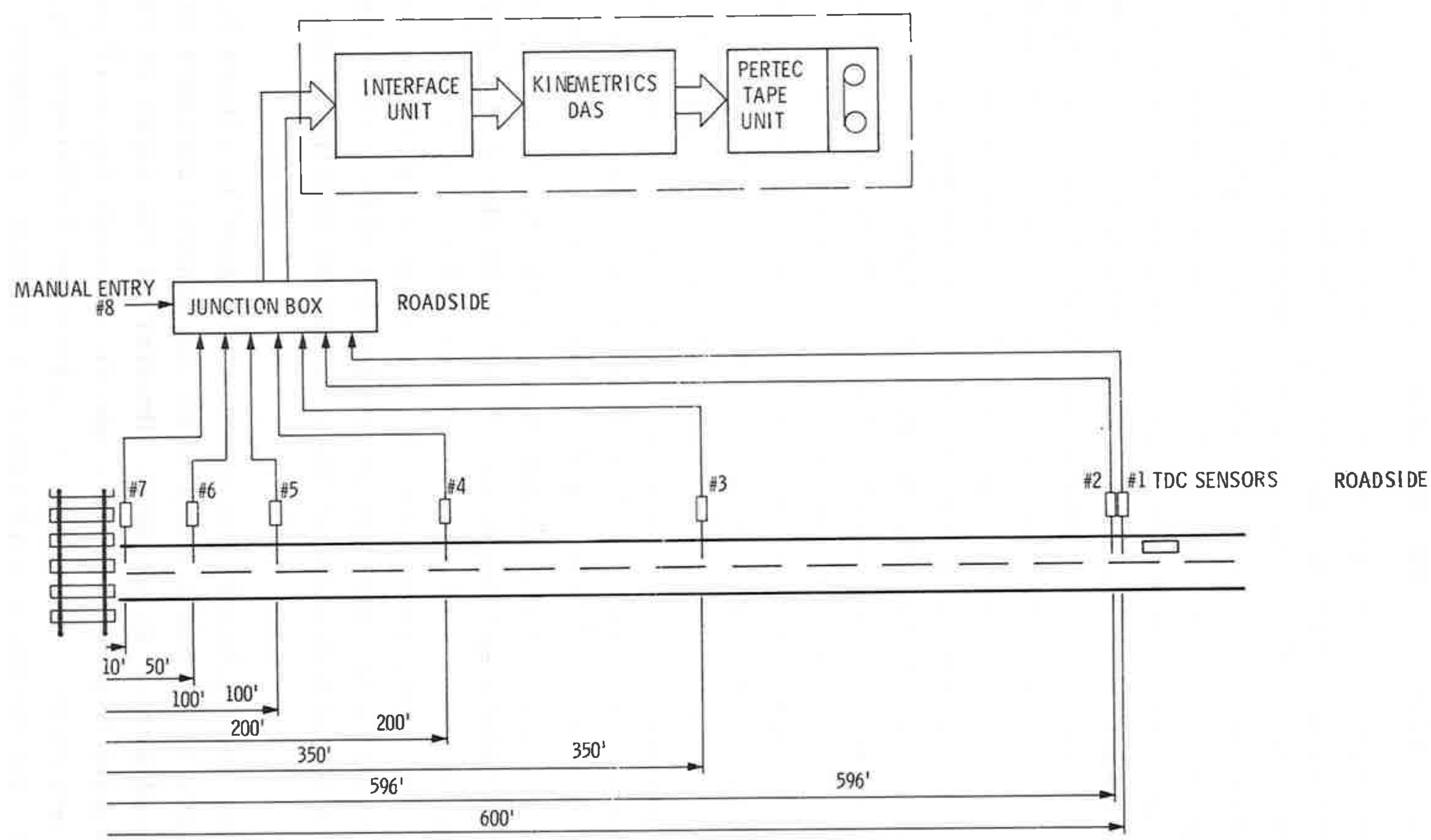

FIGURE 3. MOBILE FIELD EQUIPMENT SET-UP

data collection sheet is shown in Figure 4.

Data were collected for two days at each site including four hours of night data. Data during the daylight hours were fairly equally distributed between morning and afternoon hours in order to minimize time-of-day effects. Data collection at night (no manual data) was not initiated before one-half hour after sunset. Initially seven sites were to be included in this part of the experiment. This would have provided a balanced incomplete block design as shown by the planned sign/site arrangement in Table 1. Each new sign at each site was to be installed three weeks prior to actual data collection for that sign. However, due to vandalism, theft and poor road condition (causing damage to the sensors), two sites were abandoned half-way through the planned experiment. This required a change in the experiment design resulting in the incomplete unbalanced block design as shown in Table 2. Although not as desirable as the first arrangement, this new sign/site arrangement had the properties of testing each sign at least twice (sign configuration 1 was tested three times) and each new sign together with four other new signs. (Sign condition 1 was tested together with the remaining six new sign configurations). Increasing the number of passes at the remaining five sites was ruled out as a design alternative after the abandonment of the two sites because of the tight schedule and arrangement made with the states and railroads for completion of the experiment. Also, it was decided that the three passes for the new signs at the five sites would provide sufficent data for assessing the effectiveness of the new signs and for determining whether or not to continue into Phase II.

The actual test schedule for Phase I is shown in Figure 5. Most of the new signs had a three-week (or longer) exposure period before data collection as planned. However, a few signs at the end of the experiment had only about a one or two-week exposure period. (Subsequent analysis - in Section 4 - showed no difference in effectiveness due to these different time periods of exposure.)

OBSERVER______________

RAILROAD CROSSING EXPERIMENT

Date__________ Site #______________ Sign Condition #______________

Sheet # cr Time: Start__________ Time: End______________

VEH. #	CROSSING TIME	VEHICLE TYPE				PASSEN-GER(S)	OUT OF STATE	DRIVER		STOPPED	COMMENTS
		T	B	O	REQ. STOP			FEMALE	LOOKED		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
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22											
23											
24											
25											
26											
27											
28											
29											
30											
	TIME	T	B	O	REQ. STOP	PASSEN-GER(S)	OUT OF STATE	FEMALE	LOOKED	STOPPED	COMMENTS

FIGURE 4. SAMPLE MANUAL DATA COLLECTION SHEET

TABLE 1. PLANNED SIGN/SITE ARRANGEMENT -- KENTUCKY-OHIO

TEST SITE		EXPERIMENT PASS			
		1	2	3	4
JOHNSON, OH.		B	3	7	4
WASHINGTON COURT HOUSE, OH.	S	B	5	4	2
DARBYDALE/PLEASANT CORNERS, OH.	I	B	1	2	3
LOGANSVILLE, OH.	G	B	7	5	1
HILLSBORO/DANVILLE, OH.	N	B	4	1	6
KIMPER, KY.	S	B	2	6	7
NIGH, KY.		B	6	3	5

SIGN CONFIGURATION LEGEND*

B = BASE CONDITION
1 = YELLOW CROSSBUCK
2 = BRIGHT YELLOW GREEN
3 = SWISS CROSSBUCK
4 = TEXAS SIGNING
5 = ROUND CHOO CHOO
6 = DIAMOND CHOO CHOO
7 = LOOK FOR TRAIN

*SEE APPENDIX A FOR SIGN CONFIGURATION DESCRIPTIONS.

TABLE 2. ACTUAL SIGN/SITE ARRANGEMENT -- OHIO

TEST SITE		EXPERIMENTAL PASS 1	2	3	4
JOHNSON	S	B	3	7	6
WASHINGTON COURT HOUSE	I	B	5	4	2
DARBYDALE/PLEASANT CORNERS	G	B	1	2	3
LOGANSVILLE	N	B	5	1	7
HILLSBORO/DANVILLE	S	B	1	6	4

SIGN CONFIGURATION LEGEND*

B = BASE CONDITION

1 = YELLOW CROSSBUCK

2 = BRIGHT YELLOW GREEN

3 = SWISS CROSSBUCK

4 = TEXAS SIGNING

5 = ROUND CHOO CHOO

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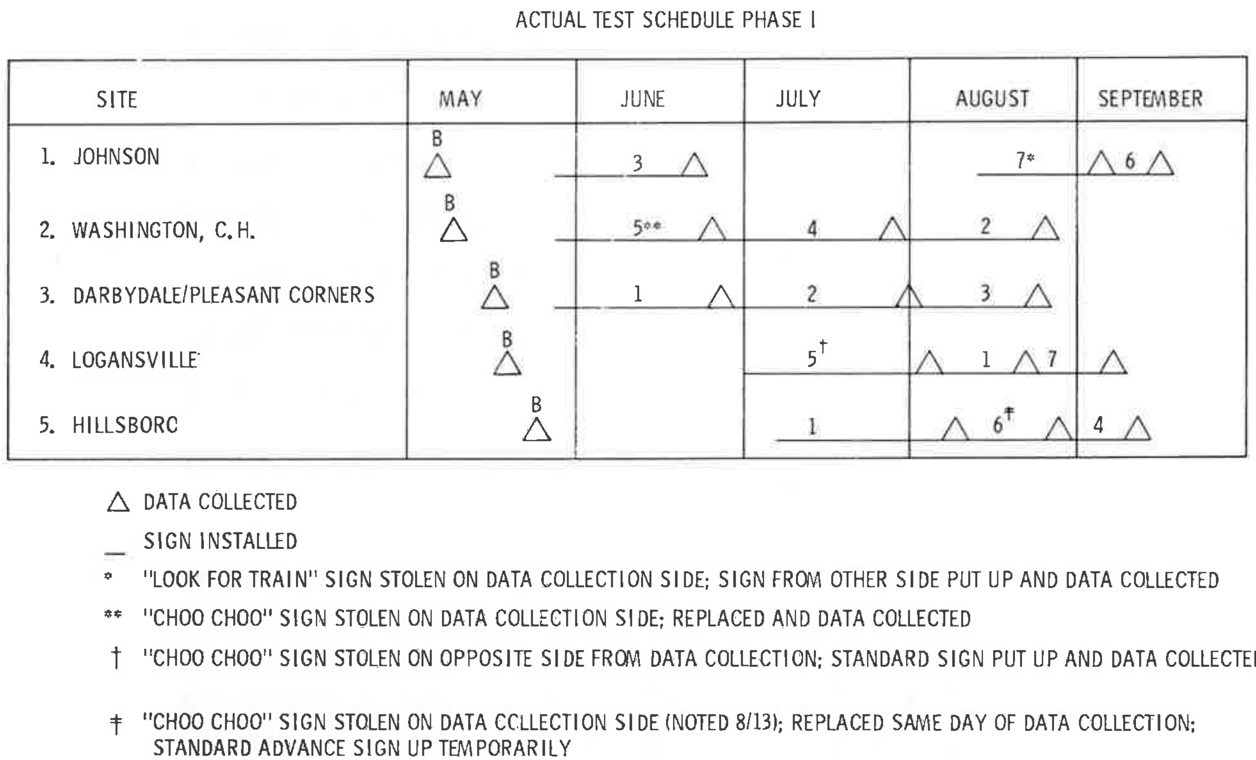

FIGURE 5. ACTUAL TEST SCHEDULE, PHASE I -- OHIO

Also apparent from Figure 5 was the high attraction to thieves of the new signs, especially the "choo choo" signs. (See Appendix A for sign configuration description.) It was difficult to determine the effect of stolen or missing signs. (It was not known, of course, exactly when a sign was stolen, but Section 4.2.1 showed that there was no significant difference in effectiveness between those conditions where a "choo choo" sign was stolen and one condition in Johnson where the "choo choo" sign was not stolen.)

Table 3 shows the sample sizes for each site and each sign configuration as well as for daytime and nighttime conditions. The daytime sample sizes ranged from a high of 245 to a low of 103 while the nighttime sample sizes ranged from 131 to 20.

3.4.2 Maine Site

The Maine railroad grade crossing site is located on the FHWA/TSC Maine Facility, which is a 15-mile stretch of instrumented highway along U.S. Route 2 in northern Maine between Newport and Canaan. This facility has the capability to detect vehicles and track their positions as they travel along sections of the electronically instrumented two-lane road and to store the collected vehicle information on magnetic tape for subsequent off-line data reduction. A schematic of the test site is shown in Figure B.6. The measurement zones for the railroad crossing experiment were 800 feet for westbound traffic and 1,000 feet for eastbound traffic. The electronic system provides link speeds between successive sensors.

Manual data were collected similarly to those for the Ohio sites. No night data were collected at the Maine site.

The data collection schedule and sample sizes for the Maine experiment are shown in Table 4. Each sign was tested over a four-week period to provide information on the "novelty" effect of each new sign. The Texas signing configuration was tested first since it was the most colorful and was expected to show the most "novelty" effect. The round choo choo and diamond choo choo configurations were tested back-to-back since it was felt their similarity would provide information on possible extended or prolonged "novelty" effects (i.e., greater than four weeks).

TABLE 3. SAMPLE SIZES - OHIO SITES

SAMPLE SIZES - OHIO SITES

SITE \ SIGN		STANDARD 0		YELLOW CROSSBUCK 1		BRIGHT YELLOW GREEN 2		SWISS CROSSBUCK 3		TEXAS SIGNING 4		ROUND CHOO CHOO 5		DIAMOND CHOO CHOO 6		LOOK FOR TRAIN 7	
		D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
JOHNSON	1	200	100					168	56					103	82	216	69
WASHINGTON, C.H.,	2	203	64			168	59			151	29	183	64				
DARBYDALE PLEASANT CORNER,	3	245	76	115	34	146	131	177	82								
LOGANSVILLE,	4	160	50	133	59							120	49			155	20
HILLSBORO/DANVILLE,	5	172	68	152	35					158	76			172	100		

TABLE 4. MAINE DATA COLLECTION SCHEDULE & SAMPLE SIZES

MAINE DATA COLLECTION SCHEDULE & SAMPLE SIZES

	STANDARD 0	TEXAS SIGNING 4	YELLOW CROSSBUCK 1	LOOK FOR TRAIN 7	ROUND CHOO CHOO 5	DIAMOND CHOO CHOO 6	BRIGHT YELLOW GREEN 2	SWISS CROSSBUCK 3
WEEK # 1	618(E)/514 (W)	246/249	174/143	236/213	*251/269	† 178/170	195/179	199/198
WEEK # 2 WEATHER DATA	192/168		257/226	240/227 ‡	**	156/227	197/226	135/134
WEEK # 3		283*/262	178/171	264/246	300/365	197/226	270/282	0/192
WEEK # 4		428/441	411/410	361/385	410/409	343/396	428/431	374/448
	3/3	3/24	4/21	5/19	6/16	7/18	8/15	9/10 – 10/6

MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER

* - CENTERLINE AND EDGE MARKINGS REPAINTED 6/18/75

** CHOO CHOO SIGN AND POST STOLEN (6/25 - 6/27) WESTBOUND, REINSTALLED 7/1

† CROSSING SMOOTHED (7/23)

‡ FLASHING LIGHT EXPERIMENT (5/30 - 8/12)

Data at the Maine site were also collected during periods of inclement weather to determine its effect on driver response to the new sign configurations.

Although weather data are shown in the Week #2 slot in Table 4, it was actually collected whenever bad weather conditions existed over the four-week period for each sign configuration. There was no inclement weather during the four-week periods that the Texas signing and round choo choo configurations were tested. Therefore, no bad weather data were collected for these sign configurations. Figure 9 also shows the sample sizes for each week, each sign configuration and each direction of travel --East (E) and West (W). Although data were collected for Week 3 of sign configuration 3 (Swiss crossbuck), Eastbound traffic, the sample size is shown as 0 because the data were electronically "lost" during data reduction and not used in the analysis.

A few events that occurred during the experimentation and might have an impact on the results are noted in Table 4. The effects of these events are discusses in the analysis section.

3.5 DATA REDUCTION

Data reduction for the railroad grade crossing experiment was performed at the Maine Facility in three phases. The first phase tracked, sorted and collated the electronic and manual data by vehicle so that all"'raw" data pertaining to each vehicle would be together for further data reduction. The data included vehicle identification, vehicle length, time of each sensor crossing, speeds at each sensor, headway in seconds (from previous vehicle), head movement and the independent variables listed in Section 3.3.1. A "sorted data file" was created for each site, sign configuration, time of day (Ohio data only), weather condition (Maine data only) consisting of all vehicles recorded during the appropriate period. Vehicles that turned off or entered from a sideroad or driveway in the test region were excluded from the "sorted data file."

In the second phase of the data reduction process, measures of effectiveness were computed and independent variables were coded for each vehicle.

In the third phase of the data reduction process, statistics for determining means, variances and cross correlations among the measures of effectiveness and the independent variables were computed. A "statistics file" was created for each "sorted data file" but excluded those vehicles arriving at the crossing within five minutes of a train crossing. Also, separate statistic files were maintained for vehicles with headways less than or equal to six seconds and with headways greater than six seconds.

The statistics provided the basis for various analysis including analysis of variance and cross correlations which are presented and discussed in the next section.

4. RESULTS

The results of Phase I of the railroad grade-crossing passive signing study are presented below in three parts. The first part evaluates the effectiveness of the seven new passive signing configurations in terms of six measures of effectiveness: head movement, speed reduction, speed near crossing, RMS deceleration, headway reduction ratio and time in hazard zone. The second part evaluates driver behavior by groups. Seven groupings (i.e., categories of groups; also independent variables) are considered. The seven groupings are:

1) Vehicle type (auto vs other);
2) Driver (male or female);
3) License Plate (in-state vs out-of-state);
4) Passengers (yes vs no);
5) Required-Stop Vehicle (yes vs no);
6) Approach speed (less than 45 mph vs greater than 45 mph);
7) Train Expected (yes vs no);

This evaluation is made in terms of the measures of effectiveness and without regard to the sign configurations. That is, all the sign configurations are treated equally and all data are pooled. The third and final part evaluates relative sign configurations effectiveness by driver groups in terms of the measures of effectiveness.

These three parts are presented separately for the Ohio data and for the Maine data. Before examining the actual results, the next section describes the analysis approach for each part in detail. Finally, the last section summarizes the important results of the entire experiment.

4.1 ANALYSIS APPROACH

4.1.1 Evaluation of Sign Effectiveness

The analysis approach in this evaluation compares the sign configurations in terms of the measures of effectiveness. In general, sign configurations that show more head movement, more speed reduction, less speed near the crossing, less RMS deceleration, less headway reduction ratio and less time in the hazard zone are considered more effective. Those sign configurations that show apparent conflicting results from one measure to another are discussed in detail when they occur. Although no specific weighting is attached to the measures of effectiveness in the evaluation, the first three measures are considered more important than the last three in this report. The first three measures are more direct and interpretable measures of driver reactions to the various sign configurations. The last three measures represent an attempt to identify new measures for evaluating motorist behavior and are thus considered experimental measures. The data actually show that these three latter measures provide vague, inconsistent results and no significant additional information compared to the first three measures.

The six measures of effectiveness are compared in this evaluation using two methods.

The first method is the mean value of each measure of effectiveness for each sign, tested at each site (Method 1). Three of the seven new passive sign configurations plus the base configuration were tested at each of the five sites in Ohio. At the Maine site, all seven new sign configurations plus the base configuration were tested, each over a four-week period. In the evaluation the mean values of each measure of effectiveness for the Maine data are further broken down by week while those for the Ohio data are provided only for each site/sign arrangement. Sample sizes and standard deviations are also provided for each mean value so that the significance of the results can be determined.

The second method is Analysis of Variance (ANOVA) - Ohio sites only (Method 2). The analysis of variance provides estimates of the relative sign configuration effects corrected for site effects. This method eases the problem of trying to rank the signs in terms of effectiveness by comparing the mean values for each measure, from site to site and sign to sign (i.e., method 1 above). Furthermore, this method (2) provides a concise, quantitative comparison of the sign configurations. The comparisons are with respect to relative mean estimates of each measure of effectiveness (i.e., base configuration measures equal zero) for each new sign configuration. Standard deviations for each relative mean estimate are also provided for determining statistical significance. The application of ANOVA relative mean estimates and standard deviations to this experiment is discussed in Appendix D.

The two methods described above are presented graphically for each major category of the Ohio data (i.e. all vehicles - daytime; all vehicles - nighttime). Only the first method is presented, also graphically, for each major category of the Maine data:

a) all vehicles, daytime, good weather, eastbound;
b) all vehicles, daytime, good weather, westbound;
c) all vehicles, daytime, bad weather, eastbound;
d) all vehicles, daytime, bad weather, westbound.

The second method was not appropriate for the Maine data because all signs were tested at one site. Furthermore, using week of test as an ANOVA variable was precluded because method one gave no indications of any week-to-week effects.

4.1.2 Evaluation of Driver Behavior by Groups

In this part of the analysis driver behavior is evaluated by groups in terms of the three primary measures of effectiveness without regard to sign configuration. That is, all sign configurations including the base configuration are pooled together. In addition, for the Maine site, all weeks are pooled together. The results are presented separately for the Ohio sites-daytime and the Maine site-good weather, daytime, eastbound and westbound. The three remaining measures RMS deceleration, headway reduction ratio and time in hazard zone were not presented because of their experimental nature and random and inconclusive characteristics.

The results are presented in bar-graph form. For the Maine site, the data are presented in terms of the means of the measures of effectiveness with solid bars superimposed providing an indication of the significance of the results. For the Ohio sites, the data are presented in terms of relative means of the measures of effectiveness corrected for site effects (described in more detail in Appendix D). Solid bars are also superimposed on the Ohio data to provide an indication of the significance of the results. These evaluations are intended to indicate the behavioral characteristics of different groups of drivers when approaching railroad crossings.

4.1.3 Evaluation of Relative Sign Configuration Effectiveness by Driver Groups

In this part of the analysis, relative sign configuration effectiveness is evaluated by driver groups in terms of the three primary measures: head movement, speed reduction and speed near crossing. The other measures are not considered, again, because of their experimental nature and their random and inconclusive characteristics. The results are presented separately for the Ohio sites and the Maine site eastbound and westbound.

The evaluations are intended to identify any unique sign configuration effectiveness for different driver populations.

The results of the Ohio data were generated from "F" tests (described in more detail in Appendix D) and are presented in tabular form. Five groupings (i.e. categories of groups; also independent variables) were tested. They were vehicle type (auto vs other); driver (male vs female); time of day (day vs night); passengers (yes vs no); and approach speed (greater than 45 MPH vs less than 45 MPH). Two groupings -- license plate (in-state vs out-of-state) and required-stop vehicles (yes vs no) -- were not tested becuase of the lack of sufficient data. Another grouping -- train expected (yes vs no) -- was not presented because it showed ambiguous results (see Section 4.3.1). Furthermore, this latter grouping may not have been as precise as desired: all vehicles crossing the tracks within one hour of a train were defined as "expected a train."

The results of the Maine data are presented and contrasted in terms of the mean values of each measure for each week of testing and for each sign configuration. Only one grouping -- license plate -- is contrasted (out-of-state vs all-vehicles). This is because (1) sufficient data were available and (2) the contrast was not made for the Ohio sites. The other groupings were not contrasted because the Maine data in general was not suitable for discriminating sign configuration differences (see Sections 4.2.5, 4.2.6, 4.2.7 and 4.2.8).

4.2 EVALUATION OF SIGN EFFECTIVENESS

4.2.1 Ohio-All Vehicles-Daytime

The mean values of each measure of effectiveness for each sign configuration tested at each site in Ohio are presented in this section. Three new passive sign configurations plus the base configuration were tested at each of the five sites in Ohio. Table 2 shows the actual sign/site arrangement. Figure 6 shows in bar-graph form the mean values of each measure of effectiveness for each new sign configuration and base sign configuration tested at each site. (The mean values for the base sign configuration were of course different from site to site.) The length of the bars represents the change in effectiveness from the base sign configuration to the new sign configuration. The solid bars represent an improvement in effectiveness from the base sign configuration to the new sign configurations while the open bars represent a lesser effectiveness. Thus, with this convention, and for those measures that havea positive sense (i.e., the larger the measure, the greater the effectiveness) - namely, head movement and speed reduction - the reading at the top of the solid bar represents the mean value for the new sign configuration while that at the bottom represents the mean value for the base sign configuration. For these same measures, the reading at the top of an open bar represents the mean value of the base sign configuration while the reading at the bottom of an open bar represents the mean value for the new sign configuration.

For those measures that have a negative sense (i.e., the more the value, the less the effectiveness) - Speed near crossing, RMS deceleration, headway reduction ratio and time in hazard zone - the reading at the top of a solid bar represents the mean value for the base sign configuration while that at the bottom represents the mean value for the new sign configuration. For these four measures, the reading at the top of an open bar represents the mean value for the new sign configuration while the reading at the bottom of an open bar represents the mean value for the base sign configuration.

The important points to remember about the presentation method are:

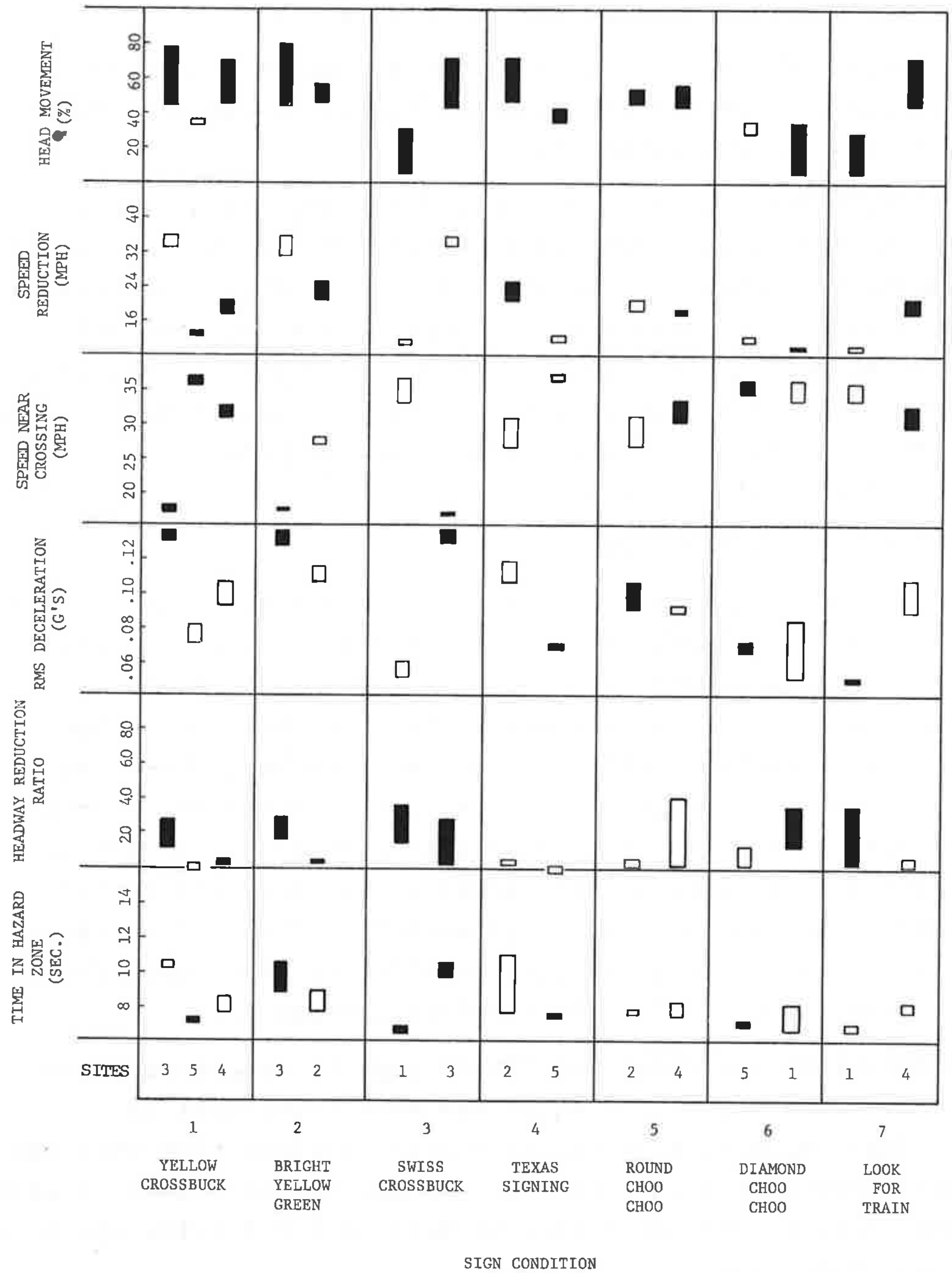

FIGURE 6. MEASURES OF EFFECTIVENESS, OHIO-ALL-DAY

a) a solid bar represents more effectiveness for the new sign configurations compared to the base sign configuration. Just the opposite is true for an open bar.

b) The length of the bar indicates the amount of change in effectiveness for the new sign configuration compared to the base sign configuration.

The method of presentation was adopted for this report because it provides the mean values for all measures for all sign configurations including the base, and for all sites in a compact and readily discernible format. The mean values, sample sizes and standard deviations corresponding to Figure 6 are given in Tables C-1, C-2, C-3 in Appendix C. These tables can be used to obtain a more precise comparison between the sign configurations and to determine the significance of any differences.

Figure 6 shows the following:

a) In terms of head movement, there is a substantial improvement over the base sign configuration for just about all new sign configurations. Only sign configuration (S.C.) 1 at site 5 and S.C. 6 at site 5 do not show an improvement. But the same signs show substantial improvements at other sites. Furthermore, these two signs at site 5 show relatively small changes compared to the base sign configuration, and the only other sign tested at site 5 (i.e., S.C. 4) likewise shows a relatively small change compared to the base sign configuration (a slight improvement). Thus, it appears that the results from site 5 are less significant than those from other sites (see Table C.3 for the standard deviations).

In attempting to determine the "best" sign by comparing signs tested at the same site, S.C. 4 shows the most consistent improvement. That is, S.C. 4 is the only sign configuration that has the most improvement at each site where it was tested. This is also shown by the ANOVA results presented in Section 4.2.3 below which mathematically takes out site effects.

b) In terms of speed reduction, no sign configuration shows significant improvement over the base configuration. For each new sign, an improvement over the base at one site is counteracted by an impairment at another site. Thus, in general, none of the changes can be considered important or significant. It should be pointed out that the relatively high speed reduction for site 3 (as well as the low speed near the crossing and high RMS deceleration) is perhaps due partially to the signalized intersection located approximately 600 ft. after the crossing.

c) In terms of speed near crossing, only S.C. 1 shows consistent improvement. However, the differences between the speeds for S.C. 1 and the base configuration is relatively small (i.e., less than 2 MPH). All the remaining new sign configurations show inconsistent results, none of which can be considered important or significant.

d) The findings for the remaining measures (i.e., RMS deceleration, headway reduction ratio and time in hazard zone) are inconclusive. RMS deceleration, in general, is complementary to the speed-reduction measure, as might be expected. Headway reduction ratio shows inconsistent results for each sign configuration except for S.C.'s 2 and 3 which show some improvement. But these two sign configurations give no other indications of significant improvement. The time-in-hazard-zone measure also shows inconsistent results for each sign configuration, and the changes in this measure from the base sign configuration to the new sign configurations are relatively small (i.e., 1-2 seconds).

4.2.2 Ohio-All Vehicles-Nighttime

Figure 7 shows the mean values of each measure of effectiveness (except head movement, for which data were not collected at night) for each sign configuration tested at each site in Ohio at night. The mean values, sample sizes and standard deviations corresponding to Figure 7 are given in Tables C-4, C-5, and C-6 in Appendix C.

Figure 7 shows the following:

a) In terms of the primary measures (i.e. speed reduction and speed near crossing) no new sign configuration shows any consistent and significant improvement over the base configuration. In fact, in most cases, the new sign configurations appear to be less effec-

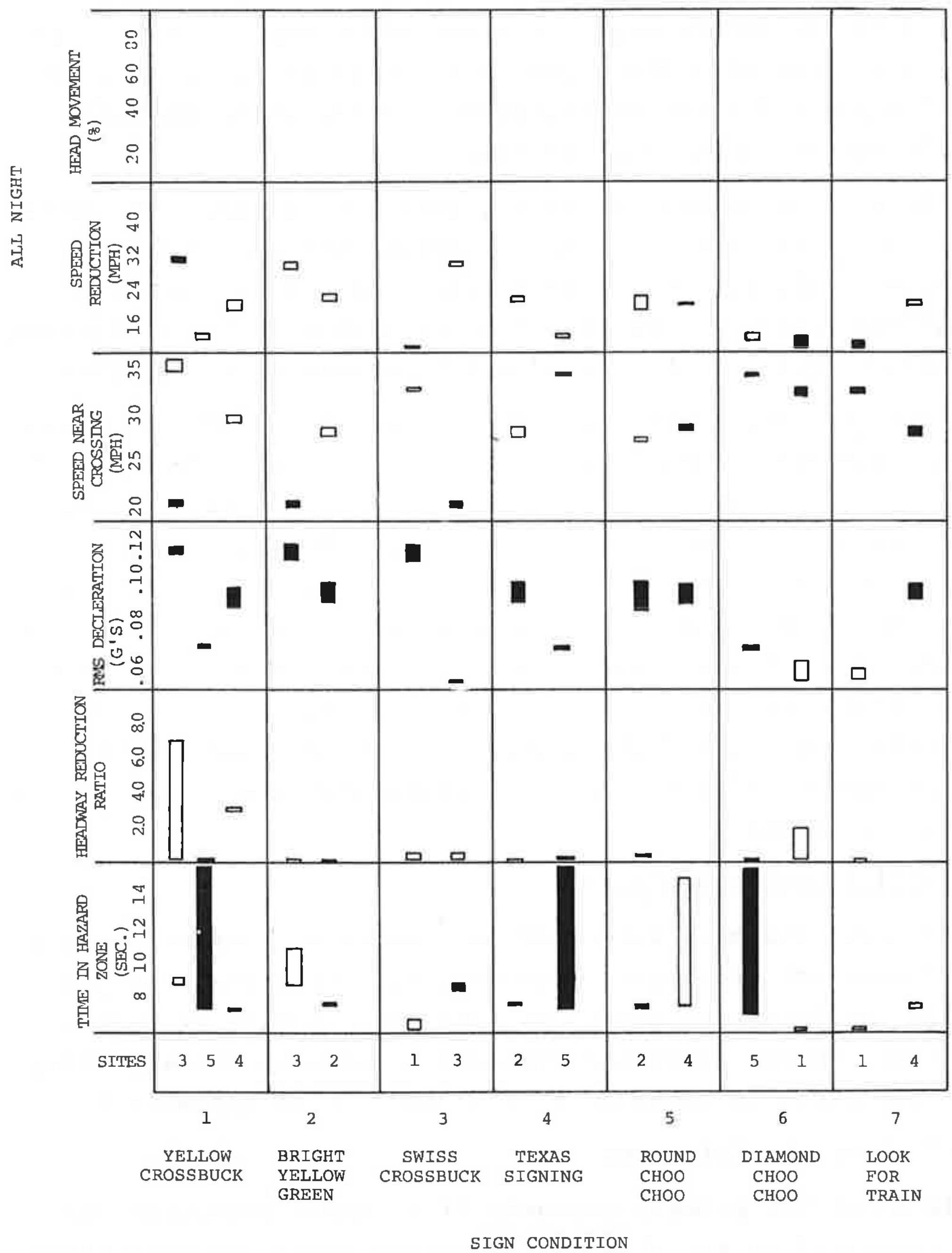

FIGURE 7. MEASURES OF EFFECTIVENESS, OHIO - ALL-NIGHT

tive than the base.

b) In terms of the remaining measures (i.e. RMS deceleration, headway reduction ratio and time in hazard zone) again, no important indications of improvement can be discerned. RMS deceleration complements the speed reduction measure: a smaller, but smoother speed reduction for most of the new signs. The headway reduction ratio changes are in most cases, quite small. The only two cases that are relatively large (i.e. S.C. 1 at site 3 and S.C. 6 at site 1) are inconsistent with the daytime results, and in light of the other measures cannot be judged important. The times in hazard zone for the new signs differ little in most cases from that for the base sign. The four or five cases that show relatively large changes are inexplicable. Three of these occur at the same site and may be due to a common system error during data collection or data reduction.

4.2.3 Ohio-All Vehicles-Daytime-ANOVA

The means of the measures of effectiveness of the new signs and the base sign as presented in the above sections, are helpful in assessing relative improvement. However, while one sign may be judged best at one site, there remains the more important question of which is the best sign of the experiment after accounting for any special site effects. The analysis of variance (ANOVA) based on the incomplete unbalanced block design of the experiment provides appropriate information for making such a determination. The ANOVA is based on the assumption that all sign and site efforts are linear and additive. A more through discussion on the particular ANOVA technique used in this report is given in Appendix D.

This results of the ANOVA are relative mean estimates of each measure of effectiveness (the base sign measures are arbitratily set equal to zero) for each new sign configuration. Figure 8 shows the results of the ANOVA for the Ohio-all vehicles-daytime category. A dashed line is drawn through the zero reference of each measure (base sign configuration value) for ease of comparison. The relative mean estimates for this category are also given in Table C-7. The standard deviations and sample sizes are given in Tables C-8 and C-2,

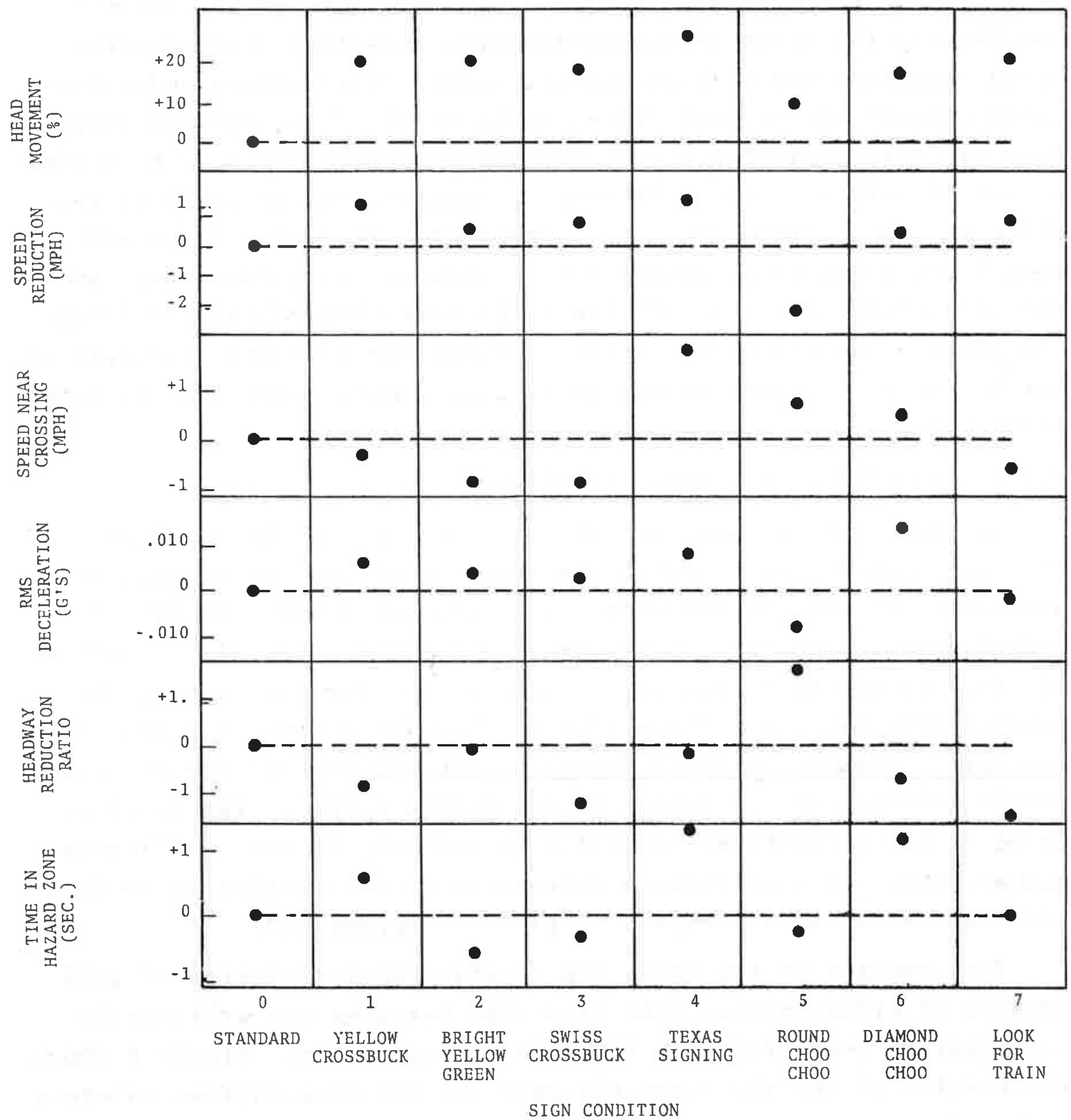

FIGURE 8. ANOVA RELATIVE MEASURES OF EFFECTIVENESS, OHIO-ALL DAY

respectively.

Figure 8 shows the following:

a) All new signs are substantially effective in terms of head movement. They average an increment of 19 percent more head movement than the base sign (99 percent significant). S.C. 4 and S.C. 7 show the most effectiveness but not significantly with respect to the other new signs.

b) All new signs except S.C. 5 are somewhat effective in terms of speed reduction, but not significantly so. Note also that unlike the results of Section 4.2.1, the ANOVA speed reduction results parallel closely the ANOVA head movement results. This tends to support the positive ANOVA results for head movement.

c) All remaining measures either show no significant differences between the signs, or the differences are relatively small, or the difference are nebulous and appear to be random and unimportant.

4.2.4 Ohio-All Vehicles-Nighttime-ANOVA

Figure 9 shows the results of the ANOVA for the Ohio-all vehicles-nighttime category. The relative mean estimates for this category are also given in Table C-9. The standard deviations and sample sizes are given in Tables C-10 and C-5, respectively.

No clear indications of significant improvements are evident from any of the measures for any of the new signs. Once again, the differences are relatively small and in many cases inconsistent with the daytime results. No important conclusions can be drawn form Figure 9 other than whereas some indications of improvement for the new signs were evident during the daytime, no such indications are evident at night.

4.2.5 Main - All Vehicles - Daytime - Good Weather - Westbound

The mean values of each measure of effectiveness for each week of the experiment and for each sign configuration including the base are plotted sequentially in Figure 10. Each sign was tested over a four-week period. Good weather data were collected during

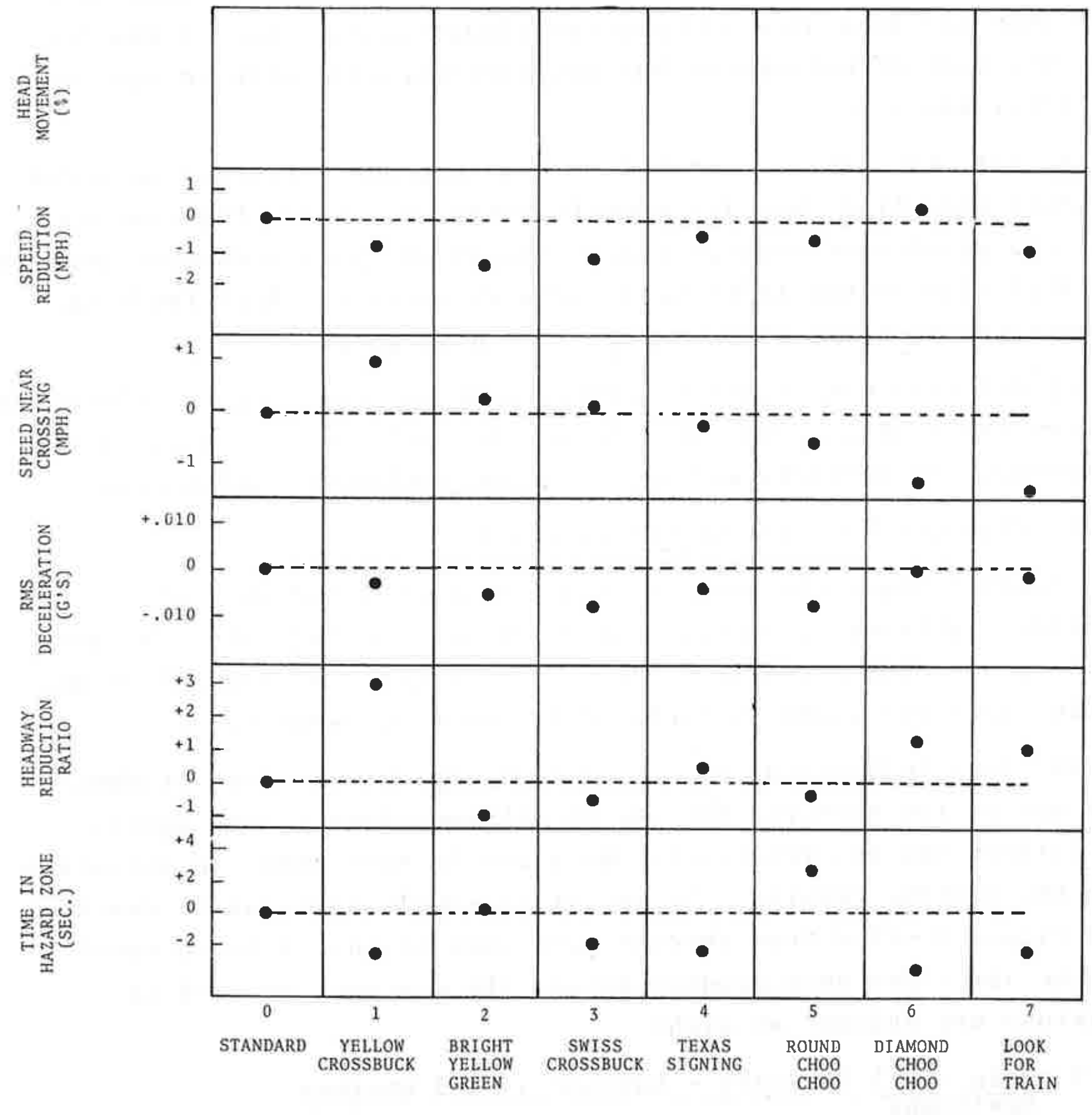

FIGURE 9. ANOVA RELATIVE MEASURES OF EFFECTIVENESS, OHIO-ALL-NIGHT

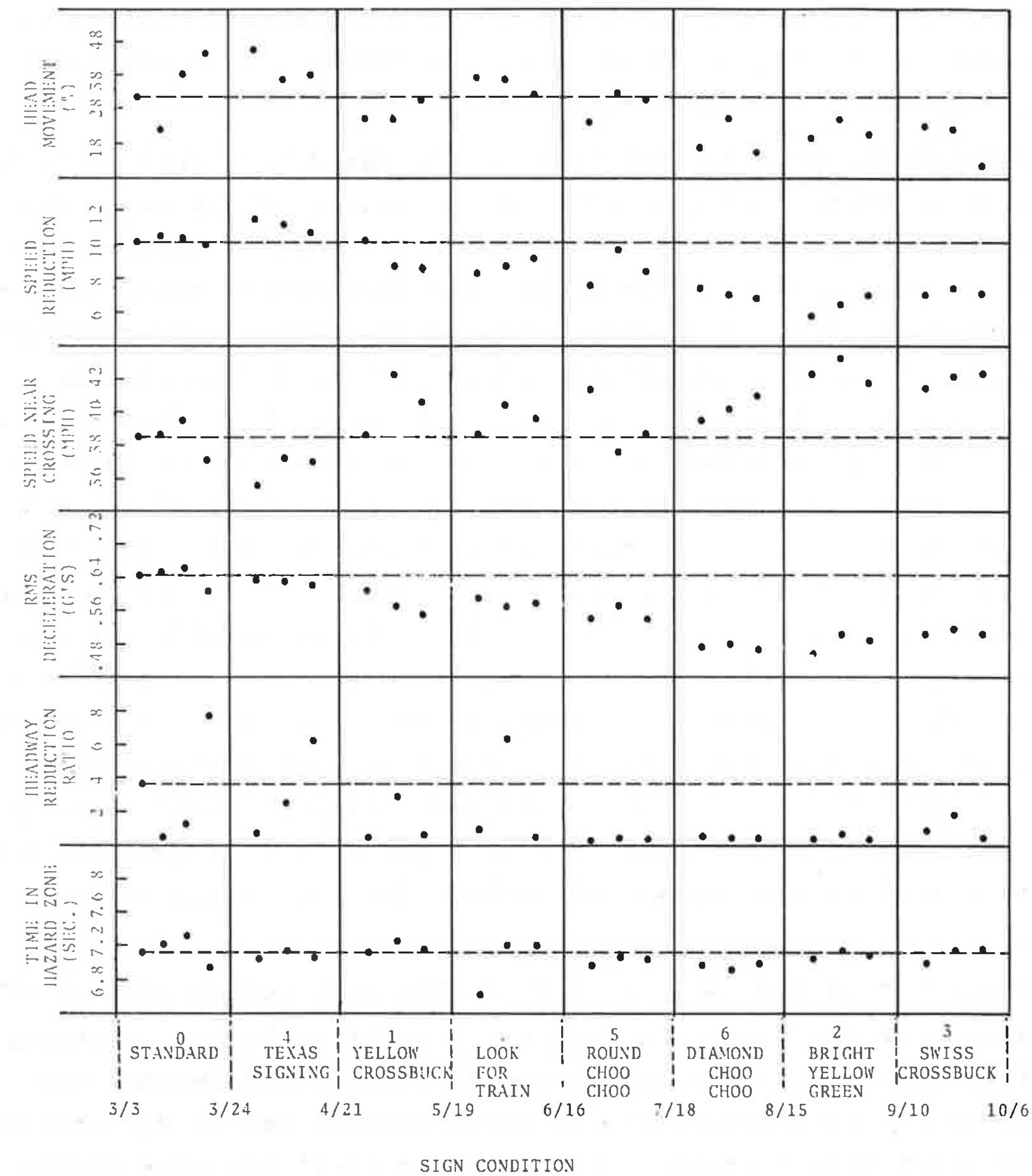

FIGURE 10. MEASURES OF EFFECTIVENESS
MAINE-ALL-DAY-WEST

weeks 1, 3 and 4 for each sign configuration. Thus, three data points are shown for each sign configuration and each measure. For each measure, the three weeks of the base sign were averaged. The average is indicated as dashed lines for reference and ease of comparison. The mean values, sample sizes and standard deviations corresponding to Figure 10 are given in Tables C-11, C-12, and C-13, respectively in Appendix C.

Perhaps the most notable feature displayed by Figure 10 is the seasonal or time-varying trend over the course of the seven-month experiment. Head movement, speed reduction and RMS deceleration appear to have a downward or decreasing trend while speed near crossing appears to have an upward or increasing trend. The remaining two measures--headway reduction ratio and time in hazard-zone -- show no apparent time-varying trend. It is unlikely that the variations over the seven-month period are due to the signs themselves or a long-term "novelty" effect, simply because most of the new sign configurations show less effectiveness than the base sign configuration (in terms of the three primary measures). The only exceptions are S.C. 4 and possibly S.C. 7 but their indicated effectiveness is not significant. This is clear from the weekly measurements for S.C. 4 and S.C. 7 compared to that for the base sign. A short-term "novelty" effect is perceptible over a four-week testing period for S.C. 4 especially in terms of speed reduction and speed near crossing. Any head-movement novelty effect for S.C. 4 is somewhat masked by the spread of the weekly data points for S.C. 4 and the base sign.

Thus, S.C. 4 and possibly S.C. 7 show some indications of effectiveness over the base sign, but not significantly so. Furthermore, the fact that S.C. 4 was the first new sign tested lessens the impact of its effectiveness: its effectiveness may be due partially to the short-term "novelty" effect of the first new sign and/or the testing period in the seasonal trend.

The RMS deceleration measure again is complementary to the speed reduction measure but does not appear to provide any important information other than a clear seasonal trend.

The headway reduction ratio and time in hazard zone measures show no consistent and significant differences between the signs.

4.2.6 Maine-All Vehicles - Daytime - Good Weather - Eastbound

The mean values of each measure of effectiveness for each week of the experiment and for each sign configuration are plotted sequentially in Figure 11. The mean values, sample sizes and standard deviations corresponding to Figure 11 are given in Tables C-14 and C-15, and C-16, respectively, in Appendix C.

Data for week 3 of S.C. 3 were lost during electronic processing. The seasonal effect for eastbound traffic is not as prominent as that for westbound traffic. From Figure 11, head movement appears to have a slight downward trend while speed reduction, RMS deceleration and time hazard zone appear to have an upward trend. Speed near crossing and headway-reduction ratio do not appear to have any long-term trend.

Note that although speed reduction and RMS deceleration once again complement each other, their long-term or seasonal trends are in the opposite direction compared to the westbound traffic. This tends to support a possible geometric effect.

Three of the electronic measures, namely, speed reduction speed near crossing and RMS deceleration show a sharp discontinuity between weeks 1 and 3 of S.C. 5. This characteristic was also present for the westbound traffic, but not as apparent. The discountinuity in the measures is perhaps due to one or more occurrences that took place around this time period (see Table 4 for list of occurrences). This shows unfortunately that the measures that were designed for determining relative sign effectiveness are also quite sensitive to extraneous effects making it a difficult task to discriminate differences between signs only.

In general, no new sign configuration appears to be consistently and significantly more effective than the base sign for eastbound traffic even after taking in account possible seasonal trends. S.C. 5 and S.C. 6 show some indications of effectiveness in terms of speed reduction and speed near crossing but this is probably due more to extraneous effects as discussed above.

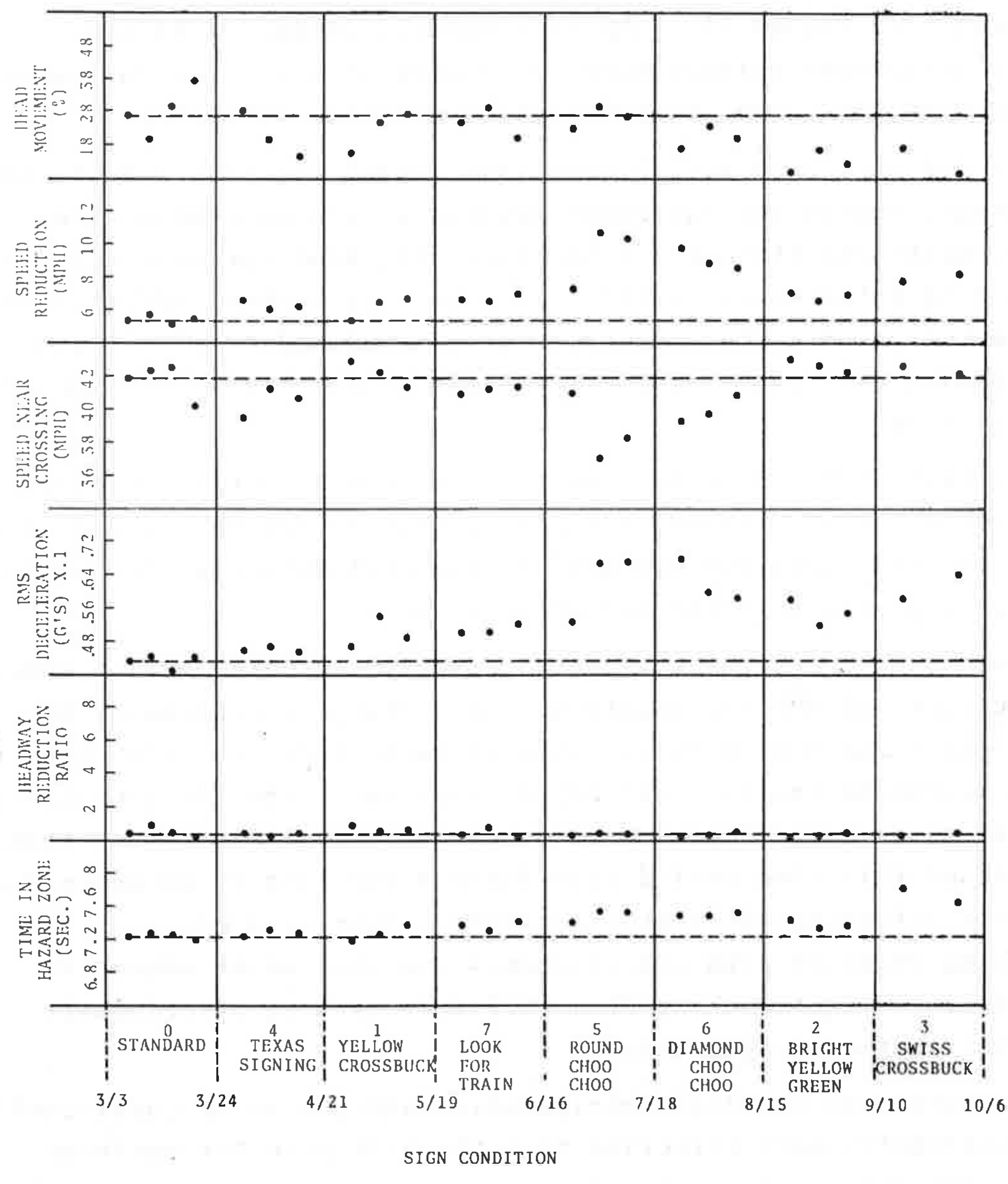

FIGURE 11. MEASURES OF EFFECTIVENESS,
MAINE - ALL-DAY-EAST

It is interesting to note that in general, westbound traffic shows more head movement, more speed reduction and less speed near crossing, than eastbound traffic. This is probably due to the geometric effects - the westbound directions being more sight restricted than the eastbound direction.

4.2.7 Maine - All Vehicles - Daytime - Bad Weather - Westbound

The mean value of each measure of effectiveness for each sign configuration and for bad weather conditions are plotted sequentially in Figure 12. Also, the mean values, sample sizes and standard deviations corresponding to Figure 12 are given in Tables C-11 and C-12 and C-13, respectively, in Appendix C. Bad-weather data was collected whenever it occurred over the four-week period that each sign was tested. One data point is shown for each sign configuration and each measure. The base sign configuration value for each measure is indicated as a dashed line for reference and ease of comparison.

From Figure 12, it can be seen that bad weather did not occur during the testing of S.C.'s and 4 and 5. Without these data points, it is difficult to discern any seasonal trends. However, there does appear to be a slight decreasing trend for speed reduction and RMS deceleration.

In terms of the three primary measures, head movement, speed reduction and speed near crossing, the new signs are less effective than the base sign. The three remaining measures, being less important, are thus considered inconsequential. The fact that no new sign appears to be more effective than the base sign during bad weather conditions, may be due to the type of bad weather prevailing during the testing of each sign configuration. No attempt was made to classify the types or severity of weather. Thus, the bad weather during the testing of the base sign may have been different and more severe than that for the remaining signs. However, based on all the data collected for the Maine railroad crossing experiment, it appears unlikely that any new sign would have been more effective than the base sign under bad weather

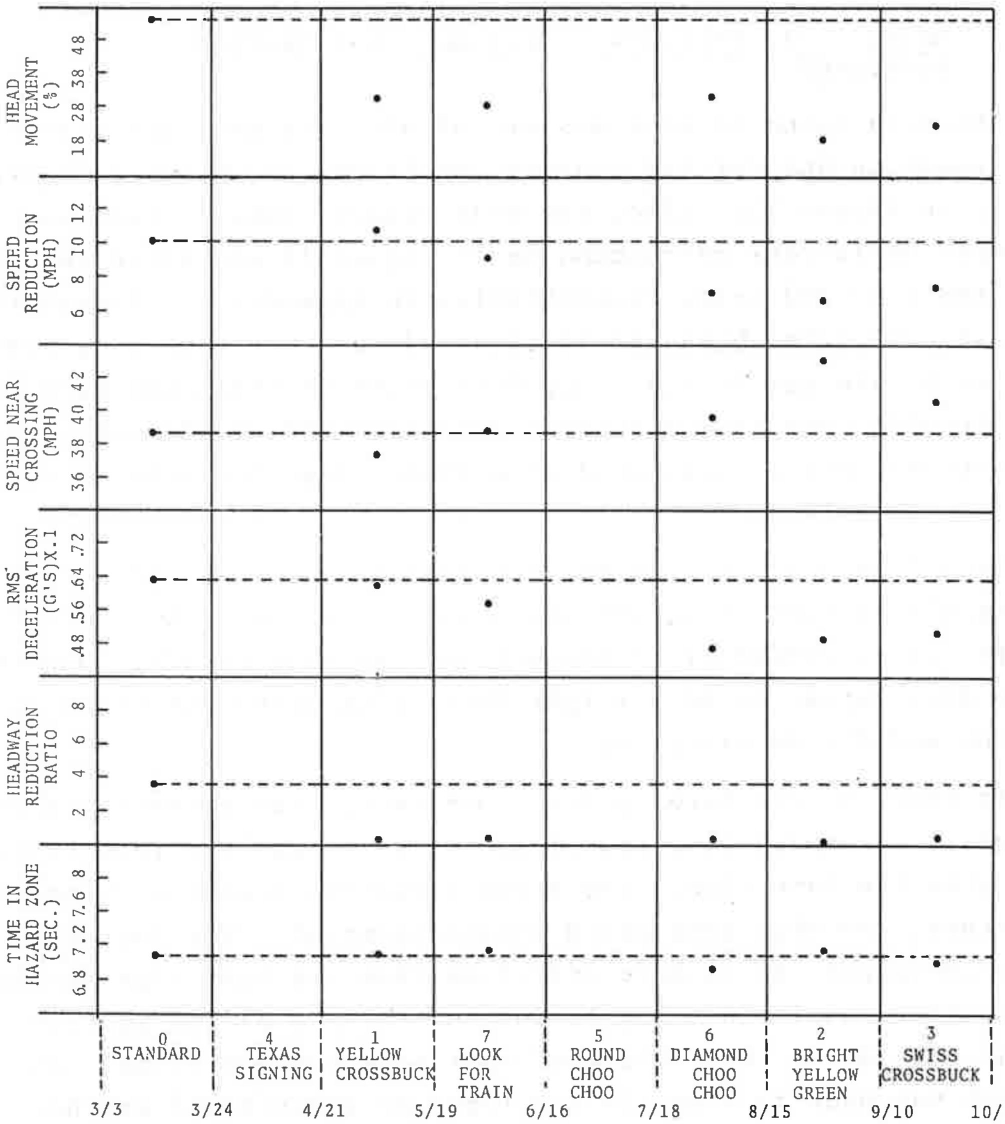

FIGURE 12. MEASURES OF EFFECTIVENESS, MAINE - ALL-DAY-BAD WEATHER-WEST

conditions even if the weather for all signs could have been classified as similar.

4.2.8 Maine-All Vehicle-Daytime-Bad Weather-Eastbound

The mean values of each measure of effectiveness for each sign configuration and for bad weather conditions are plotted sequentially in Figure 13. Also, the mean values, sample sizes and standard deviations corresponding to Figure 13 are given in Tables C-14, C-15 and C-16, respectively, in Appendix C. Similar to westbound traffic, no new sign configuration can be considered more effective than the base sign. Again, lack of data, and lack of classification of the weather according to type and severity impose limitations on the interpretation of the results.

4.3 EVALUATION OF DRIVER BEHAVIOR BY GROUPS

4.3.1 Ohio Sites

In this part of the analysis, driver behavior is evaluated by groups, in terms of the three primary measures without regard to sign configuration. That is, all sign configurations are pooled together in the evaluation. Seven groupings (i.e., categories of groups; also independent variables) are considered . The seven groupings are:

1. Vehicle type (auto vs other);
2. Driver (male vs female);
3. License Plate (in-state vs out-of-state);
4. Passengers (yes vs no);
5. Required-Stop Vehicle (yes vs no);
6. Approach speed (less than 45 mph vs greater than 45 mph);
7. Train Expected (yes vs no).

The three primary measures are:

a) head movement;
b) speed reduction;
c) speed near crossing.

The results are presented in terms of relative means (see below) of the measures corrected for site effects. This correction process

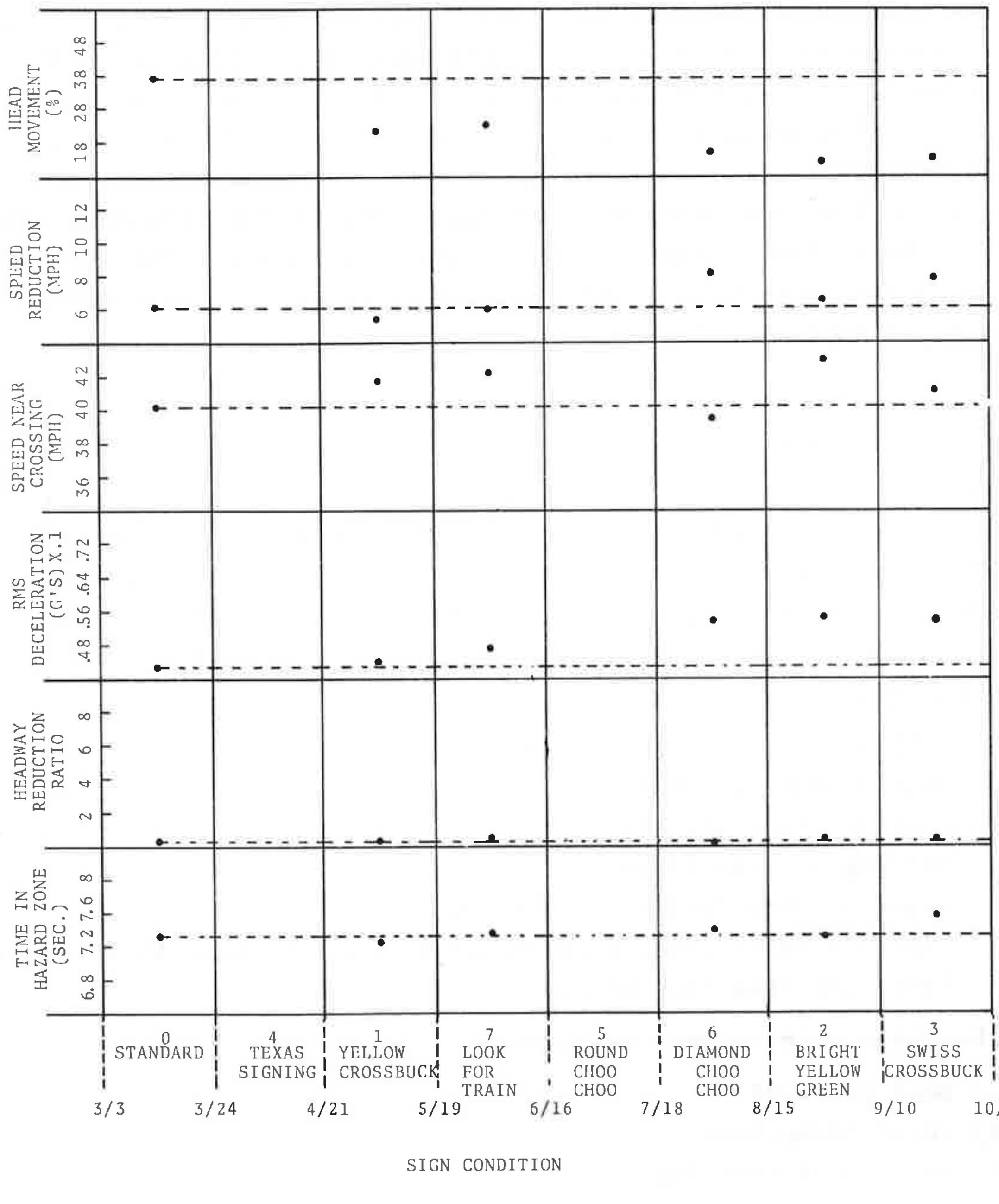

FIGURE 13. MEASURES OF EFFECTIVENESS, MAINE - ALL-DAY-BAD WEATHER-EAST

eliminates potential bias which might have occurred, for example, where a site that necessitates certain behavior (i.e., low speeds) also had a high preponderance of male drivers. The relative means for head movement, speed reduction and speed near crossing are shown in Figures 14, 15 and 16, respectively. The solid bars represent the standard deviation for each respective group contrast (e.g., male vs female) and provide indications of the significance of the contrast. See Appendix D for a discussion and derivation of the relative means and standard deviations.

The relative means are interpreted as follows: From Figure 14, female driver show about 16 percent more head movement than male drivers (since the units for head movement are in percent, the 16 percent difference means that if male drivers have 30 percent head movement female drivers would have 46 percent head movement). The standard deviation for this contrast is 2.4 percent indicating that the difference is highly significant.

Although the results shown in Figures 14, 15 and 16 provide no information on the relative effectiveness of the new signs, which was the primary objective of this study, they do provide interesting information on the characteristics of various groups of drivers which might have some safety implications. First of all, there is a strong consistency from measure to measure: drivers that have more head movement also have more speed reduction and less speed near the crossing. (There is an expected deviation from this for the approach-speed grouping - Drivers that approach the crossing at speeds less than 45 mph show more head movement, less speed near the crossing but also less speed reduction than drivers that approach the crossing at speeds greater than 45 mph). Significant differences in head movement are shown for three groupings: male vs female driver, passengers vs no passengers, and approach speed less than 45 mph vs greater than 45 mph. Four groupings show significant differences in speed reduction: auto vs other vehicle, male vs female driver, passengers vs no passengers and approach speed less than 45 mph vs greater than 45 mph. Finally, three groupings show significant differences in speed near crossing: male vs female driver, passengers vs no passengers and approach speed less than

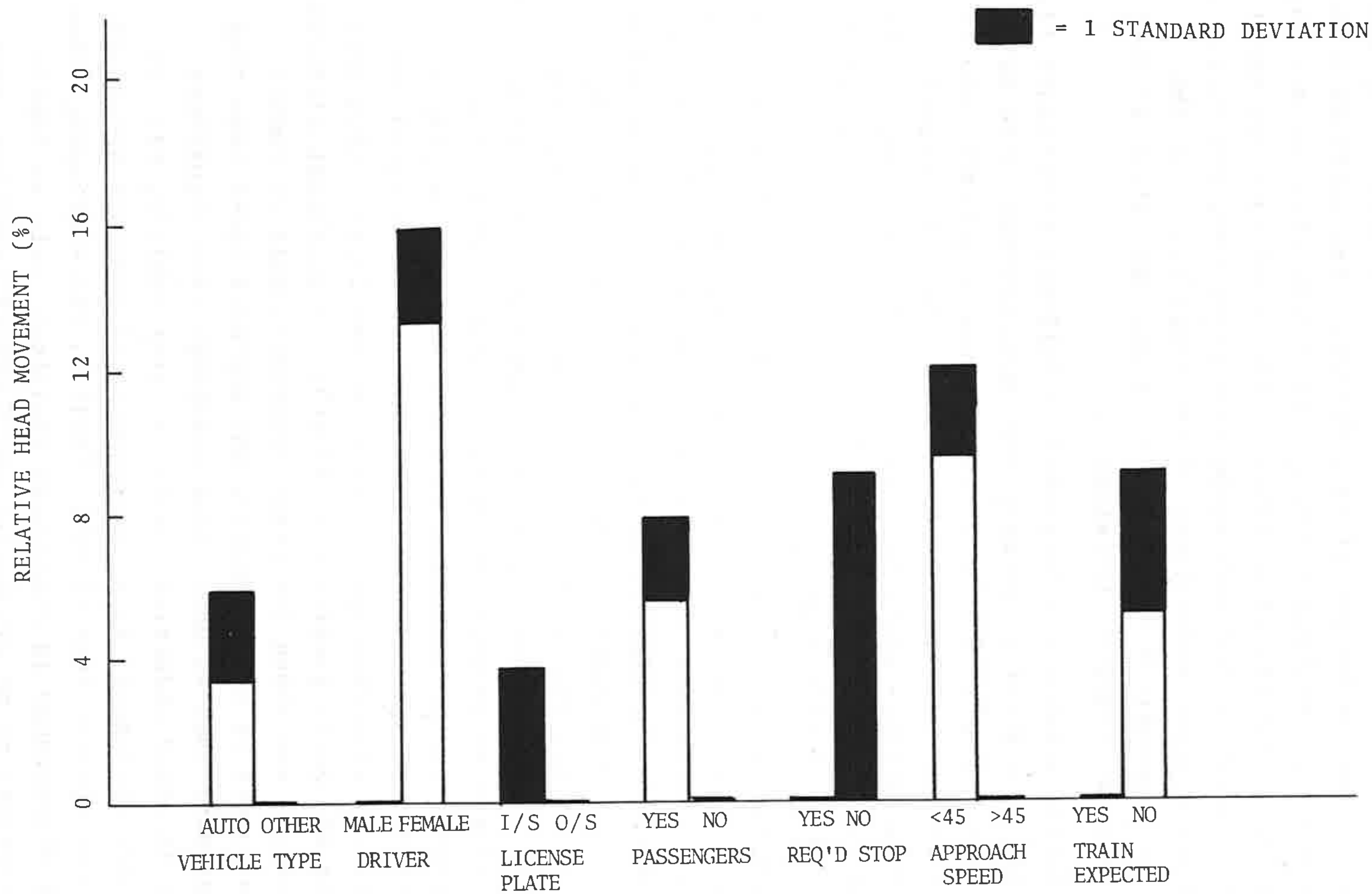

FIGURE 14. CONTRASTS OF DRIVER GROUPS - OHIO-DAY (HEAD MOVEMENT)

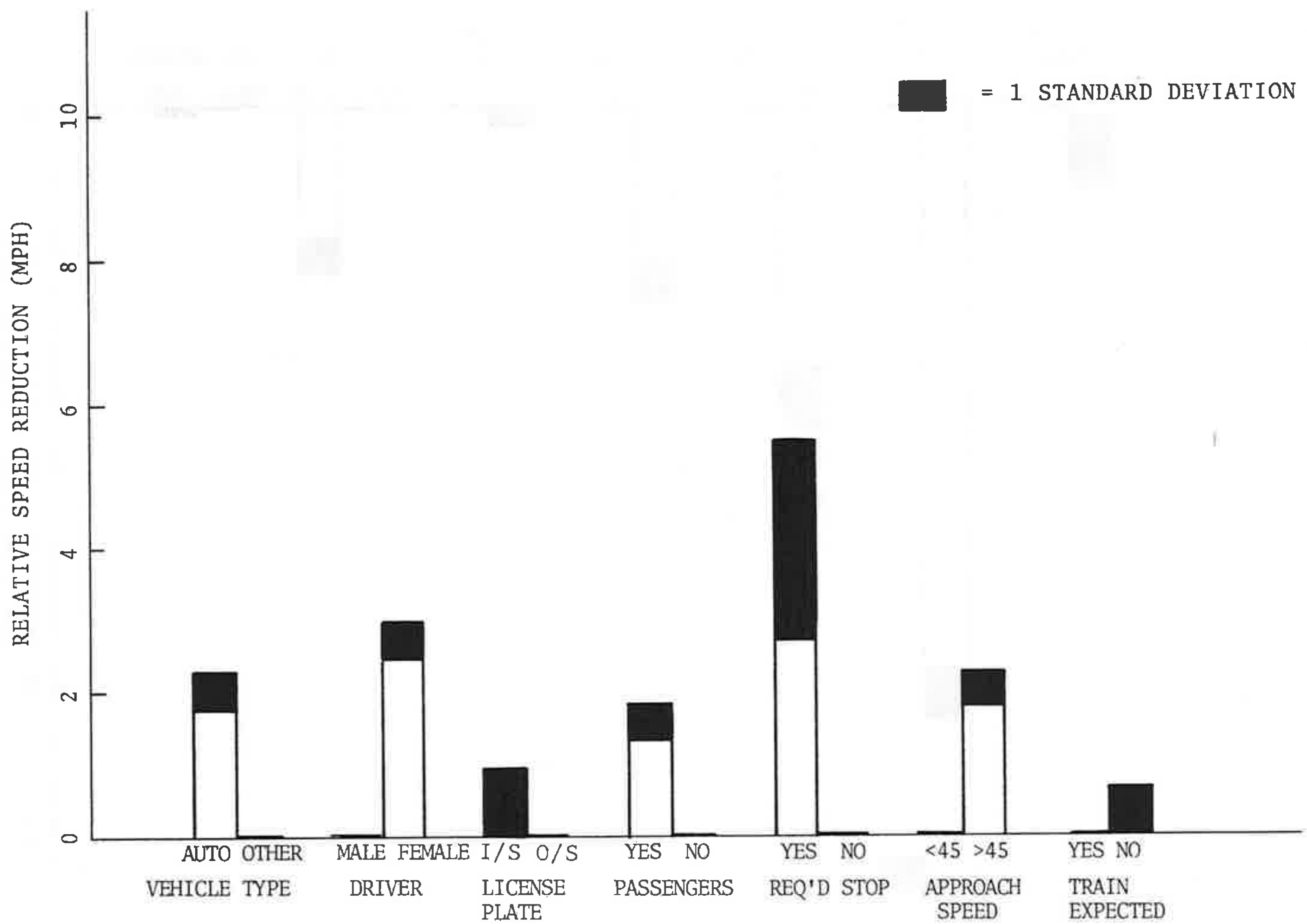

FIGURE 15. CONTRASTS OF DRIVER GROUPS - OHIO-DAY (SPEED REDUCTION)

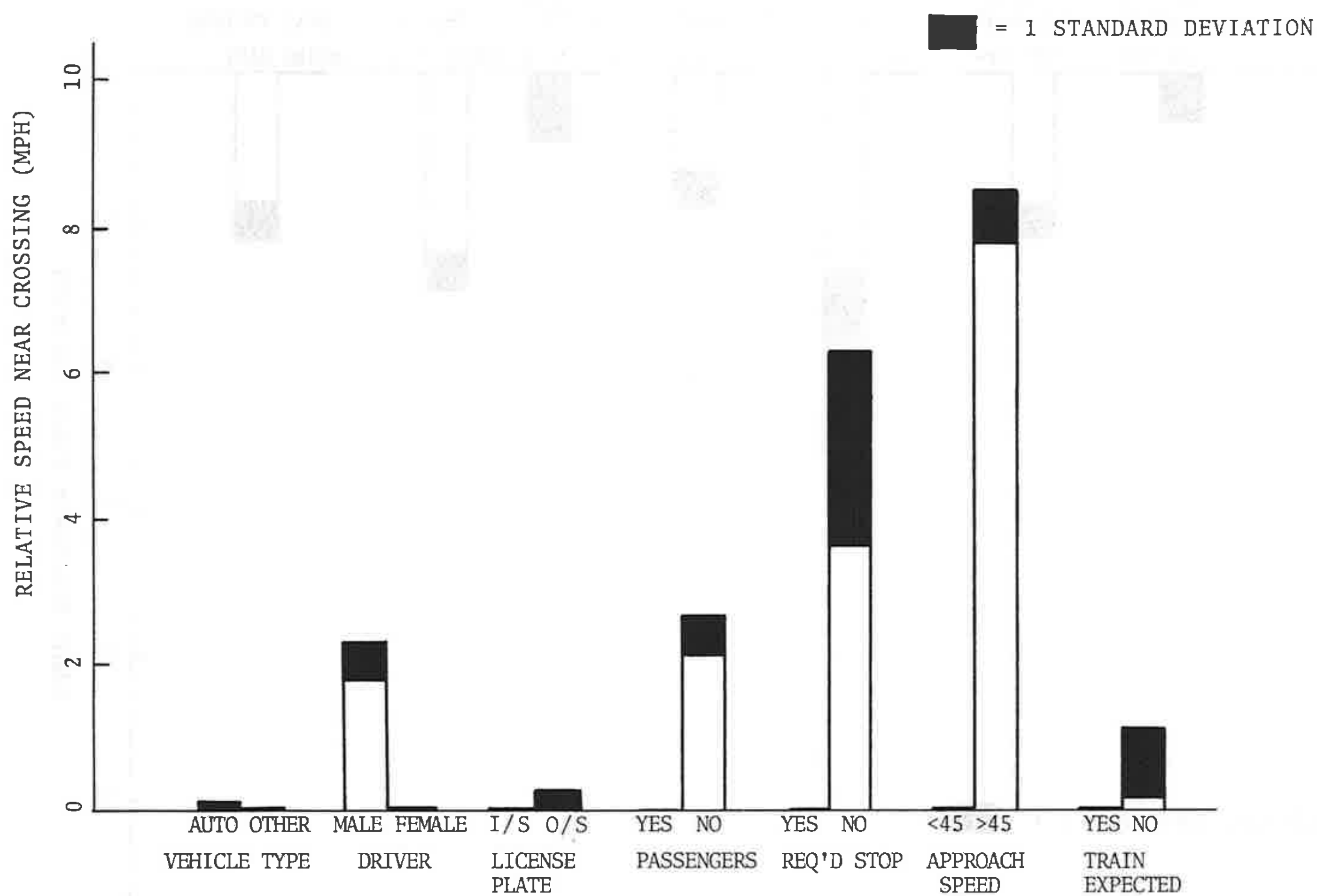

FIGURE 16. CONTRASTS OF DRIVER GROUPS - OHIO-DAY (SPEED NEAR CROSSING)

45 mph vs greater than 45 mph. The other differences are either marginal or nonexistent. Although the grouping-- required stop vehicle vs not required stop -- shows relatively large mean differences, the standard deviation, is also quite large due to small numbers of required-stop vehicles in the study. Thus, no significant conclusions can be made. The grouping -- train expected vs not expected -- is not only marginal but also inconsistent and confusing. One would expect more head movement, more speed reduction and less speed near the crossing when a train is expected. The conflicting result may be due to the arbitrary definition of train expected: all vehicles crossing the tracks within one hour of a train. These vehicles may not have in fact been expecting a train. This variable was thus eliminated from further analysis in Section 4.4.

4.3.2 Maine Site

In this part of the analysis, the results are presented in terms of the absolute means of the measures (i.e., no correction was necessary for different site effects). Furthermore, each week of all sign configurations are pooled together in the contrast.

The absolute means for head movement, speed reduction and speed near crossing are shown in Figures 17, 18 and 19, respectively, for westbound traffic and in Figures 20, 21 and 22, respectively, for eastbound traffic.

The main feature from these figures is the sharp and significant contrast between required-stop vehicles and those not required to stop. Required stop vehicles show significantly more head movement, more speed reduction, and less speed near the crossing.

The data also show strong consistency between eastbound and westbound traffic in terms of head movement and speed near crossing, but less consistency in terms of speed reduction.

There is also strong consistency between the Maine data and the Ohio data for three groupings: male vs female driver, passengers vs no passengers, and approach speed less than 45 mph vs greater than 45 mph. The chief inconsistency between the Maine data and the Ohio data is for the grouping by vehicle type.

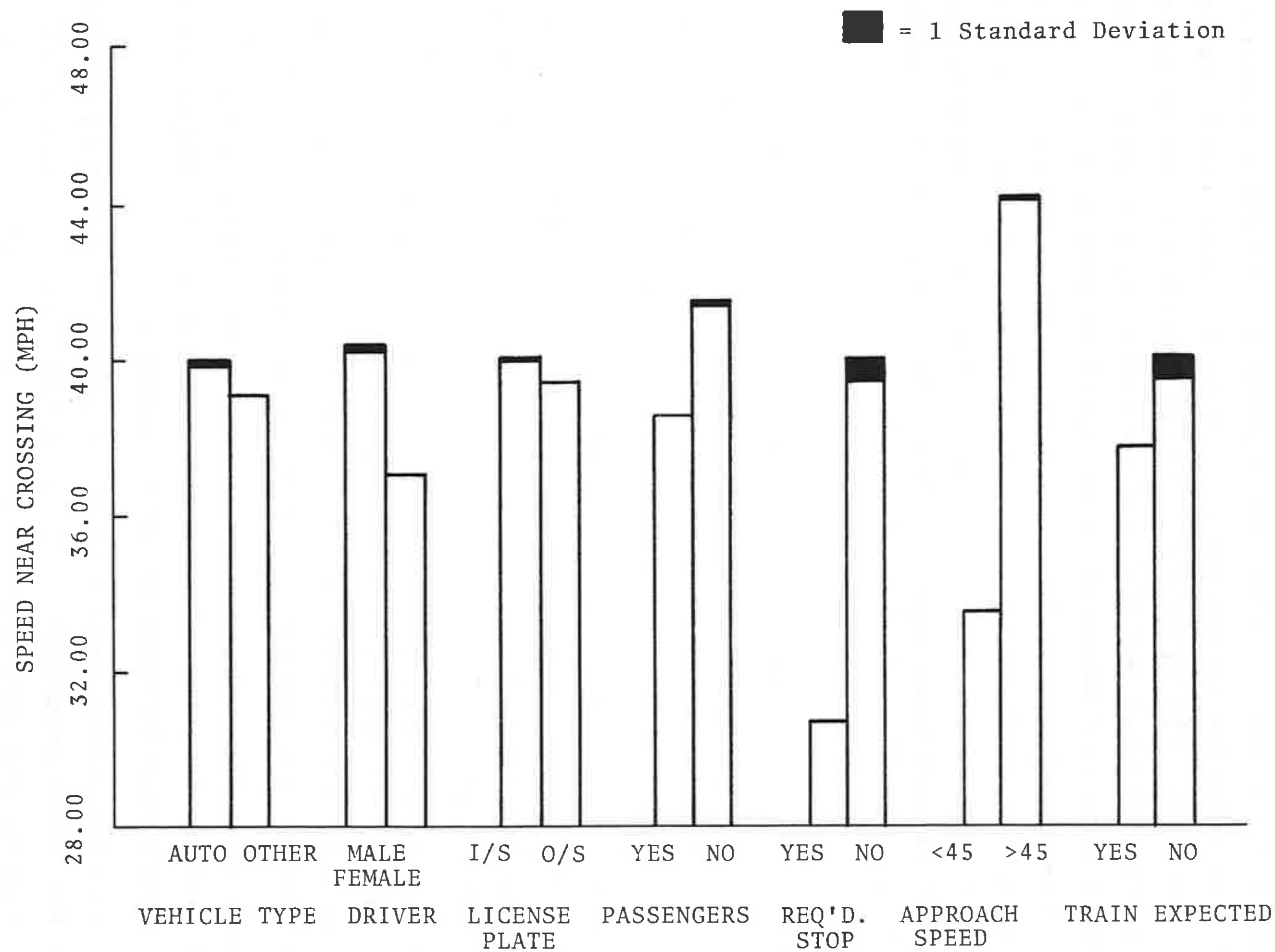

FIGURE 17. CONTRASTS OF DRIVER GROUPS, MAINE-DAY-WEST (HEAD MOVEMENT)

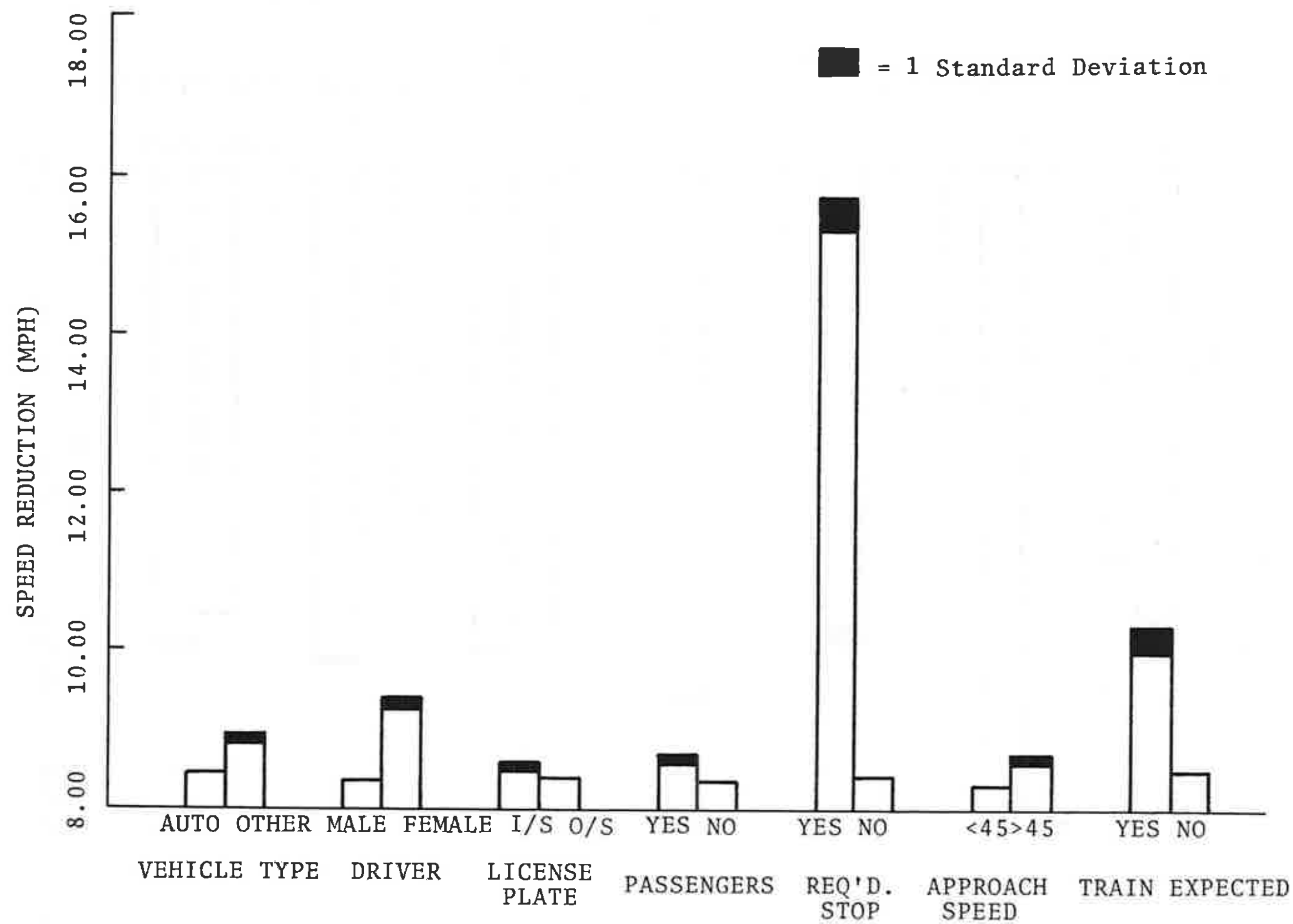

FIGURE 18. CONTRASTS OF DRIVER GROUPS, MAINE - DAY-WEST (SPEED REDUCTION)

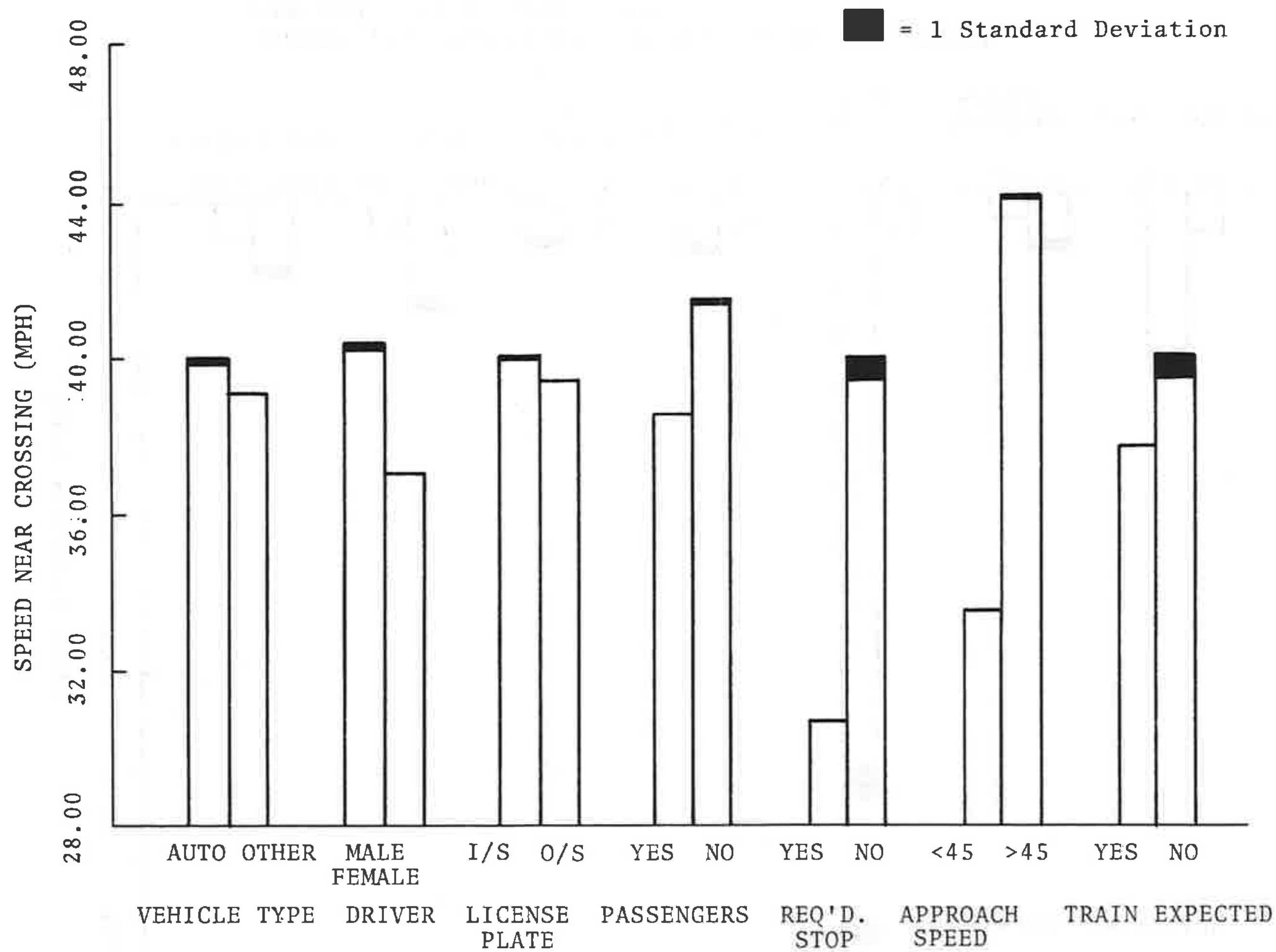

FIGURE 19. CONTRASTS OF DRIVER GROUPS, MAINE - DAY-WEST (SPEED NEAR CROSSING)

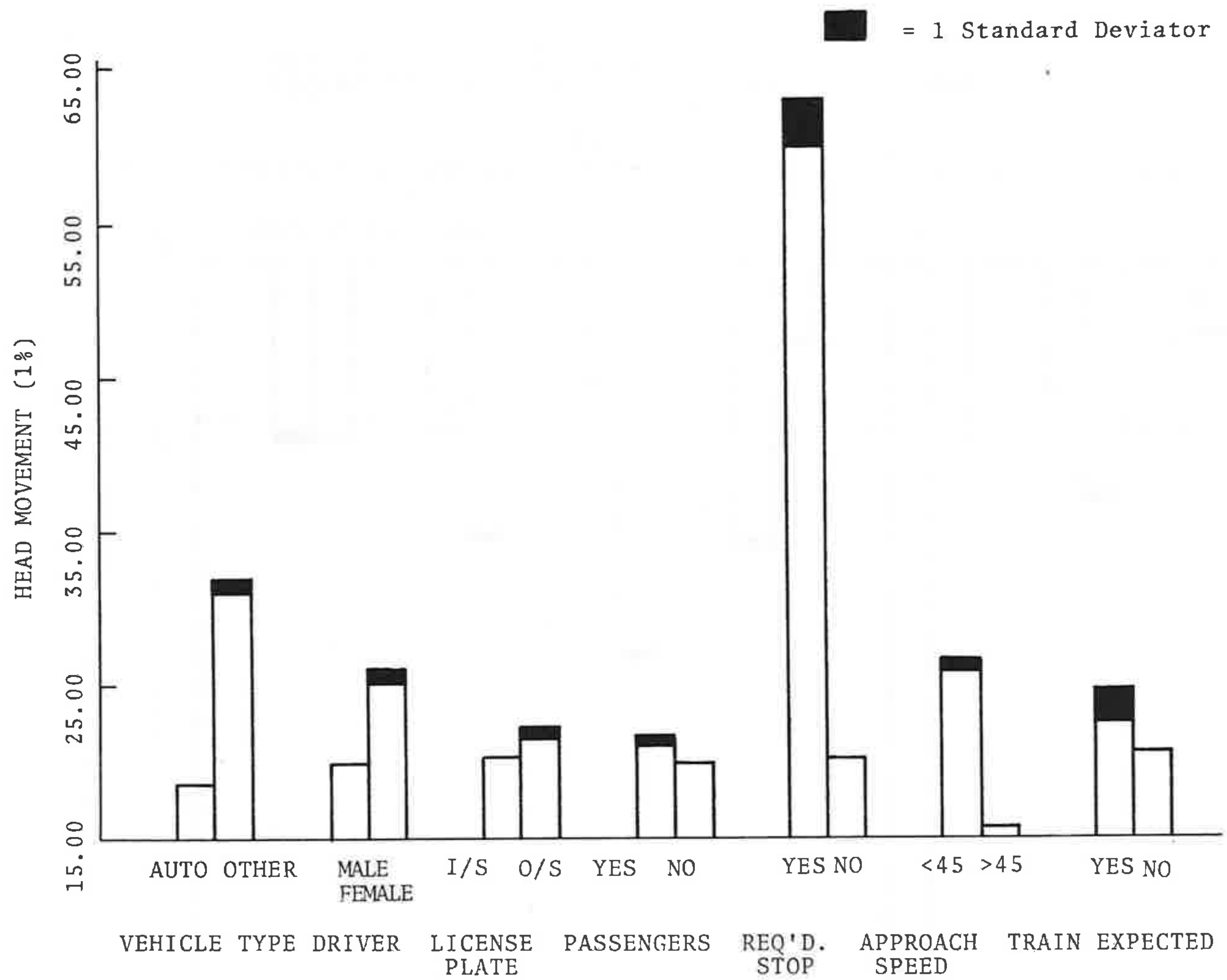

FIGURE 20. CONTRASTS OF DRIVER GROUPS, MAINE - DAY-EAST (HEAD MOVEMENT)

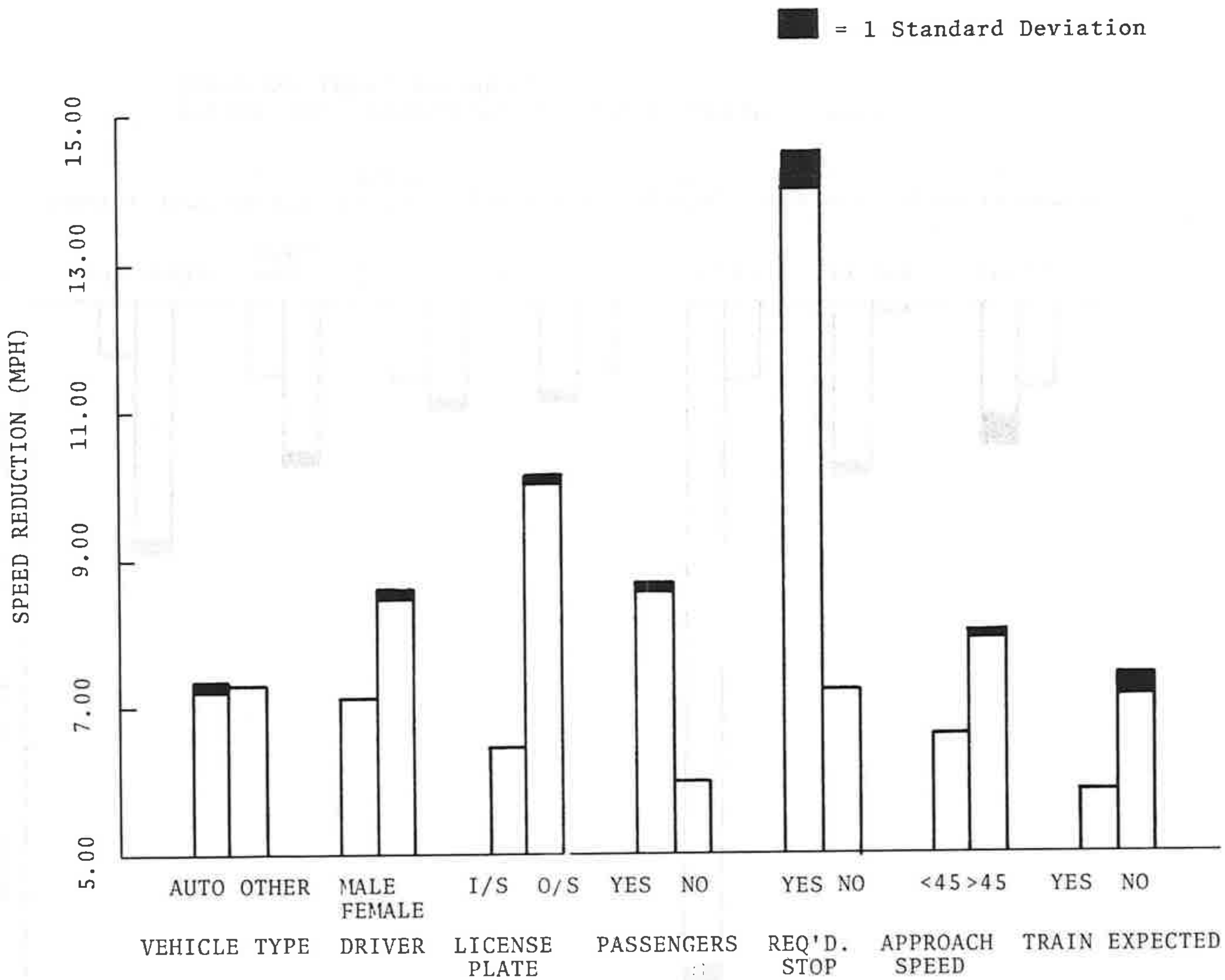

FIGURE 21. CONTRASTS OF DRIVER GROUPS, MAINE - DAY-EAST (SPEED REDUCTION)

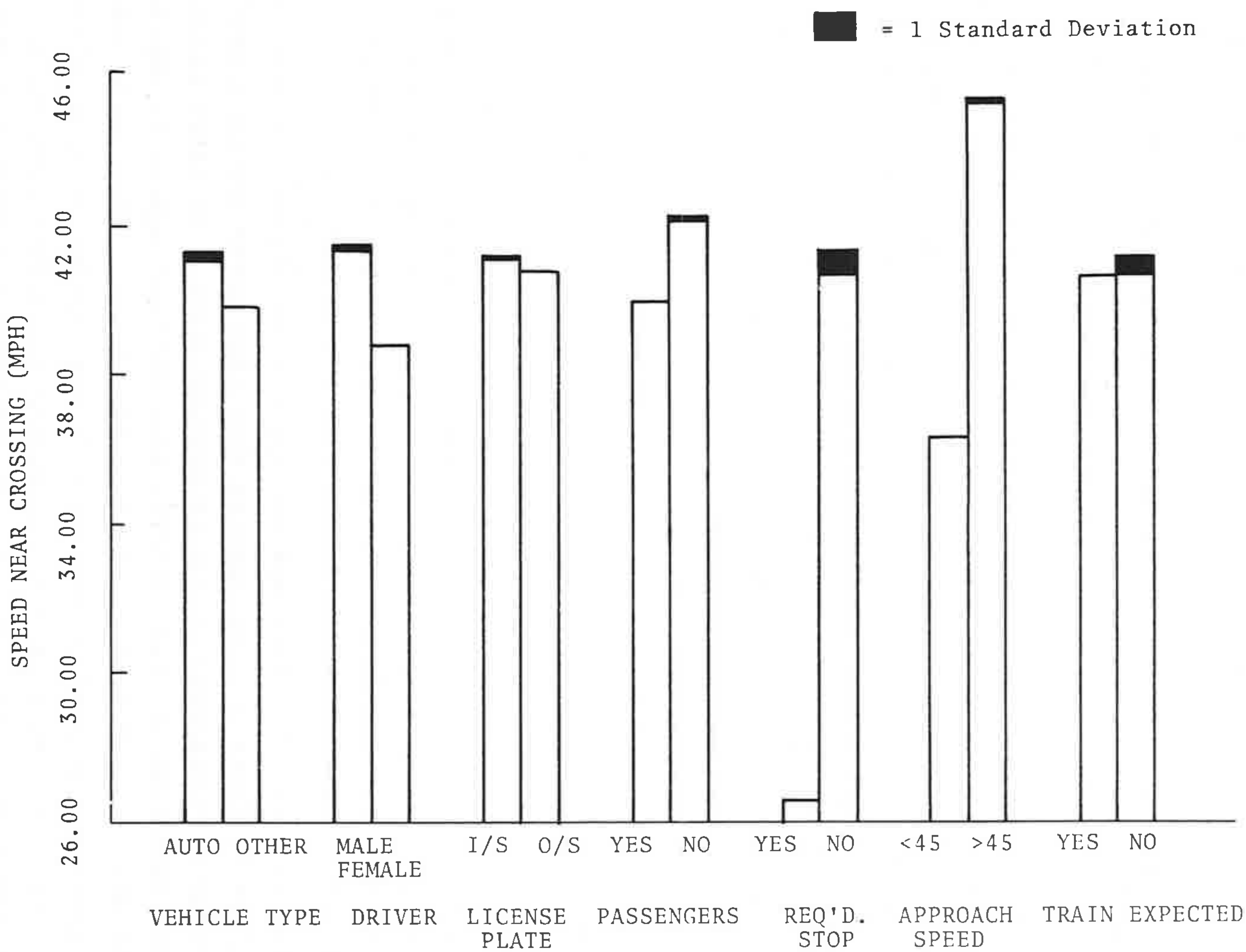

FIGURE 22. CONTRASTS OF DRIVER GROUPS, MAINE - DAY-EAST (SPEED NEAR CROSSING)

Finally, the Maine data indicates that our-of-state drivers tend to have more head movement, more speed reduction and less speed near the crossing than in-state drivers. This information was lacking from the Ohio data due to the paucity of out-of-state drivers.

4.4 EVALUATION OF RELATIVE SIGN-CONFIGURATION EFFECTIVENESS BY DRIVER GROUPS

4.4.1 Ohio Sites

Relative sign-configuration effectiveness is evaluated by driver groups in terms of the three primary measures using standard "F" test calculations. (The "F" test calculations are developed and described in Appendix D.) Five groupings (i.e., categories of groups) are considered. The five groupings are:

1. vehicle type (auto vs other)
2. driver (male vs female)
3. time of day (day vs night)
4. passengers (yes vs no)
5. approach speed (greater than 45 mph vs less than 45 mph).

The three primary measures are head movement, speed reduction and speed near crossing.

The evaluations are intended to identify any unique sign configuration effectiveness for different driver populations (groups). For example, the tests are intended to determine whether male drivers react favorably to one sign configuration while female drivers react favorably to another sign configuration.

The resulting F values and the appropriate degrees of freedom are given in Table 5. The results show that there are no significant differences in behavior at the 10 percent level. In other words, the determination of sign effectiveness does not appear to depend on the driver population to which it it subject. This would tend to support the general contention that, in further testing of the signs, it is not necessary to categorize the driver population (at least according to the groupings or independent variables listed above) for determining unique sign-configuration effectiveness. Any differences in sign effectiveness that exist can be determined from the characteristics of the total or mixed driver population.

TABLE 5. "F" TEST VALUES FOR DRIVER GROUPINGS AND MEASURES OF EFFECTIVENESS n = 6, m = 18 ($F_{.9,\ 6,\ 18} = 2.13$)

MEASURE OF EFFECTIVENESS	Vehicle Type (Auto vs Other) F	Driver (Male vs Female) F	Time of Day (Day vs Night) F	Passengers (Yes vs no) F	Approach Speed >45 vs <45 MPH F
Head Movement	.547	.313	No head movement data collected night	.568	.810
Speed Reduction	.093	.735	.915	.610	.887
Speed Near Crossing	.327	1.193	1.072	.460	.573

4.4.2 Maine Site

In this part of the analysis, sign configuration effectiveness is evaluated for out-of-state drivers and contrasted with all drivers in terms of the mean values of the three primary measures for each week of testing and for each sign configuration. Figure 23 shows the westbound results. The out-of-state results are presented in the upper half of the figure while the all-driver results are repeated (from Figure 10) and presented in the bottom half of the figure. The mean values, sample sizes and standard deviations corresponding to the upper half of Figure 23 are given in Tables C-17, C-18 and C-19, respectively, in Appendix C.

The similarity in the measures between out-of-state drivers and all drivers is quite apparent: seasonal trends are present, no new sign is significantly more effective than the base sign, and S.C.'s 4 and 7 show marginal effectiveness over the base sign. The minor differences are: (1) S.C. 7 is somewhat more effective for out-of-state drivers compared to all drivers in terms of speed reductions and (2) S.C. 4 is somewhat less effective for out-of-state drivers compared to all drivers in terms of speed near crossing. These differences are not considered significant. Thus, in general, there appear to be no significant differences in behavior between out-of-state drivers and all drivers. Since most drivers were from in-state, it can also be said that there appears to be no significant differences in behavior between out-of-state drivers and in-state drivers.

Figure 24 shows the eastbound results. Again, the out-of-state results are presented in the upper half of the figure while the all-driver results are repeated (from Figure 11) and presented in the bottom half of the figure. The mean values, sample sizes and standard deviations corresponding to the upper half of Figure 24 are given in Tables C-20, C-21 and C-22, respectively, in Appendix C.

Once again, the similarity in the measures between out-of-state drivers and all drivers is quite apparent. There are minor differences in the speed-near-crossing measure (i.e., S.C. 4 some-

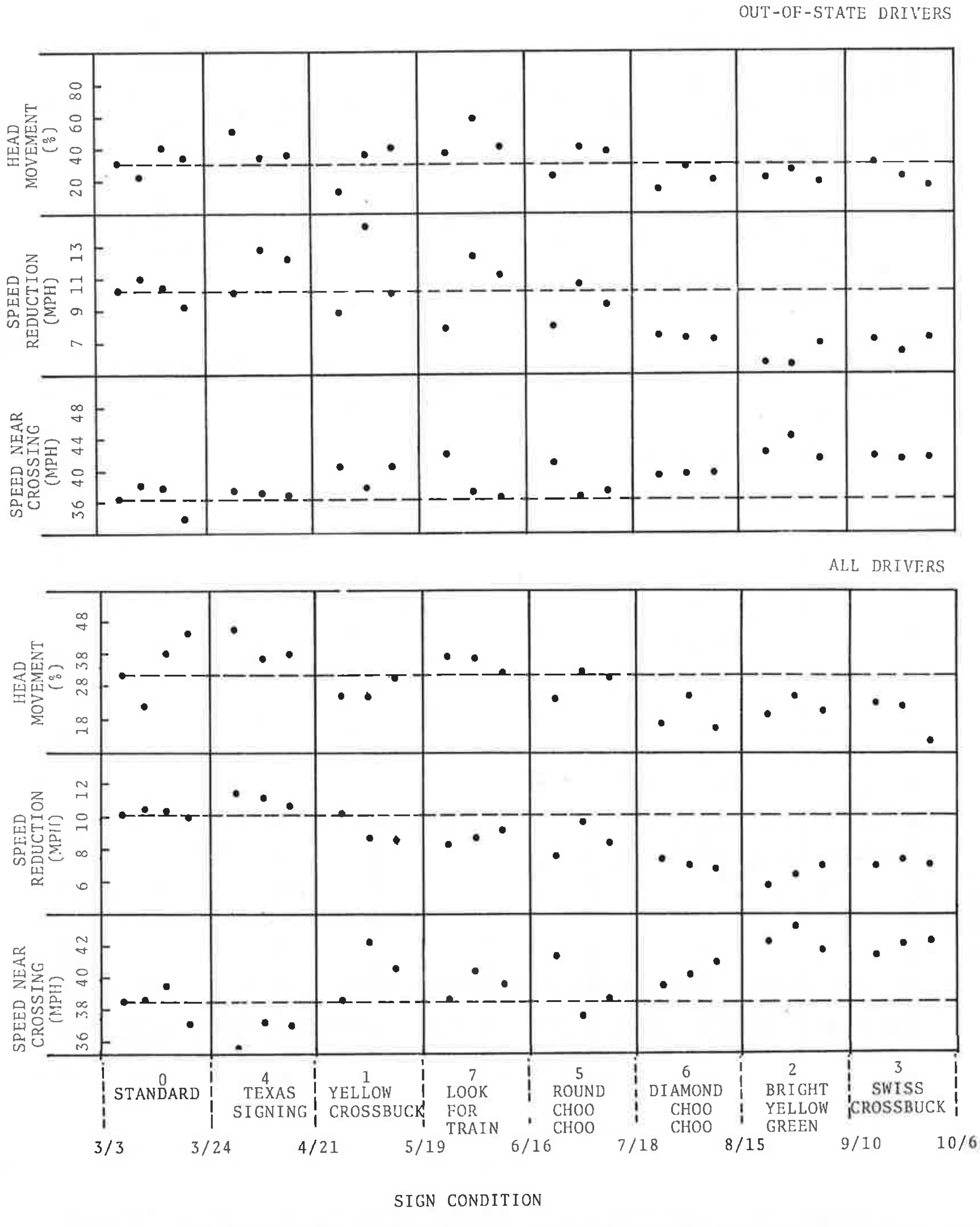

FIGURE 23. CONTRASTS OF EFFECTIVENESS OF OUT-OF-STATE DRIVERS WITH ALL DRIVERS, MAINE-DAY-WEST

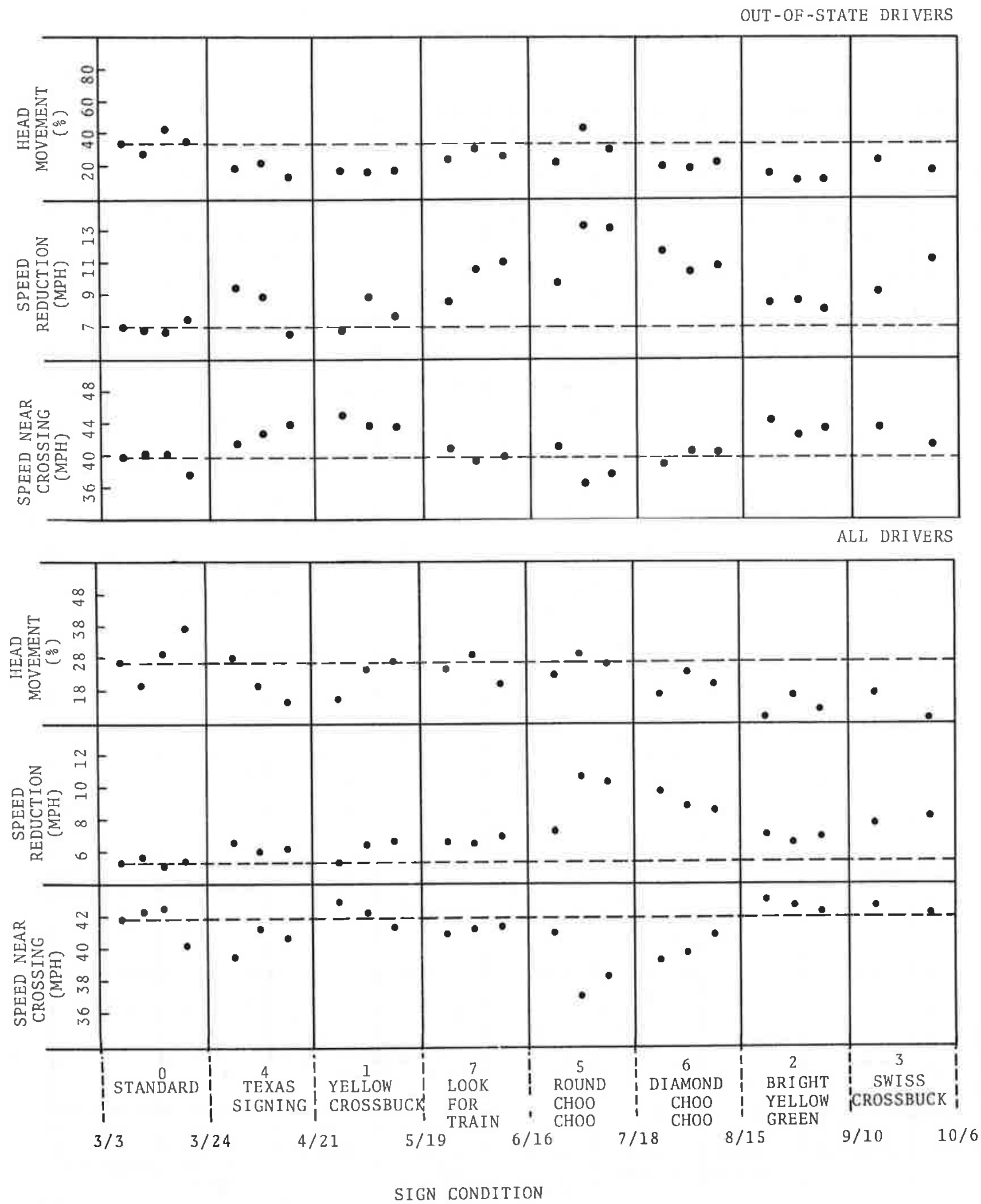

FIGURE 24. CONTRASTS OF EFFECTIVENESS OF OUT-OF-STATE DRIVERS WITH ALL DRIVERS, MAINE-DAY-EAST

what less effective for out-of-state drivers) but these are not considered significant. Thus, as was the case for westbound drivers, there appears to be no significant differences in behavior between out-of-state drivers and all drivers or in-state drivers.

4.5 SUMMARY

4.5.1 Evaluation of Sign Effectiveness

The only major significant finding of the study was that the new signs in Ohio averaged an increment of 19 percent more head movement than the base sign (99 percent significant). The Texas signing configuration (S.C. 4) and the look-for-train signing configuration (S.C. 7) showed the most effectiveness but not significantly with respect to the other new signs.

In terms of all the remaining measures, no new sign showed any consistent strong indications of effectiveness.

The Maine data appeared to be strongly influenced by a seasonal trend and other extraneous effects, making a determination of the most effective sign(s) quite difficult. In general, the Maine data did not show the strong indications of effectiveness (in terms of head movement) for all signs as was the case for the Ohio data. Also there were only a few indications of effectiveness (not significant) for the Texas and look-for-train signs.

4.5.2 Evaluation of Driver Behavior by Groups

The following groups of drivers showed significantly more head movement, more speed reduction and less speed near the crossing than their counterparts:

a) Required-stop vehicles;
b) Female drivers;
c) Drivers with passengers;
d) Out-of-state drivers.

Also, vehicles that approached the crossing at speeds less than 45 mph showed more head movement, less speed reduction and less speed near the crossing than vehicles that approached the crossing at speeds greater than 45 mph.

4.5.3 Evaluation of Relative Sign-Configuration Effectiveness By Driver Groups

No significant differences in sign-configuration effectiveness were observed for the following groups of drivers (i.e., each group responded similarly to its counterpart to the various sign configurations):

a) Drivers in autos vs drivers in other vehicles;

b) Males drivers vs females drivers;

c) Day drivers vs night drivers;

d) Drivers with passengers vs drivers without passengers;

e) Drivers with approach speed greater than 45 mph vs drivers with approach speed less than 45 mph;

f) In-state drivers vs out-of-state drivers.

5. CONCLUDING REMARKS

The major findings of Phase I of the Railroad Crossing Passive Signing Study were:

a) The new signs averaged an increment of 19 percent more head movement than the base sign (99 percent significance) in Ohio.

b) The Texas signing configuration and the "look-for-train" signing configuration showed the most effectiveness although not significantly with respect to the other new signs.

Furthermore, these findings were independent of any particular group or classification of drivers.

However, the impact of the major findings above is somewhat diminished by the inconsistency in results between the sites in Ohio and the site in Maine. Not only were there no significant findings in terms of new sign effectiveness from the Maine data but also most new signs studied in Maine appeared to be no more effective than the base sign configuration. These differences may be explained partly by the seasonal and extraneous effects that hampered the Maine study. It is also possible that the differences may have been due to observer variability since the major findings were based primarily on manual data. The different groups of observers may have experienced different learning effects. As a matter of fact, the observers in Ohio obtained very little head movement initially (i.e., for the base sign configuration). If this was indeed a learning effect the major findings in Ohio may not have been so significant.

Accordingly, Phase II of the experiment will put more emphasis on the collection of head-movement data. An attempt will be made to minimize as much observer variability by (1) defining head movement more precisely, (2) balancing the schedule of the observers in the field and (3) having two observers obtain head-movement data simulateneously from two different strategic locations near each crossing.

This should provide a more strengthened design for Phase II and a firmer basis for selecting the most effective sign(s).

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1. Johnson, Arnold A., "Maximum Safe Vehicle Speeds at Railroad Grade Crossings," Traffic Engineering, June, 1958, p. 20-22.

2. John, Peter W. M., "Statistical Design and Analysis of Experiments," Macmillan, New York City NY, 1971.

3. Manual on Uniform Traffic Control Devices (MUTCD) for Street and Highways, U.S. Department of Transportation, Federal Highway Administration, Washington DC, 1971.

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1. Dommasch, I. N., Hollinger, R. L., and Reilly, E. F., "Passive Control at Rail-Highway Grade Crossings," Presented at Transportation Research Board Meeting, January, 1976.

2. Hopkins, J. B., and Hazel, M. E., "Technological Innovation In Grade Crossing Protective Systems," U.S. Department of Transportation, Transportation Systems Center, Cambridge MA, Report No. DOT-TSC-FRA-71-3, June 1971.

3. Report to Congress, Railroad-Highway Safety Part I: A Comprehensive Statement of the Problem, November, 1971. Part II: Recommendations For Resolving the Problem, U.S. Department of Transportation, Federal Railroad Administration and Federal Highway Administration, Washington DC, August, 1972.

4. Sanders, James H. Jr., "Human Factors Countermeasures to Improve Highway-Railway Intersection Safety," U.S. Department of Transportation, Federal Railroad Administration and National Highway Traffic Safety Administration, Washington DC, DOT-HS-800-888, July, 1973.

APPENDIX A
SIGN CONFIGURATION AND SELECTION PROCEDURES

A.1 SIGN CONFIGURATIONS

Seven new passive sign configurations plus the existing (base) configuration were evaluated during Phase I. These signs are shown in Figures A-1 through A-8.

The base configuration shown in Figure A-1 was in conformance with the 1971 Manual on Uniform Traffic Control Devices (reference 3) includes a standard white crossbuck, 48 inches for each diagonal with "Railroad Crossing" legend on each side of the crossing and standard advance warning sign, a 36-inch reflectorized yellow circular sign with a block "X" and the letters RR. The warning sign advised of the crossing ahead but gave no other information.

Sign configuration 1 (Figure A-2) was the standard advance warning sign and a yellow crossbuck at-crossing sign with black border.

Sign configuration 2 (Figure A-3) was the same as sign configuration 1 except both signs were bright yellow green instead of yellow.

Sign configuration 3 (Figure A-4) consisted of the International Swiss crossbuck (or the St. Andrew's Cross) as the at-crossing sign and a circular advance warning sign with the same type of cross and letters RR on a yellow background.

Sign configuration 4 (Figure A-5) consisted of the so-called Texas at-crossing sign with the top and bottom quadrants red and the side quadrants yellow, and the standard advance warning sign with the top and bottom quadrants changed to red.

Sign configuration 5 (Figure A-6) consisted of the yellow crossbuck with black border at-crossing sign and a round yellow advance warning sign with a train (choo-choo) symbol.

Sign configuration 6 (Figure A-7) was the same as sign configuration 5 except the advance warning sign was a diamond shape.

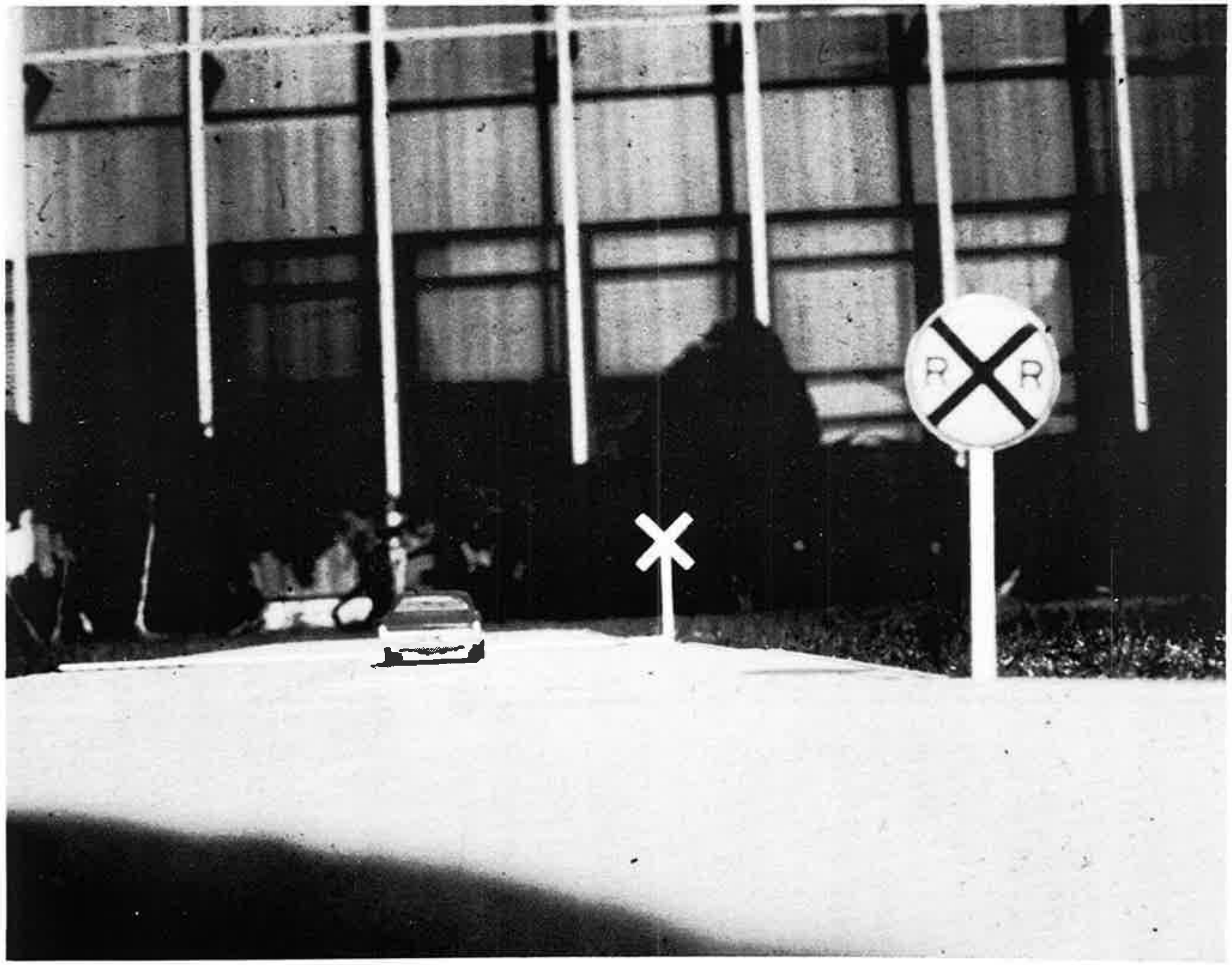


Figure A-1. Basic Sign Configuration (1971 MUTCD)

Figure A-2. Sign Configuration 1

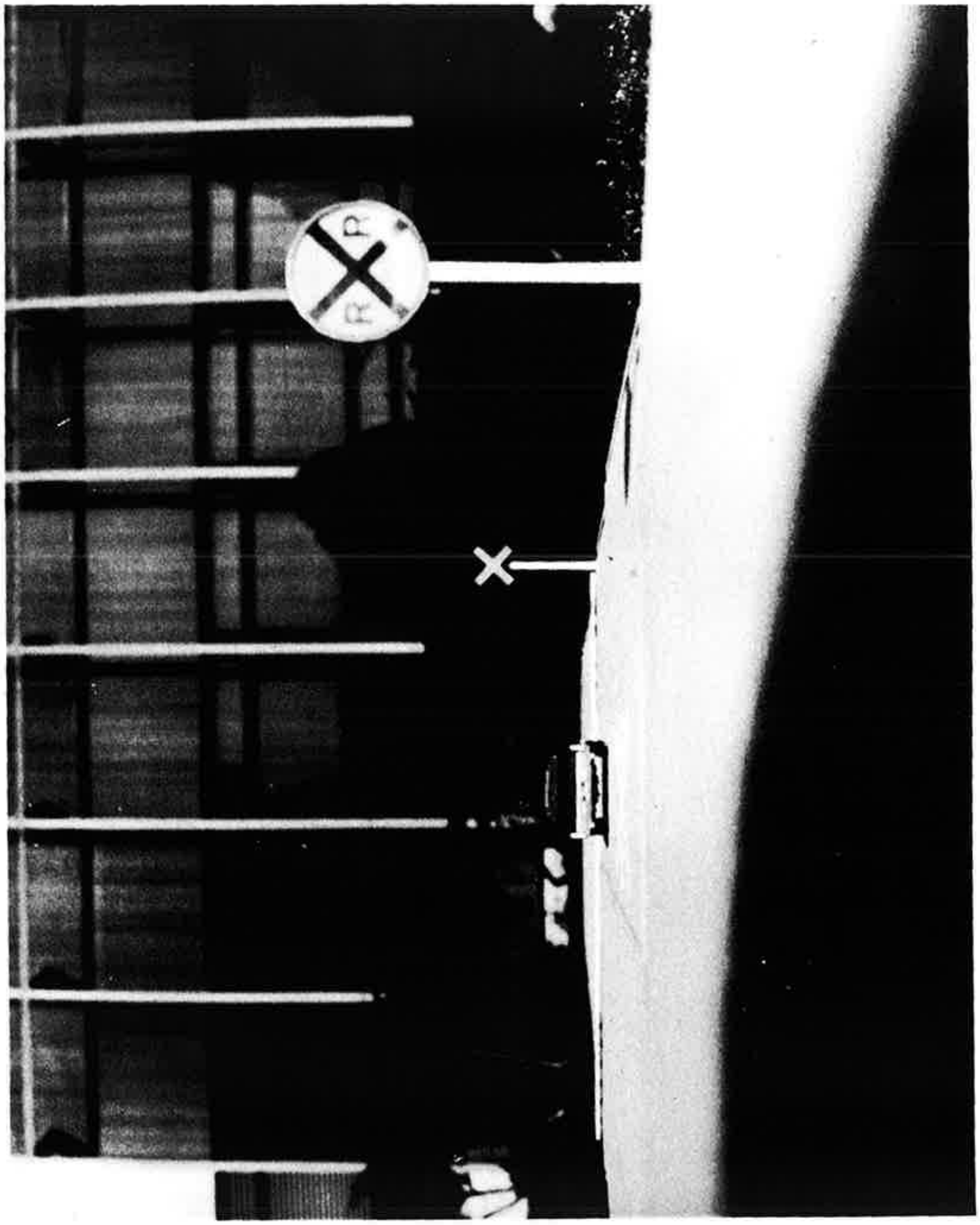


Figure A-3. Sign Configuration 2

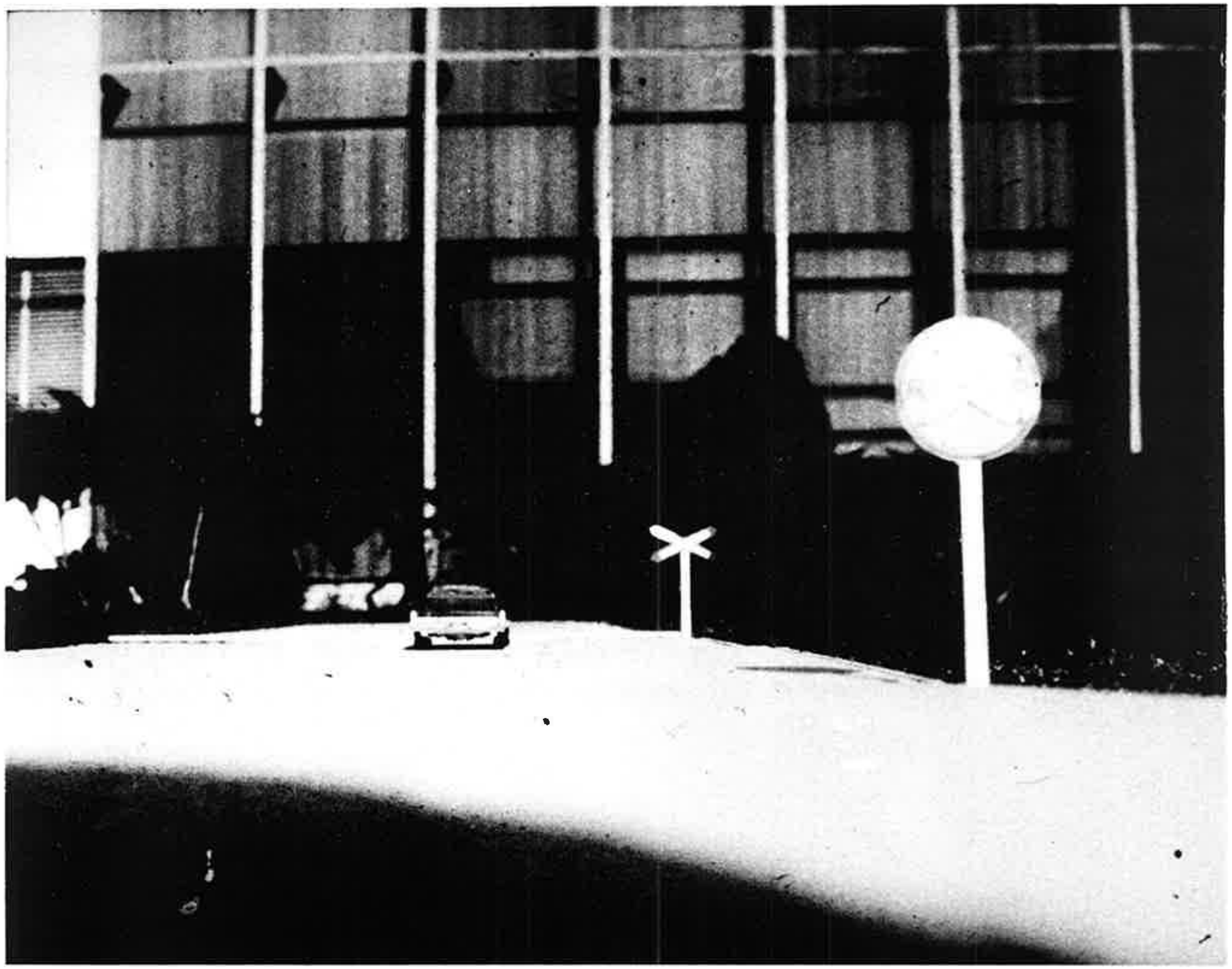


Figure A-4. Sign Configuration 3

Figure A-5. Sign Configuration 4

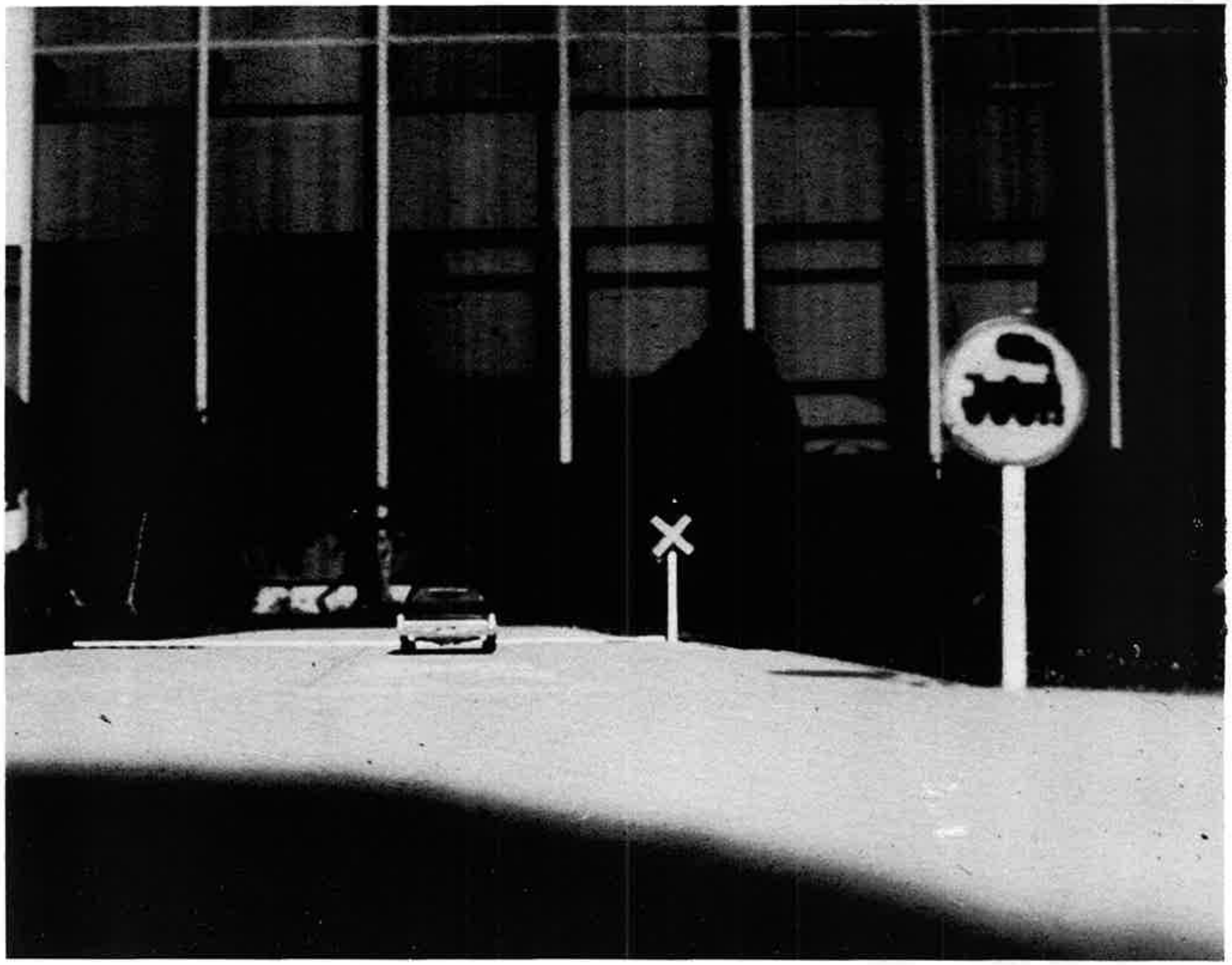


Figure A-6. Sign Configuration 5

Figure A-7. Sign Configuration 6

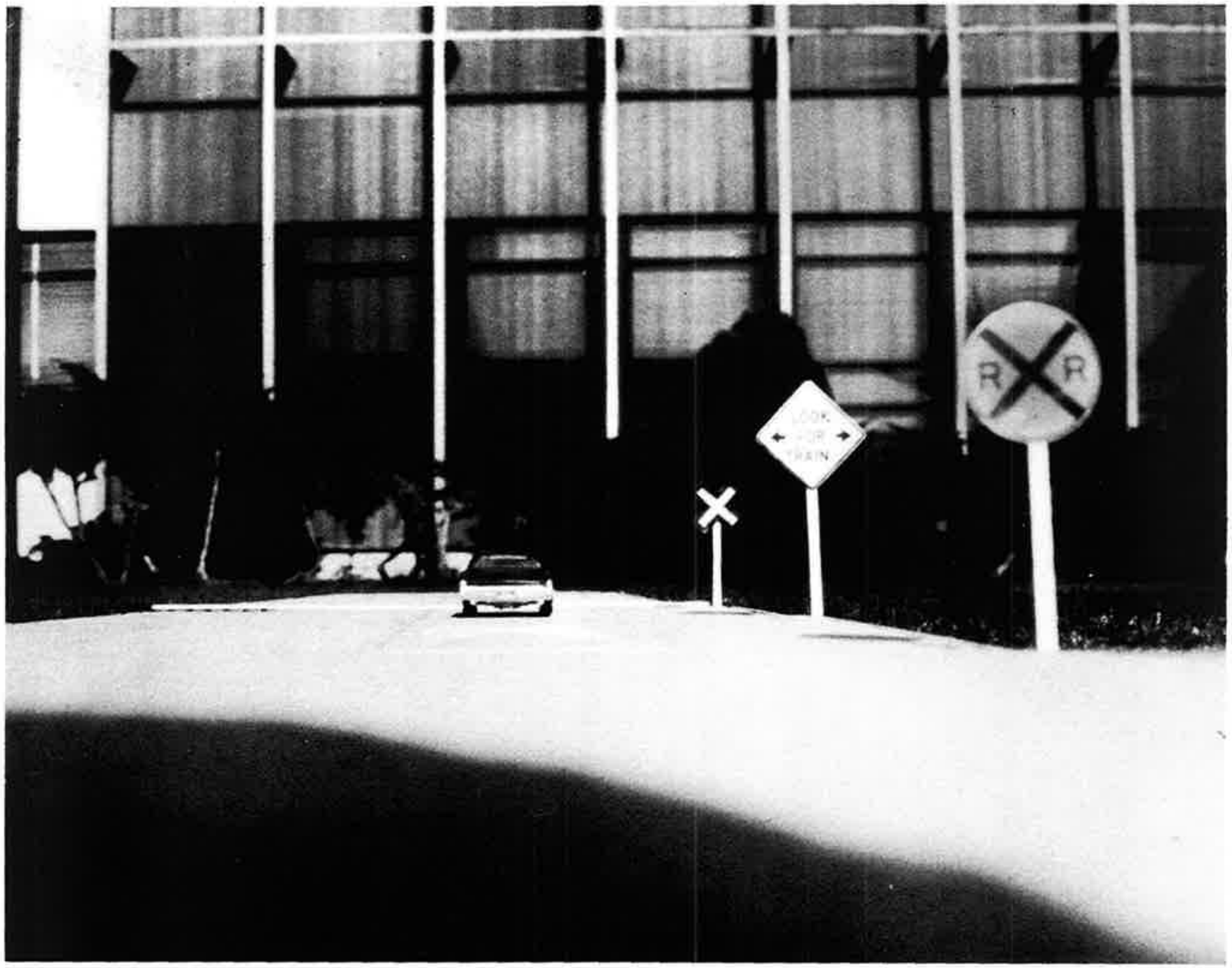


Figure A-8. Sign Configuration 7

Sign configuration 7 (Figure A-8) was the same as sign configuration 1 with the addition of an auxiliary sign, diamond shaped, yellow background, with the legend "Look for Trains." The auxiliary sign was located midway between the advance and at-crossing signs.

Only the base and Texas "at-crossing" signs bore the legend "Railroad Crossing." All other "at-crossing" signs had no legend. The advance warning signs were all 36 inches across and the crossbucks were all 48 inches in diagonal length. All configurations had pavement markings consisting of a distinctive "X" and the letters RR located adjacent to the advance warning signs (see reference 3).

A.2 SELECTION PROCEDURES

The above signs were selected by a program advisory committee that was formed at the initial stages of this project. This advisory committee consisted of representatives from each of the participating states, the Federal Railroad Administration, the Federal Highway Administration and the Association of American Railroads.

Miniature versions of 50 initial sign candidates were mailed to every member of the advisory committee for ranking. This was done in a two-phase evaluation process, in which the weighing of the goals for sign selection was done in the first phase and ranking of the railroad-crossing signs was done in the second phase. The following three general goals that the signs had to meet were established in the first phase:

Goal I - Gain and Hold the driver's attention;

Goal II - Convey the information needed for correct response;

Goal III - Present the information clearly and unambiguously.

In addition to the basic goals, several subgoals were established to answer the respective questions of : <u>how</u> to best get attention; what information was most important; and <u>which</u> communication technique would be most successful and unambiguous. Each member of the advisory committee was asked to review the various goals and subgoals and then assign relative weights to them to indicate their opinion in the relative importance of each goal and subgoal. Results of the national average as represented by the participants were sent to all members, who were then asked to rank the various railroad-crossing signs within the framework of the weights assigned for each goal and subgoal.

Advisory committee members were also asked to rate the various candidate signs subjectively where no formalized constraints of weights, goals, and subgoals were placed.

At an advisory committee meeting in Sacramento, summaries of the results of the subjective sign rating from the general sign opinion poll and the results from the objective rating scores submitted by the advisory committee members were displayed and passed out to each attendee. Miniature scale models of the road-surface, railroad crossing, and miniature signposts were also developed and displayed at this meeting. Slides were shown of a roadway scene with some possible signing configurations.

The candidate sign configurations were developed by arranging the members into four subcommittees, each developing a candidate signing configuration from one of the four top ranked "at-crossing" signs assigned to each subcommittee. The subcommittees then developed other candidate configurations using one of the top ranked advance warning signs. The configurations were compared and discussed at length and general agreement was reached on the resulting seven configurations.

Pictures of the seven configurations selected by the advisory committee were then mailed to the members of the sign subcommittee of the National Advisory Committee on the Manual Uniform Traffic Control Devices (NACMUTCD) for its review. In January 1974, a briefing was given to the members of the sign subcommittee of the NACMUTCD in Washington, DC, and the seven sign configurations were approved for experimental testing by the NACMUTCD and by the Federal Highway Administrator.

APPENDIX B
SITE DESCRIPTIONS

B.1 OHIO

The plan views of the five test sites in Ohio for the passive signing study are shown in Figures B-1 through B-5. Also shown or identified in each of the figures are the sight distances, side of the crossing on which the test was conducted, locations of the advance, auxiliary and at-crossing signs, and the location of the van during the tests.

Each site had the following general characteristics:

a) Two-lane, two-way rural roadway with a high speed limit (greater than 45 MPH) preceding the crossing;

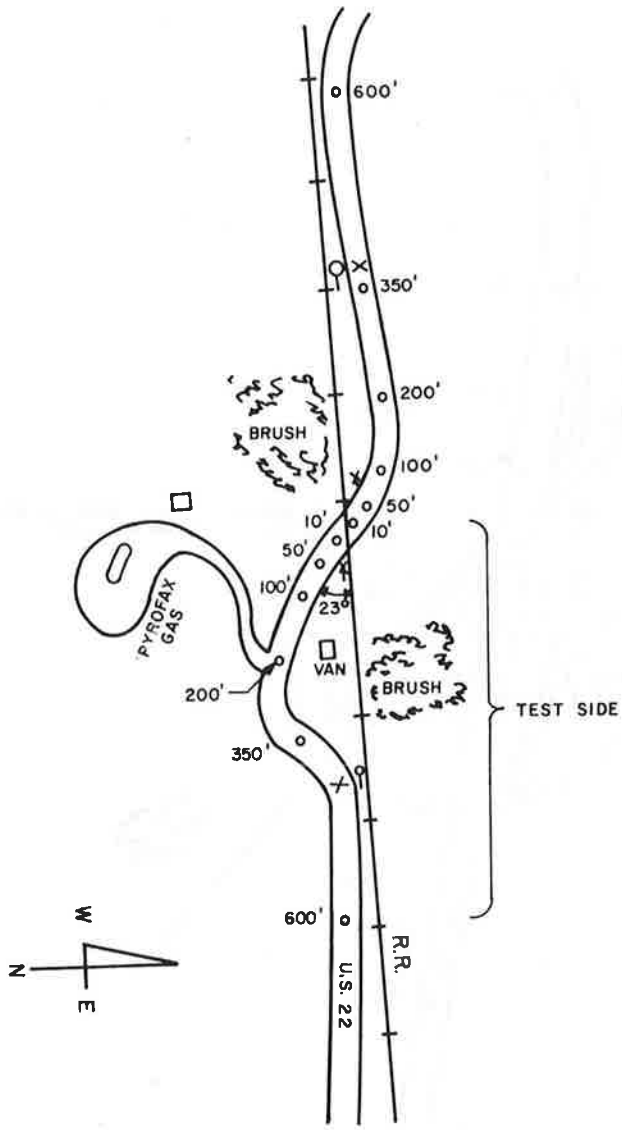
b) Average Daily Traffic (ADT) between 1,000 and 4,000;

c) Two - four trains per day;

d) Sight distance restrictions in at least one quadrant.

Site number 1, Johnson, is shown in Figure B-1. This site had a level roadway with an "S" curve at the crossing. Sight was restricted in the sense that a driver would have to look behind himself in order to observe an oncoming train.

Site number 2, Washington Court House, is shown in Figure B-2. This site also had a level roadway. Sight was restricted in the left quadrant on the approach and test side due to the fertilizer plant. Also, there was some sight restriction in the right quadrant due to the high corn stalks during the period the test was being conducted. This latter sight restriction was, of course, seasonal and could influence driver behavior accordingly. However, this did not invalidate the relative differences between the signs obtained during the test period. It should also be pointed out that the two-lane roadway on the test side increased to four lanes about 600 feet from the crossing on the opposite side.



SIGHT DISTANCES

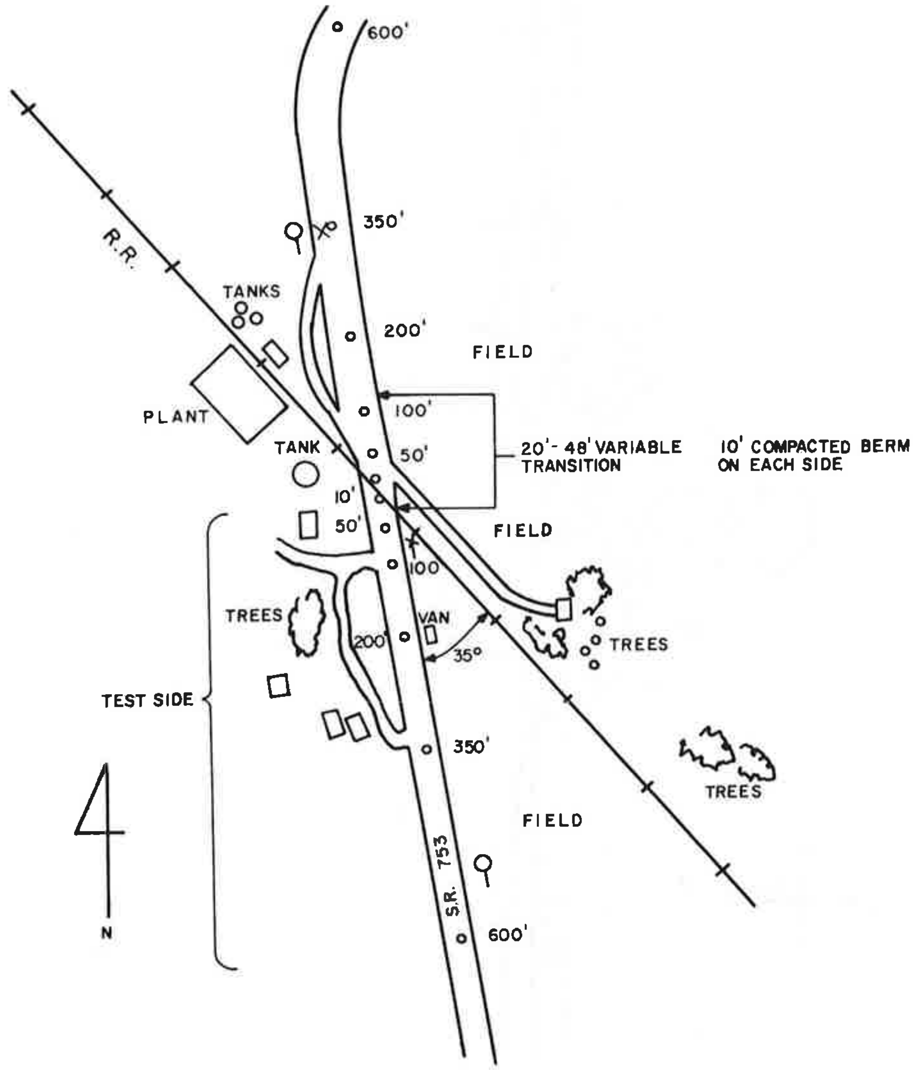
WEST APPROACH

	RIGHT	LEFT
AT 600'	500'	70'
AT 350'	320'	70'
AT 200'	180'	175'
AT 100'	90'	700'
AT 50'	40'	1800'
AT 10'	10'	2000'

EAST APPROACH

	RIGHT	LEFT
AT 600'	500'	400'
AT 350'	320'	310'
AT 200'	170'	190'
AT 100'	85'	300'
AT 50'	45'	400'
AT 10'	10'	2000'

Figure B-1. Site No. 1, Johnson



SIGHT DISTANCES

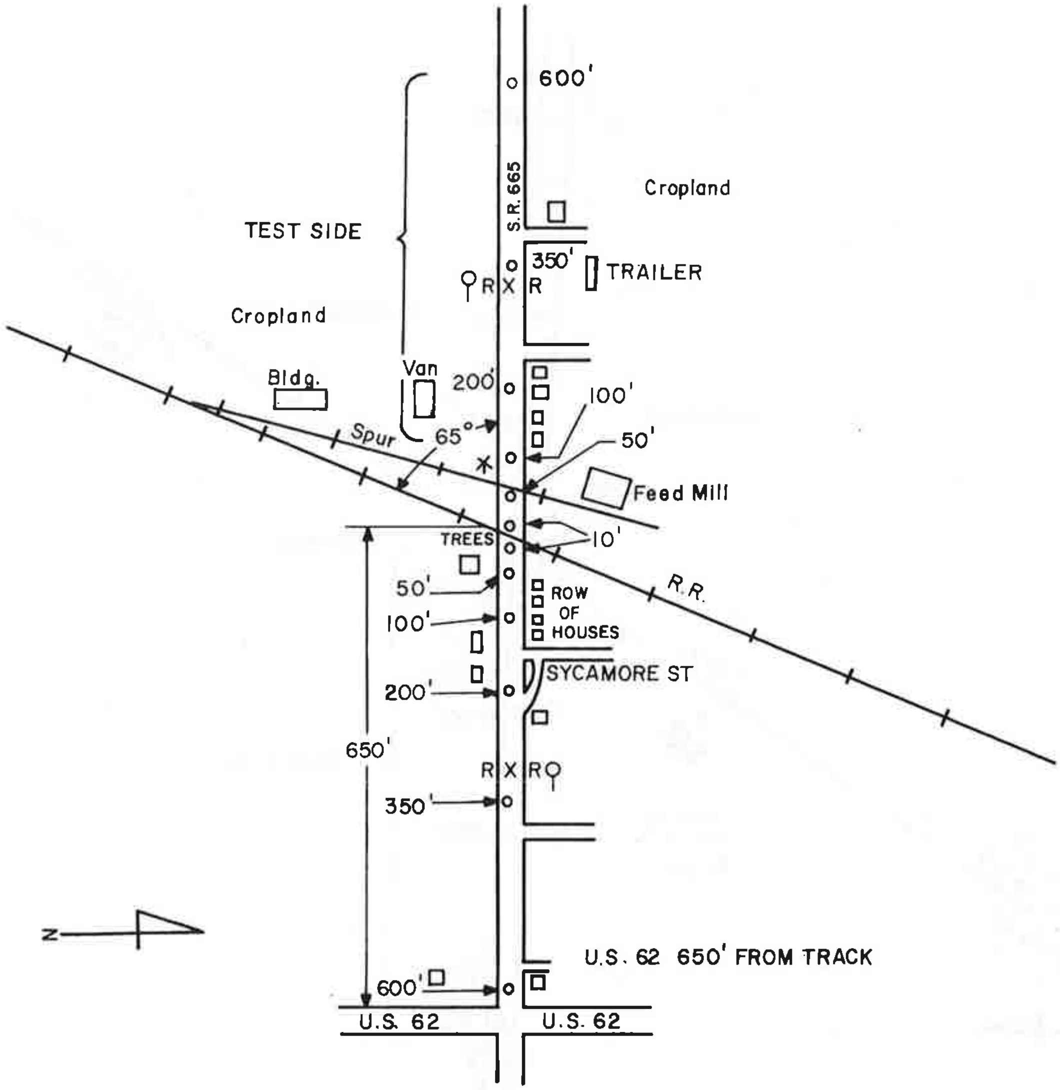
NORTH APPROACH

	RIGHT	LEFT
AT 600'	600'	150'
AT 350'	350'	150'
AT 200'	200'	150'
AT 100'	100'	160'
AT 50'	50'	200'
AT 10'	10'	2000'

SOUTH APPROACH

	RIGHT	LEFT
AT 600'	30'	300'
AT 350'	30'	400'
AT 200'	40'	600'
AT 100'	50'	900'
AT 50'	60'	1500'
AT 10'	10'	2000'

Figure B-2. Site No. 2, Washington Court House



SIGHT DISTANCES

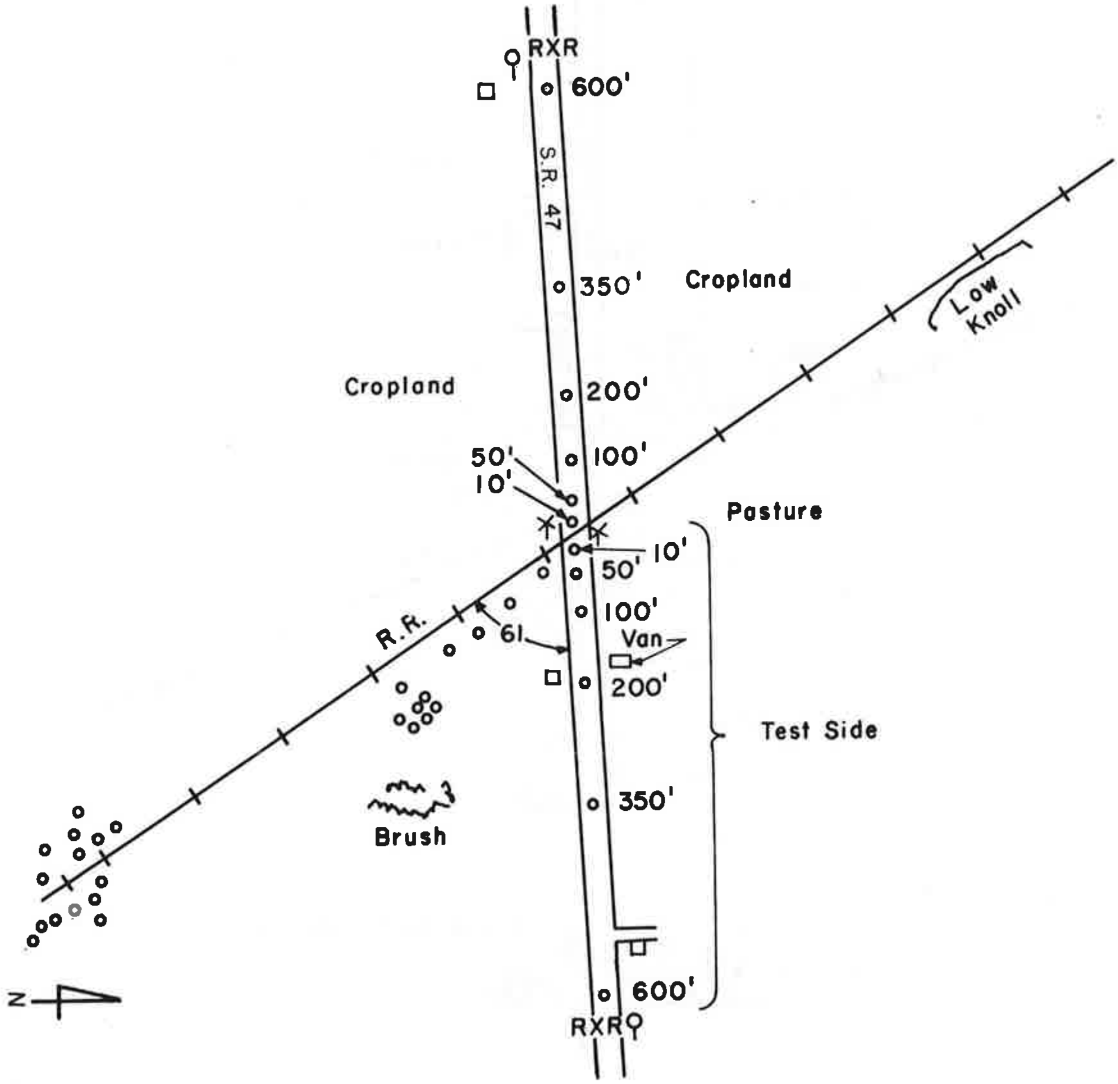
WEST APPROACH

	RIGHT	LEFT
AT 600'	260'	50'
AT 350'	300'	90'
AT 200'	250'	220'
AT 100'	120'	700'
AT 50'	70'	1300'
AT 10'	20'	2000'

EAST APPROACH

	RIGHT	LEFT
AT 600'	50'	30'
AT 350'	60'	40'
AT 200'	80'	70'
AT 100'	100'	90'
AT 50'	65'	300'
AT 10'	15'	2000'

Figure B-3. Site No. 3, Darbydale-Pleasant Corners

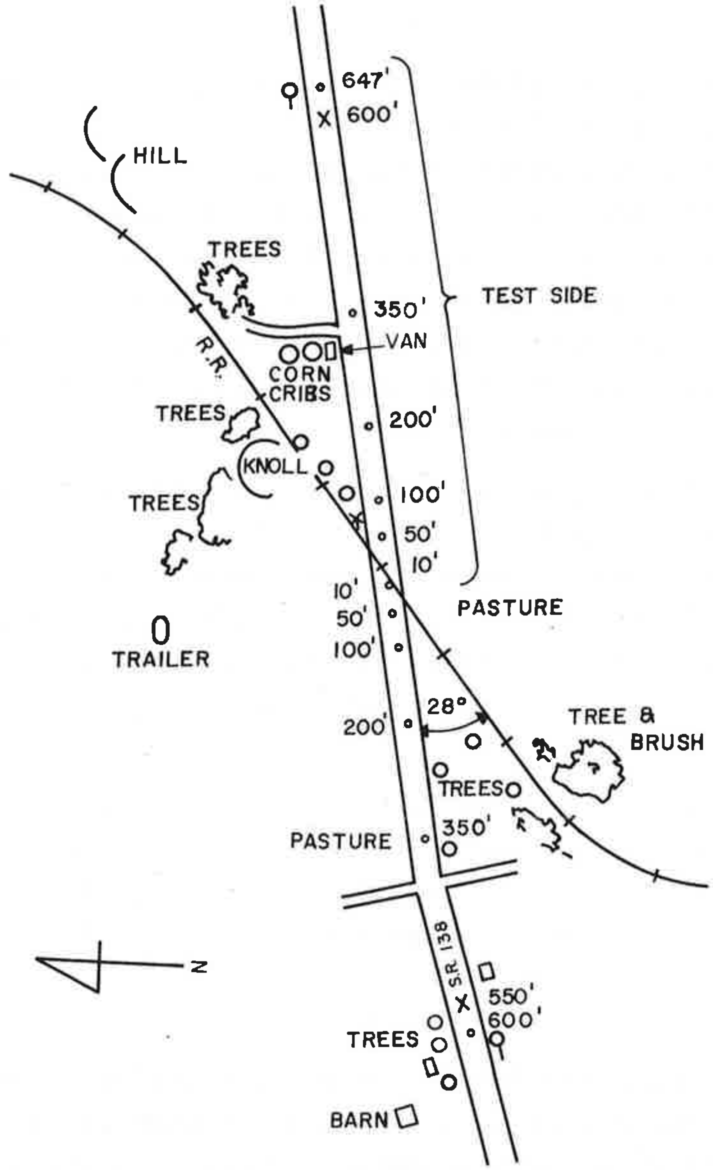


SIGHT DISTANCES

WEST APPROACH	RIGHT	LEFT
AT 600'	720'	650'
AT 350'	810'	410'
AT 200'	900'	240'
AT 100'	1200'	120'
AT 50'	2000'	60'
AT 10'	2000'	15'

EAST APPROACH	RIGHT	LEFT
AT 600'	560'	600'
AT 350'	630'	540'
AT 200'	700'	150'
AT 100'	720'	90'
AT 50'	900'	45'
AT 10'	2000'	10'

Figure B-4. Site No. 4, Logansville



SIGHT DISTANCES

WEST APPROACH

	RIGHT	LEFT
AT 600'	0'	100'
AT 350'	40'	150'
AT 200'	50'	150'
AT 100'	80'	150'
AT 50'	80'	350'
AT 10'	10'	400'

EAST APPROACH

	RIGHT	LEFT
AT 600'	350'	300'
AT 350'	350'	500'
AT 200'	350'	530'
AT 100'	90'	600'
AT 50'	60'	720'
AT 10'	10'	750'

Figure B-5. Site No. 5, Hillsboro-Danville

Site number 3, Darbydale-Pleasant Corners, is shown in Figure B-3. This site also had a level roadway. However, this site was hampered by a major intersection with overhead, centered beacons, only 650 feet from the crossing. Vehicles that approached from the west side (test side) were thus expected to slow down significantly and cross the railroad tracks at a low speed due to the intersection ahead if not the railroad crossing. At night, the flashing red beacon at the intersection seemed to predominate over the other signs along the roadside.

Site number 4, Logansville, is shown in Figure B-4. This site had a slightly rolling roadway on the test side compared to the first three sites. However, in all respects this site was considered most suitable for the passive signing study (e.g., sight restricted, high ADT, high train volume, high vehicle and train speeds, no undesirable characteristics such as near intersections or acute crossing angles).

Site number 5, Hillsboro-Danville, is shown in Figure B-5. This site had a long mild decline to the crossing on the test side. This gave the driver an overview of the crossing thus tending to minimize any sight restriction effects.

B.2 MAINE

The Maine test site for the RR passive signing study was located on the Maine Facility, a 15-mile stretch of instrumented highway on Route 2 in northern Maine. Route 2 is the major east-west artery in northern Maine. Embedded in the roadway of the Maine Facility are inductive loops which sense the presence of vehicles. The sensors are located approximately every 200 feet along the roadway providing link speeds between successive sensors. The plan and profile views of the railroad crossing site on the Maine Facility are shown in Figure B-6. A pictorial representation of the sight distances is shown in Figure B-7. The site was located on a mild grade (7 percent) and there was a narrow bridge about 600 feet east of the crossing. Data was collected in both directions although the eastbound direction was not as sight restricted as the westbound direction.

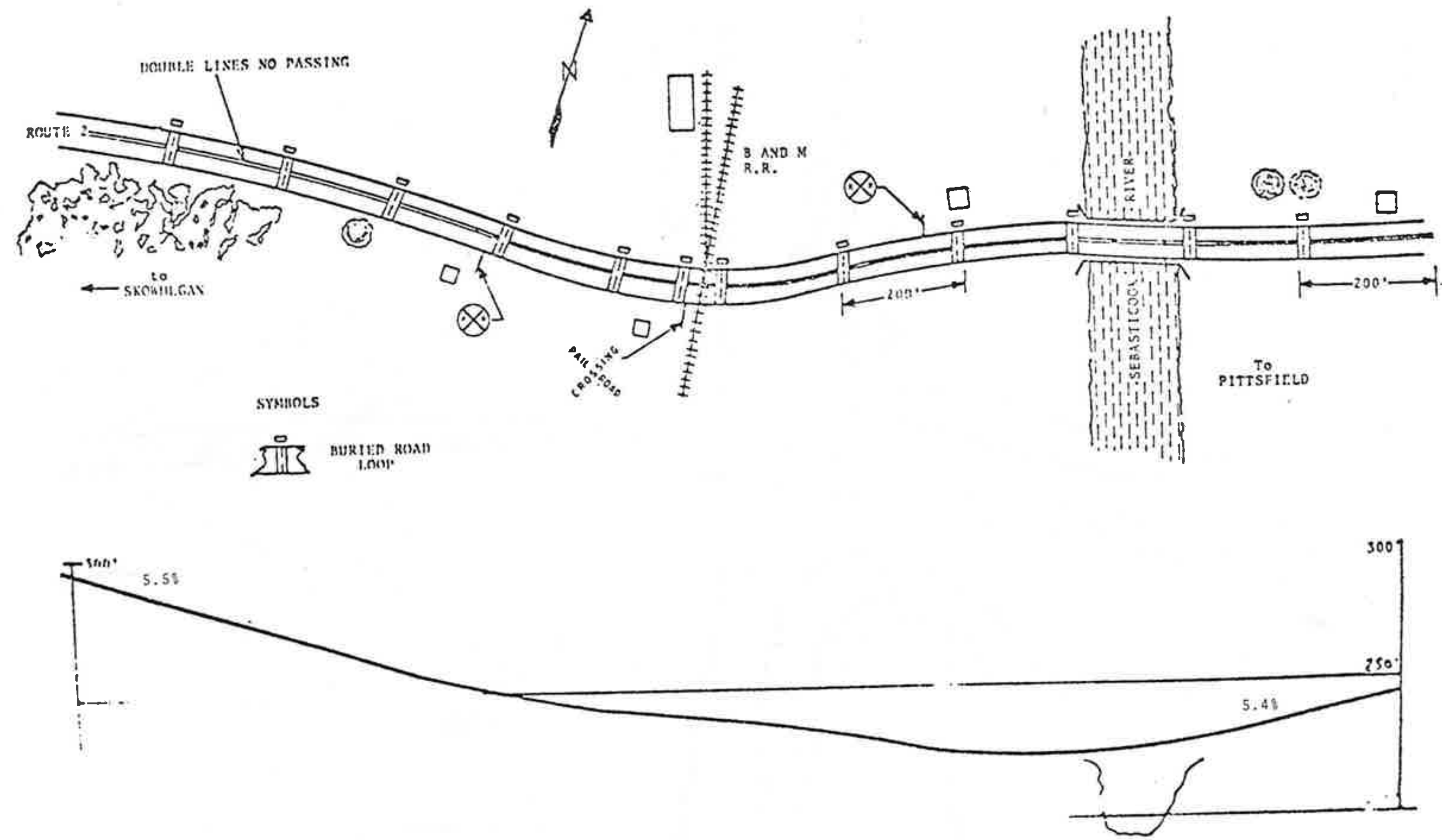


Figure B-6. Maine Facility Railroad Crossing Site

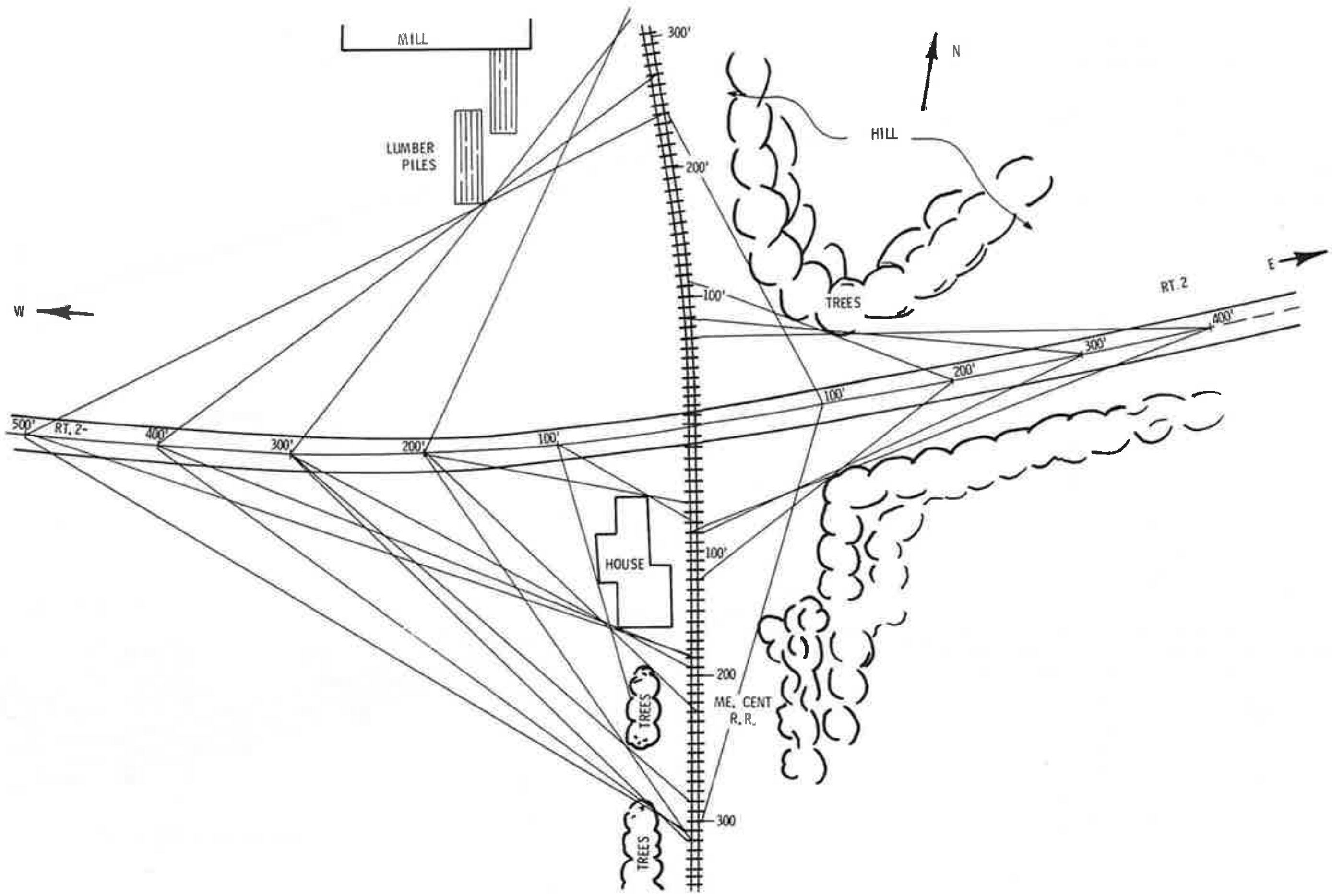


Figure B-7. Maine Facility Sight Distances Summer Foliage

APPENDIX C

TABLE STATISTICS

Means
Sample Sizes
Standard Deviations

TABLE C-1. OHIO ALL-DAY MEAN AND SITE NUMBER

HEAD MOVEMENT	5.5% 1	79.1% 3	80.1% 3	30.4% 1	72.8% 2	54.1% 2	27.9% 5	28.8% 1
	47.3% 2	33.6% 5	57.1% 2	72.3% 3	43.0% 5	57.5% 4	35.9% 1	72.3% 4
	43.7% 3	69.9% 4						
	46.3% 4							
	34.9% 5							
SPEED REDUCTION	10.2MPH 1	32.8MPH 3	31.3MPH 3	10.0MPH 1	25.5MPH 2	19.5MPH 2	12.6MPH 5	9.8MPH 1
	21.6MPH 2	14.1MPH 5	25.2MPH 2	33.3MPH 3	12.6MPH 5	19.6MPH 4	10.3MPH 1	21.7MPH 4
	34.7MPH 3	21.6MPH 4						
	18.0MPH 4							
	13.2MPH 5							
MEAN SPEED NEAR CROSSING	34.1MPH 1	16.6MPH 3	17.1MPH 3	36.2MPH 1	30.9MPH 2	30.8MPH 2	36.0MPH 5	36.2MPH 1
	27.3MPH 2	36.6MPH 5	27.4MPH 2	17.4MPH 3	38.0MPH 5	30.3MPH 4	37.3MPH 1	29.6MPH 4
	17.8MPH 3	30.8MPH 4						
	32.8MPH 4							
	37.4MPH 5							
RMS DECELERATION	0.052G'S 1	0.131G'S 3	0.128G'S 3	0.059G'S 1	0.119G'S 2	0.092G'S 2	0.067G'S 5	0.051G'S 1
	0.102G'S 2	0.080G'S 5	0.115G'S 2	0.134G'S 3	0.071G'S 5	0.096G'S 4	0.085G'S 1	0.105G'S 4
	0.139G'S 3	0.104G'S 4						
	0.094G'S 4							
	0.072G'S 5							
HEADWAY REDUCTION RATIO	3.26 1	1.17 3	1.49 3	1.44 1	0.26 2	0.35 2	0.91 5	0.19 1
	0.19 2	0.09 5	0.14 2	0.15 3	0.13 5	4.11 4	0.73 1	0.34 4
	2.57 3	0.10 4						
	0.13 4							
	0.06 5							
HAZARD TIME	6.9SEC. 1	10.6SEC. 3	8.8SEC. 3	6.8SEC. 1	10.6SEC. 2	8.1SEC. 2	7.1SEC. 5	7.0SEC. 1
	7.9SEC. 2	7.2SEC. 5	8.8SEC. 2	9.8SEC. 3	7.2SEC. 5	8.2SEC. 4	9.0SEC. 1	8.3SEC. 4
	10.5SEC. 3	8.4SEC. 4						
	7.8SEC. 4							
	7.3SEC. 5							
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-2. OHIO ALL-DAY SAMPLE SIZE AND SITE NUMBER

HEAD MOVEMENT	200 1	115 3	146 3	168 1	151 2	183 2	172 5	212 1
	203 2	152 5	168 2	177 3	158 5	120 4	103 1	155 4
	245 3	133 4						
	160 4							
	172 5							
SPEED REDUCTION	200 1	115 3	146 3	168 1	151 2	183 2	172 5	212 1
	203 2	152 5	168 2	177 3	158 5	120 4	103 1	155 4
	245 3	133 4						
	160 4							
	172 5							
MEAN SPEED NEAR CROSSING	200 1	115 3	146 3	168 1	151 2	183 2	172 5	212 1
	203 2	152 5	168 2	177 3	158 5	120 4	103 1	155 4
	245 3	133 4						
	160 4							
	172 5							
RMS DECELERATION	200 1	115 3	146 3	168 1	151 2	183 2	172 5	212 1
	203 2	152 5	168 2	177 3	158 5	120 4	103 1	155 4
	245 3	133 4						
	160 4							
	172 5							
HEADWAY REDUCTION RATIO	47 1	23 3	30 3	59 1	19 2	25 2	23 5	49 1
	27 2	22 5	24 2	37 3	18 5	17 4	21 1	19 4
	67 3	16 4						
	18 4							
	15 5							
HAZARD TIME	200 1	115 3	146 3	168 1	151 2	183 2	172 5	212 1
	203 2	152 5	169 2	177 3	158 5	120 4	103 1	155 4
	245 3	133 4						
	160 4							
	172 5							
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-3. OHIO ALL-DAY 2*STANDARD DEVIATION AND SITE NUMBER

HEAD MOVEMENT	3.2% 1 7.0% 2 6.3% 3 7.9% 4 7.3% 5	7.6% 3 7.7% 5 8.0% 4	6.6% 3 7.6% 2	7.1% 1 6.7% 3	7.2% 2 7.9% 5	7.4% 2 9.0% 4	6.8% 5 9.5% 1	6.2% 1 7.2% 4
SPEED REDUCTION	1.1MPH 1 1.4MPH 2 1.0MPH 3 1.8MPH 4 1.4MPH 5	1.1MPH 3 1.3MPH 5 2.3MPH 4	1.2MPH 3 1.7MPH 2	1.0MPH 1 1.0MPH 3	2.0MPH 2 1.3MPH 5	1.5MPH 2 2.2MPH 4	1.2MPH 5 1.9MPH 1	0.9MPH 1 2.0MPH 4
MEAN SPEED NEAR CROSSING	1.1MPH 1 1.4MPH 2 0.7MPH 3 1.9MPH 4 1.5MPH 5	0.9MPH 3 1.5MPH 5 2.2MPH 4	0.8MPH 3 1.5MPH 2	1.2MPH 1 0.8MPH 3	1.8MPH 2 1.6MPH 5	1.6MPH 2 2.3MPH 4	1.4MPH 5 1.4MPH 1	1.0MPH 1 2.2MPH 4
RMS DECELERATION	0.007G'S 1 0.006G'S 2 0.004G'S 3 0.008G'S 4 0.008G'S 5	0.007G'S 3 0.007G'S 5 0.009G'S 4	0.006G'S 3 0.007G'S 2	0.009G'S 1 0.005G'S 3	0.008G'S 2 0.006G'S 5	0.006G'S 2 0.009G'S 4	0.006G'S 5 0.038G'S 1	0.004G'S 1 0.008G'S 4
HEADWAY REDUCTION RATIO	3.63 1 0.19 2 4.38 3 0.13 4 0.06 5	1.99 3 0.09 5 0.09 4	2.12 3 0.10 2	2.54 1 0.10 3	0.17 2 0.20 5	0.31 2 5.50 4	1.56 5 1.03 1	0.10 1 0.41 4
HAZARD TIME	0.9SEC. 1 0.3SEC. 2 0.5SEC. 3 0.3SEC. 4 0.7SEC. 5	2.8SEC. 3 0.2SEC. 5 0.3SEC. 4	0.3SEC. 3 0.4SEC. 2	0.1SEC. 1 0.4SEC. 3	2.3SEC. 2 0.1SEC. 5	0.8SEC. 2 0.4SEC. 4	0.1SEC. 5 3.2SEC. 1	0.6SEC. 1 0.3SEC. 4
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-4. OHIO ALL-NIGHT MEAN AND SITE NUMBER

SPEED REDUCTION	9.1MPH 1 22.7MPH 2 30.3MPH 3 20.6MPH 4 13.4MPH 5	31.3MPH 3 12.0MPH 5 18.1MPH 4	29.2MPH 3 20.6MPH 2	9.2MPH 1 29.9MPH 3	20.8MPH 2 12.4MPH 5	19.5MPH 2 21.1MPH 4	11.6MPH 5 11.9MPH 1	10.2MPH 1 19.7MPH 4
MEAN SPEED NEAR CROSSING	34.9MPH 1 27.3MPH 2 18.2MPH 3 29.1MPH 4 36.8MPH 5	17.1MPH 3 39.4MPH 5 30.4MPH 4	17.2MPH 3 28.9MPH 2	35.0MPH 1 17.4MPH 3	29.2MPH 2 36.1MPH 5	28.0MPH 2 28.6MPH 4	36.3MPH 5 33.2MPH 1	33.6MPH 1 27.2MPH 4
RMS DECELERATION	0.048G'S 1 0.103G'S 2 0.125G'S 3 0.102G'S 4 0.068G'S 5	0.120G'S 3 0.067G'S 5 0.091G'S 4	0.116G'S 3 0.096G'S 2	0.046G'S 1 0.114G'S 3	0.093G'S 2 0.066G'S 5	0.090G'S 2 0.093G'S 4	0.062G'S 5 0.058G'S 1	0.054G'S 1 0.095G'S 4
HEADWAY REDUCTION RATIO	0.12 1 0.16 2 0.15 3 0.30 4 0.16 5	7.21 3 0.63 5 3.11 4	0.17 3 0.00 2	0.27 1 0.30 3	0.00 2 0.06 5	0.15 2 0.30 4	0.04 5 1.86 1	0.16 1 3.11 4
HAZARD TIME	6.2SEC. 1 7.9SEC. 2 9.0SEC. 3 7.7SEC. 4 15.8SEC. 5	9.3SEC. 3 7.1SEC. 5 7.6SEC. 4	10.7SEC. 3 7.7SEC. 2	6.6SEC. 1 8.4SEC. 3	7.6SEC. 2 7.1SEC. 5	7.5SEC. 2 15.2SEC. 4	6.9SEC. 5 6.3SEC. 1	6.3SEC. 1 7.9SEC. 4
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-5. OHIO ALL-NIGHT SAMPLE SIZE AND SITE NUMBER

SPEED REDUCTION	100	1	34	3	131	3	56	1	14	2	64	2	100	5	70	1
	64	2	35	5	59	2	82	3	76	5	49	4	82	1	20	4
	76	3	59	4												
	50	4														
	80	5														
MEAN SPEED NEAR CROSSING	100	1	34	3	131	3	56	1	14	2	64	2	100	5	70	1
	64	2	35	5	59	2	82	3	76	5	49	4	82	1	20	4
	76	3	59	4												
	50	4														
	80	5														
RMS DECELERATION	100	1	34	3	131	3	56	1	14	2	64	2	100	5	70	1
	64	2	35	5	59	2	82	3	76	5	49	4	82	1	20	4
	76	3	59	4												
	50	4														
	80	5														
HEADWAY REDUCTION RATIO	7	1	4	3	18	3	5	1	2	2	4	2	9	5	5	1
	7	2	5	5	2	2	18	3	3	5	0	4	10	1	0	4
	12	3	6	4												
	0	4														
	12	5														
HAZARD TIME	100	1	34	3	131	3	56	1	14	2	64	2	100	5	70	1
	64	2	35	5	59	2	82	3	76	5	49	4	82	1	20	4
	76	3	59	4												
	50	4														
	80	5														
SIGN CONDITION	0		1		2		3		4		5		6		7	

TABLE C-6. OHIO ALL-NIGHT 2* STANDARD DEVIATION AND SITE NUMBER

SPEED REDUCTION	1.1MPH 1 2.4MPH 2 1.6MPH 3 3.5MPH 4 2.0MPH 5	2.3MPH 3 2.6MPH 5 3.0MPH 4	1.4MPH 3 2.7MPH 2	2.1MPH 1 1.5MPH 3	5.8MPH 2 1.8MPH 5	2.5MPH 2 3.4MPH 4	1.7MPH 5 2.0MPH 1	1.8MPH 1 4.3MPH 4
MEAN SPEED NEAR CROSSING	1.4MPH 1 2.5MPH 2 1.3MPH 3 3.6MPH 4 2.2MPH 5	2.2MPH 3 2.9MPH 5 2.9MPH 4	1.0MPH 3 3.0MPH 2	2.2MPH 1 1.3MPH 3	7.0MPH 2 2.3MPH 5	2.6MPH 2 4.1MPH 4	2.0MPH 5 2.5MPH 1	2.1MPH 1 4.3MPH 4
RMS DECELERATION	0.005G'S 1 0.011G'S 2 0.008G'S 3 0.017G'S 4 0.009G'S 5	0.011G'S 3 0.013G'S 5 0.012G'S 4	0.007G'S 3 0.011G'S 2	0.008G'S 1 0.007G'S 3	0.027G'S 2 0.009G'S 5	0.011G'S 2 0.013G'S 4	0.008G'S 5 0.009G'S 1	0.010G'S 1 0.022G'S 4
HEADWAY REDUCTION RATIO	0.16 1 0.31 2 0.14 3 0.26 4 0.18 5	8.01 3 0.06 5 5.96 4	0.18 3 0.00 2	0.35 1 0.26 3	0.00 2 0.07 5	0.29 2 0.26 4	0.06 5 3.37 1	0.14 1 5.96 4
HAZARD TIME	0.2SEC. 1 0.3SEC. 2 0.5SEC. 3 0.6SEC. 4 11.9SEC. 5	1.4SEC. 3 0.3SEC. 5 0.5SEC. 4	3.8SEC. 3 0.4SEC. 2	0.5SEC. 1 0.6SEC. 3	0.8SEC. 2 0.2SEC. 5	0.3SEC. 2 13.8SEC. 4	0.2SEC. 5 0.4SEC. 1	0.3SEC. 1 1.1SEC. 4
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-7. OHIO ALL-DAY ANOVA RELATIVE MEAN EFFECT ESTIMATE

HEAD MOVEMENT	0.0%	20.1%	19.5%	18.6%	26.4%	9.2%	16.8%	20.4%
SPEED REDUCTION	0.0MPH	1.1MPH	0.5MPH	0.6MPH	1.4MPH	-2.1MPH	0.5MPH	0.8MPH
MEAN SPEED NEAR CROSSING	0.0MPH	-0.3MPH	-0.8MPH	0.2MPH	1.9MPH	0.8MPH	0.9MPH	-0.5MPH
RMS DECELERATION	0.000G'S	0.007G'S	0.003G'S	0.003G'S	0.209G'S	-0.010G'S	0.015G'S	-0.001G'S
HEADWAY REDUCTION RATIO	0.00	-0.89	-0.09	-1.32	-0.11	1.59	-0.69	-1.58
HAZARD TIME	0.0SEC.	0.6SEC.	-0.6SEC.	-0.3SEC.	1.4SEC.	-0.2SEC.	1.3SEC.	-0.0SEC.
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-8. OHIO ALL-DAY ANOVA STANDARD DEVIATION

HEAD MOVEMENT	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%
SPEED REDUCTION	1.7MPH	1.7MPH	1.7MPH	1.7MPH	1.7MPH	1.7MPH	1.7MPH	1.7MPH
MEAN SPEED NEAR CROSSING	1.4MPH	1.4MPH	1.4MPH	1.4MPH	1.4MPH	1.4MPH	1.4MPH	1.4MPH
RMS DECELERATION	0.010G'S	0.010G'S	0.010G'S	0.010G'S	0.010G'S	0.010G'S	0.010G'S	0.010G'S
HEADWAY REDUCTION RATIO	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
HAZARD TIME	0.7SEC.	0.7SEC.	0.7SEC.	0.7SEC.	0.7SEC.	0.7SEC.	0.7SEC.	0.7SEC.
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-9. OHIO ALL-NIGHT ANOVA RELATIVE MEAN EFFECT ESTIMATE

SPEED REDUCTION	0.0MPH	-0.9MPH	-1.4MPH	-1.2MPH	-0.5MPH	-0.7MPH	0.2MPH	-0.5MPH
MEAN SPEED NEAR CROSSING	0.0MPH	1.1MPH	0.3MPH	0.2MPH	-0.2MPH	-0.5MPH	-1.3MPH	-1.6MPH
RMS DECELERATION	0.000G'S	-0.004G'S	-0.006G'S	-0.009G'S	-0.005G'S	-0.008G'S	-0.001G'S	-0.002G'S
HEADWAY REDUCTION RATIO	0.00	3.19	-0.71	-0.42	0.60	-0.15	1.60	1.35
HAZARD TIME	0.0SEC.	-2.4SEC.	0.4SEC.	-1.6SEC.	-1.8SEC.	2.6SEC.	-2.9SEC.	-1.9SEC.
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-10. OHIO ALL-NIGHT ANOVA STANDARD DEVIATION

SPEED REDUCTION	1.3MPH	1.3MPH	1.3MPH	1.3MPH	1.3MPH	1.3MPH	1.3MPH	1.3MPH
MEAN SPEED NEAR CROSSING	0.9MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH
RMS DECELERATION	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S
HEADWAY REDUCTION RATIO	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
HAZARD TIME	2.6SEC.	2.6SEC.	2.6SEC.	2.6SEC.	2.6SEC.	2.6SEC.	2.6SEC.	2.6SEC.
SIGN CONDITION	0	1	2	3	4	5	6	7

TABLE C-11. MAINE ALL-WEST-DAY MEAN AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

SIGN CONDITION	WEEK	[illegible]	4	1	7	5	6	2	3
HEAD MOVEMENT	1	32.4%	46.2%	25.2%	37.6%	24.2%	16.5%	19.6%	23.7%
	2	55.4%	******%	31.4%	29.1%	******%	31.7%	18.6%	23.1%
	3	******%	36.6%	25.1%	37.4%	32.3%	24.8%	25.5%	22.4%
	4	******%	37.9%	31.5%	32.5%	31.1%	15.4%	20.4%	11.6%
SPEED REDUCTION	1	10.3MPH	11.6MPH	10.3MPH	8.2MPH	7.5MPH	7.4MPH	5.9MPH	7.1MPH
	2	10.2MPH	*****MPH	10.9MPH	9.2MPH	*****MPH	7.2MPH	6.7MPH	7.3MPH
	3	*****MPH	11.3MPH	8.7MPH	8.7MPH	9.5MPH	7.0MPH	6.4MPH	7.4MPH
	4	*****MPH	10.8MPH	8.6MPH	9.2MPH	8.4MPH	6.8MPH	7.0MPH	7.1MPH
MEAN SPEED NEAR CROSSING	1	38.5MPH	35.7MPH	38.6MPH	38.6MPH	41.4MPH	39.4MPH	42.5MPH	41.5MPH
	2	38.6MPH	*****MPH	37.4MPH	38.8MPH	*****MPH	39.6MPH	43.1MPH	40.8MPH
	3	*****MPH	37.3MPH	42.3MPH	40.4MPH	37.6MPH	40.0MPH	43.3MPH	42.2MPH
	4	*****MPH	37.1MPH	40.6MPH	39.6MPH	38.7MPH	41.1MPH	41.7MPH	42.3MPH
RMS DECELERATION	1	0.064G'S	0.063G'S	0.061G'S	0.058G'S	0.054G'S	0.047G'S	0.045G'S	0.050G'S
	2	0.063G'S	******G'S	0.062G'S	0.058G'S	******G'S	0.048G'S	0.050G'S	0.050G'S
	3	******G'S	0.063G'S	0.057G'S	0.057G'S	0.057G'S	0.048G'S	0.050G'S	0.052G'S
	4	******G'S	0.062G'S	0.055G'S	0.058G'S	0.053G'S	0.047G'S	0.049G'S	0.050G'S
HEADWAY REDUCTION RATIO	1	3.63	0.66	0.43	0.79	0.21	0.46	0.30	0.78
	2	3.65	*****	0.37	0.39	*****	0.30	0.27	0.40
	3	*****	2.42	2.82	6.24	0.30	0.35	0.51	1.72
	4	*****	6.22	0.46	0.38	0.31	0.30	0.32	0.41
HAZARD TIME	1	7.1SEC.	7.1SEC.	7.1SEC.	6.6SEC.	7.0SEC.	7.0SEC.	7.0SEC.	7.0SEC.
	2	7.1SEC.	*****SEC.	7.1SEC.	7.1SEC.	*****SEC.	6.9SEC.	7.1SEC.	7.0SEC.
	3	*****SEC.	7.2SEC.	7.3SEC.	7.2SEC.	7.1SEC.	6.9SEC.	7.1SEC.	7.1SEC.
	4	*****SEC.	7.1SEC.	7.2SEC.	7.2SEC.	7.0SEC.	7.0SEC.	7.1SEC.	7.1SEC.

TABLE C-12. MAINE ALL-WEST-DAY SAMPLE SIZE AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

	Week	Sign Condition 0	4	1	7	5	6	2	3
HEAD MOVEMENT	1	574	249	143	213	269	170	179	198
	2	168	*******	226	227	*******	227	226	134
	3	*******	262	171	246	365	226	282	192
	4	*******	441	410	385	409	396	431	448
SPEED REDUCTION	1	574	249	143	213	269	170	179	198
	2	168	*******	226	227	*******	227	226	134
	3	*******	262	171	246	365	226	282	192
	4	*******	441	410	385	409	396	431	448
MEAN SPEED NEAR CROSSING	1	574	249	143	213	269	170	179	198
	2	168	*******	226	227	*******	227	226	134
	3	*******	262	171	246	365	226	282	192
	4	*******	441	410	385	409	396	431	448
RMS DECELERATION	1	574	249	143	213	269	170	179	198
	2	168	*******	226	227	*******	227	226	134
	3	*******	262	171	246	365	226	282	192
	4	*******	441	410	385	409	396	431	448
HEADWAY REDUCTION RATIO	1	79	45	43	57	59	96	116	48
	2	22	*******	50	44	*******	135	92	62
	3	*******	42	31	44	193	147	70	54
	4	*******	80	85	99	162	244	144	179
HAZARD TIME	1	574	249	143	213	269	170	179	198
	2	168	*******	226	227	*******	227	226	134
	3	*******	262	171	246	365	226	282	192
	4	*******	441	410	385	409	396	431	448
SIGN CONDITION		0	4	1	7	5	6	2	3

TABLE C-13. MAINE ALL-WEST-DAY 2*STANDARD DEVIATION AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

	Week								
HEAD MOVEMENT	1	3.9%	6.3%	7.3%	6.6%	5.2%	5.7%	5.9%	6.0%
	2	7.7%	******%	6.2%	6.0%	******%	6.2%	5.2%	7.3%
	3	******%	6.0%	6.6%	6.2%	4.9%	5.7%	5.2%	6.0%
	4	******%	4.6%	4.6%	4.8%	4.6%	3.6%	3.9%	3.0%
SPEED REDUCTION	1	0.5MPH	0.9MPH	1.1MPH	0.9MPH	0.7MPH	1.0MPH	0.9MPH	0.8MPH
	2	1.0MPH	*****MPH	0.9MPH	1.1MPH	*****MPH	0.9MPH	0.8MPH	1.2MPH
	3	*****MPH	0.8MPH	1.0MPH	1.0MPH	0.7MPH	0.8MPH	0.7MPH	1.0MPH
	4	*****MPH	0.6MPH	0.7MPH	0.7MPH	0.7MPH	0.6MPH	0.6MPH	0.6MPH
MEAN SPEED NEAR CROSSING	1	0.7MPH	1.1MPH	1.6MPH	1.2MPH	1.0MPH	1.1MPH	1.2MPH	1.1MPH
	2	1.3MPH	*****MPH	1.2MPH	1.3MPH	*****MPH	1.1MPH	1.1MPH	1.4MPH
	3	*****MPH	1.1MPH	1.4MPH	1.3MPH	0.9MPH	1.0MPH	1.1MPH	1.2MPH
	4	*****MPH	0.9MPH	0.9MPH	1.0MPH	0.9MPH	0.8MPH	0.8MPH	0.8MPH
RMS DECELERATION	1	0.003G'S	0.004G'S	0.005G'S	0.005G'S	0.004G'S	0.005G'S	0.004G'S	0.004G'S
	2	0.005G'S	******G'S	0.004G'S	0.004G'S	******G'S	0.004G'S	0.004G'S	0.006G'S
	3	******G'S	0.004G'S	0.005G'S	0.004G'S	0.003G'S	0.004G'S	0.003G'S	0.004G'S
	4	******G'S	0.004G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S
HEADWAY REDUCTION RATIO	1	4.82	0.68	0.28	0.70	0.10	0.23	0.14	0.64
	2	6.43	*****	0.30	0.15	*****	0.09	0.13	0.29
	3	*****	3.99	5.41	11.54	0.09	0.15	0.33	3.11
	4	*****	6.95	0.26	0.15	0.15	0.06	0.13	0.21
HAZARD TIME	1	0.1SEC.	0.1SEC.	0.1SEC.	0.2SEC.	0.1SEC.	0.2SEC.	0.1SEC.	0.1SEC.
	2	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	3	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	4	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.
SIGN CONDITION		[illegible]	4	1	7	5	6	2	3

TABLE C-14. MAINE ALL-EAST-DAY MEAN AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

HEAD MOVEMENT	1	27.0%	28.0%	14.9%	24.6%	23.5%	16.9%	10.3%	17.6%
	2	37.5%	******%	17.9%	23.8%	******%	14.7%	12.2%	13.3%
	3	******%	19.4%	24.7%	28.8%	30.0%	24.4%	17.4%	25.5%
	4	******%	14.5%	26.8%	20.5%	26.1%	20.4%	12.4%	8.6%
SPEED REDUCTION	1	5.5MPH	6.7MPH	5.4MPH	6.7MPH	7.2MPH	9.7MPH	7.2MPH	7.7MPH
	2	6.2MPH	*****MPH	5.3MPH	6.1MPH	*****MPH	8.1MPH	6.6MPH	7.8MPH
	3	*****MPH	6.1MPH	6.5MPH	6.5MPH	10.7MPH	8.8MPH	6.7MPH	6.4MPH
	4	*****MPH	6.3MPH	6.8MPH	7.1MPH	10.4MPH	8.6MPH	7.1MPH	8.2MPH
MEAN SPEED NEAR CROSSING	1	41.9MPH	39.5MPH	43.1MPH	40.9MPH	41.1MPH	39.2MPH	43.1MPH	42.6MPH
	2	40.1MPH	*****MPH	41.7MPH	42.4MPH	*****MPH	39.4MPH	42.9MPH	41.2MPH
	3	*****MPH	41.3MPH	42.4MPH	41.3MPH	37.0MPH	39.7MPH	42.7MPH	43.3MPH
	4	*****MPH	40.9MPH	41.4MPH	41.4MPH	38.3MPH	41.0MPH	42.4MPH	42.3MPH
RMS DECELERATION	1	0.043G'S	0.046G'S	0.047G'S	0.051G'S	0.053G'S	0.068G'S	0.059G'S	0.059G'S
	2	0.043G'S	******G'S	0.044G'S	0.048G'S	******G'S	0.054G'S	0.054G'S	0.054G'S
	3	******G'S	0.047G'S	0.054G'S	0.051G'S	0.067G'S	0.060G'S	0.052G'S	0.050G'S
	4	******G'S	0.046G'S	0.049G'S	0.053G'S	0.067G'S	0.059G'S	0.055G'S	0.064G'S
HEADWAY REDUCTION RATIO	1	0.46	0.36	0.79	0.26	0.31	0.24	0.20	0.33
	2	0.31	*****	0.34	0.38	*****	0.30	0.37	0.42
	3	*****	0.24	0.60	0.75	0.47	0.31	0.35	0.51
	4	*****	0.49	0.69	0.24	0.45	0.42	0.48	0.46
HAZARD TIME	1	7.3SEC.	7.3SEC.	7.2SEC.	7.3SEC.	7.4SEC.	7.5SEC.	7.4SEC.	7.8SEC.
	2	7.3SEC.	*****SEC.	7.3SEC.	7.3SEC.	*****SEC.	7.4SEC.	7.3SEC.	7.6SEC.
	3	*****SEC.	7.3SEC.	7.3SEC.	7.3SEC.	7.5SEC.	7.5SEC.	7.3SEC.	7.1SEC.
	4	*****SEC.	7.3SEC.	7.4SEC.	7.4SEC.	7.5SEC.	7.5SEC.	7.4SEC.	7.7SEC.
SIGN CONDITION		0	4	1	7	5	6	2	3

TABLE C-15. MAINE ALL-EAST-DAY SAMPLE SIZE AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

Measure	Week	Sign Condition 0	4	1	7	5	6	2	3
HEAD MOVEMENT	1	618	246	174	236	251	178	195	199
	2	192	*******	257	240	*******	156	197	135
	3	*******	283	178	264	300	197	270	0
	4	*******	428	411	361	410	343	428	374
SPEED REDUCTION	1	618	246	174	236	251	178	195	199
	2	192	*******	257	240	*******	156	197	135
	3	*******	283	178	264	300	197	270	0
	4	*******	428	411	361	410	343	428	374
MEAN SPEED NEAR CROSSING	1	618	246	174	236	251	178	195	199
	2	192	*******	257	240	*******	156	197	135
	3	*******	283	178	264	300	197	270	0
	4	*******	428	411	361	410	343	428	374
RMS DECELERATION	1	618	246	174	236	251	178	195	199
	2	192	*******	257	240	*******	156	197	135
	3	*******	283	178	264	300	197	270	0
	4	*******	428	411	361	410	343	428	374
HEADWAY REDUCTION RATIO	1	92	54	30	61	77	108	108	82
	2	32	*******	47	41	*******	72	51	38
	3	*******	54	24	57	138	160	59	0
	4	*******	76	101	105	169	180	129	142
HAZARD TIME	1	618	246	174	236	251	178	195	199
	2	192	*******	257	240	*******	156	197	135
	3	*******	283	178	264	300	197	270	0
	4	*******	428	411	361	410	343	428	374

TABLE C-16. MAINE ALL-EAST-DAY 2*STANDARD DEVIATION AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

	Week								
HEAD MOVEMENT	1	3.6%	5.7%	5.4%	5.6%	5.4%	5.6%	4.3%	5.4%
	2	7.2%	******%	4.8%	5.5%	******%	5.7%	4.7%	5.9%
	3	******%	4.7%	6.5%	5.6%	5.3%	6.1%	4.6%	5.2%
	4	******%	3.4%	4.4%	4.2%	4.3%	4.4%	3.2%	2.9%
SPEED REDUCTION	1	0.5MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH	1.3MPH	1.0MPH	1.1MPH
	2	0.9MPH	*****MPH	0.7MPH	0.9MPH	*****MPH	1.0MPH	0.7MPH	1.5MPH
	3	*****MPH	0.8MPH	1.0MPH	0.9MPH	1.0MPH	1.0MPH	0.8MPH	0.7MPH
	4	*****MPH	0.6MPH	0.7MPH	0.8MPH	0.8MPH	0.8MPH	0.6MPH	0.7MPH
MEAN SPEED NEAR CROSSING	1	0.7MPH	1.3MPH	1.4MPH	1.2MPH	1.1MPH	1.2MPH	1.1MPH	1.1MPH
	2	1.3MPH	*****MPH	1.0MPH	1.2MPH	*****MPH	1.3MPH	1.0MPH	1.4MPH
	3	*****MPH	1.0MPH	1.4MPH	1.2MPH	1.0MPH	1.1MPH	1.0MPH	1.1MPH
	4	*****MPH	0.9MPH	0.8MPH	1.0MPH	0.8MPH	0.9MPH	0.7MPH	0.9MPH
RMS DECELERATION	1	0.002G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.010G'S	0.007G'S	0.005G'S
	2	0.004G'S	******G'S	0.003G'S	0.004G'S	******G'S	0.005G'S	0.004G'S	0.007G'S
	3	******G'S	0.004G'S	0.006G'S	0.004G'S	0.005G'S	0.005G'S	0.004G'S	0.003G'S
	4	******G'S	0.003G'S	0.003G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S
HEADWAY REDUCTION RATIO	1	0.35	0.17	0.53	0.11	0.12	0.09	0.08	0.15
	2	0.25	*****	0.20	0.18	*****	0.14	0.21	0.32
	3	*****	0.15	0.50	0.67	0.19	0.10	0.20	0.33
	4	*****	0.24	0.43	0.11	0.32	0.19	0.24	0.18
HAZARD TIME	1	0.0SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.5SEC.
	2	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	0.3SEC.
	3	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	4	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.3SEC.
SIGN CONDITION		?	4	1	7	5	6	2	3

TABLE C-17. MAINE O/S-WEST-DAY MEAN AND WEEK NUMBER (WEEK 1,3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

HEAD MOVEMENT	1	30.2%	50.0%	13.3%	37.0%	22.1%	14.4%	21.6%	31.3%
	2	28.6%	******%	40.0%	47.4%	******%	41.8%	17.6%	23.0%
	3	******%	35.0%	35.7%	56.4%	40.3%	29.3%	26.3%	22.4%
	4	******%	36.0%	40.0%	40.6%	39.2%	20.3%	19.4%	16.2%
SPEED REDUCTION	1	10.2MPH	10.1MPH	8.9MPH	7.9MPH	7.9MPH	7.3MPH	5.7MPH	7.1MPH
	2	9.4MPH	*****MPH	11.3MPH	11.8MPH	*****MPH	8.5MPH	7.5MPH	8.2MPH
	3	*****MPH	12.9MPH	14.3MPH	12.5MPH	10.6MPH	7.3MPH	5.6MPH	6.3MPH
	4	*****MPH	12.3MPH	10.0MPH	11.2MPH	9.3MPH	7.2MPH	7.0MPH	7.2MPH
MEAN SPEED NEAR CROSSING	1	36.5MPH	37.6MPH	40.3MPH	41.8MPH	41.0MPH	39.2MPH	42.1MPH	41.6MPH
	2	42.5MPH	*****MPH	37.1MPH	35.6MPH	*****MPH	38.9MPH	41.6MPH	39.7MPH
	3	*****MPH	37.2MPH	37.9MPH	37.1MPH	36.6MPH	39.3MPH	44.1MPH	41.4MPH
	4	*****MPH	36.9MPH	40.3MPH	36.7MPH	37.2MPH	39.4MPH	41.4MPH	41.5MPH
RMS DECELERATION	1	0.061G'S	0.060G'S	0.063G'S	0.060G'S	0.059G'S	0.046G'S	0.044G'S	0.051G'S
	2	0.059G'S	******G'S	0.069G'S	0.070G'S	******G'S	0.053G'S	0.053G'S	0.055G'S
	3	******G'S	0.072G'S	0.074G'S	0.075G'S	0.061G'S	0.050G'S	0.051G'S	0.048G'S
	4	******G'S	0.076G'S	0.066G'S	0.064G'S	0.057G'S	0.047G'S	0.052G'S	0.050G'S
HEADWAY REDUCTION RATIO	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	*****	0.00	0.00	*****	0.00	0.00	0.00
	3	*****	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	*****	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HAZARD TIME	1	7.0SEC.	7.2SEC.	7.2SEC.	6.8SEC.	6.9SEC.	7.0SEC.	7.0SEC.	7.0SEC.
	2	7.3SEC.	*****SEC.	7.1SEC.	7.3SEC.	*****SEC.	7.1SEC.	7.1SEC.	7.1SEC.
	3	*****SEC.	7.4SEC.	7.7SEC.	7.5SEC.	7.2SEC.	6.9SEC.	7.1SEC.	7.0SEC.
	4	*****SEC.	7.2SEC.	7.3SEC.	7.3SEC.	7.0SEC.	6.9SEC.	7.1SEC.	7.1SEC.
SIGN CONDITION		0	4	1	7	5	6	2	3

TABLE C-18. MAINE O/S-WEST-DAY SAMPLE SIZE AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

HEAD MOVEMENT	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
SPEED REDUCTION	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
MEAN SPEED NEAR CROSSING	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
RMS DECELERATION	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
HEADWAY REDUCTION RATIO	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
HAZARD TIME	96	1	20	1	15	1	27	1	77	1	111	1	97	1	67	1
	14	2	*******	2	25	2	57	2	*******	2	122	2	91	2	61	2
	*******	3	20	3	14	3	39	3	181	3	116	3	80	3	67	3
	*******	4	25	4	65	4	96	4	204	4	192	4	170	4	130	4
SIGN CONDITION	0		4		1		7		5		6		2		3	

TABLE C-19. MAINE O/S-WEST-DAY 2*STANDARD DEVIATION AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

Measure	Week	Sign Condition 0	4	1	7	5	6	2	3
HEAD MOVEMENT	1	9.4%	22.4%	17.6%	18.6%	9.5%	6.7%	8.4%	11.3%
	2	24.1%	******%	19.6%	13.2%	******%	8.9%	8.0%	10.8%
	3	******%	21.3%	25.6%	15.9%	7.3%	8.5%	9.8%	10.2%
	4	******%	19.2%	12.2%	10.0%	6.8%	5.8%	6.1%	6.5%
SPEED REDUCTION	1	0.5MPH	0.9MPH	1.1MPH	0.9MPH	0.7MPH	1.0MPH	0.9MPH	0.8MPH
	2	1.0MPH	*****MPH	0.9MPH	1.1MPH	*****MPH	0.9MPH	0.8MPH	1.2MPH
	3	*****MPH	0.8MPH	1.0MPH	1.0MPH	0.7MPH	0.8MPH	0.7MPH	1.0MPH
	4	*****MPH	0.6MPH	0.7MPH	0.7MPH	0.7MPH	0.6MPH	0.6MPH	0.6MPH
MEAN SPEED NEAR CROSSING	1	0.7MPH	1.1MPH	1.6MPH	1.2MPH	1.0MPH	1.1MPH	1.2MPH	1.1MPH
	2	1.3MPH	*****MPH	1.2MPH	1.3MPH	*****MPH	1.1MPH	1.1MPH	1.4MPH
	3	*****MPH	1.1MPH	1.4MPH	1.3MPH	0.9MPH	1.0MPH	1.1MPH	1.2MPH
	4	*****MPH	0.9MPH	0.9MPH	1.0MPH	0.9MPH	0.8MPH	0.8MPH	0.8MPH
RMS DECELERATION	1	0.003G'S	0.004G'S	0.005G'S	0.005G'S	0.004G'S	0.005G'S	0.004G'S	0.004G'S
	2	0.005G'S	******G'S	0.004G'S	0.004G'S	******G'S	0.004G'S	0.004G'S	0.006G'S
	3	******G'S	0.004G'S	0.005G'S	0.004G'S	0.003G'S	0.004G'S	0.003G'S	0.004G'S
	4	******G'S	0.004G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S	0.003G'S
HEADWAY REDUCTION RATIO	1	4.82	0.68	0.28	0.70	0.10	0.23	0.14	0.64
	2	6.43	*****	0.30	0.15	*****	0.09	0.13	0.29
	3	*****	3.99	5.41	11.54	0.09	0.15	0.33	3.11
	4	*****	6.95	0.26	0.15	0.15	0.06	0.13	0.21
HAZARD TIME	1	0.1SEC.	0.1SEC.	0.1SEC.	0.2SEC.	0.1SEC.	0.2SEC.	0.1SEC.	0.1SEC.
	2	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	3	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	4	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.

TABLE C-20. MAINE O/S-EAST-DAY MEAN AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

HEAD MOVEMENT	1	33.3%	18.8%	16.7%	23.5%	22.4%	19.6%	14.3%	22.2%
	2	26.3%	******%	18.2%	26.0%	******%	18.1%	4.7%	12.2%
	3	******%	22.2%	15.4%	30.8%	43.1%	17.8%	10.4%	26.3%
	4	******%	12.9%	16.1%	25.9%	30.9%	21.0%	10.1%	15.2%
SPEED REDUCTION	1	7.0MPH	9.5MPH	6.6MPH	8.4MPH	9.7MPH	11.8MPH	8.3MPH	9.1MPH
	2	6.1MPH	*****MPH	6.6MPH	8.7MPH	*****MPH	9.2MPH	7.6MPH	10.2MPH
	3	*****MPH	8.9MPH	8.9MPH	10.5MPH	13.4MPH	10.5MPH	8.4MPH	5.6MPH
	4	*****MPH	6.5MPH	7.7MPH	12.8MPH	13.0MPH	10.7MPH	8.0MPH	11.2MPH
MEAN SPEED NEAR CROSSING	1	39.6MPH	41.2MPH	45.0MPH	41.4MPH	41.4MPH	39.0MPH	44.5MPH	43.6MPH
	2	43.2MPH	*****MPH	43.7MPH	42.7MPH	*****MPH	39.3MPH	43.8MPH	41.1MPH
	3	*****MPH	42.6MPH	43.5MPH	39.4MPH	36.4MPH	40.8MPH	42.8MPH	44.1MPH
	4	*****MPH	43.7MPH	43.7MPH	40.1MPH	37.6MPH	40.7MPH	43.4MPH	41.6MPH
RMS DECELERATION	1	0.049G'S	0.059G'S	0.064G'S	0.063G'S	0.065G'S	0.081G'S	0.067G'S	0.069G'S
	2	0.044G'S	******G'S	0.048G'S	0.064G'S	******G'S	0.061G'S	0.059G'S	0.069G'S
	3	******G'S	0.064G'S	0.068G'S	0.072G'S	0.082G'S	0.070G'S	0.061G'S	0.051G'S
	4	******G'S	0.052G'S	0.059G'S	0.074G'S	0.082G'S	0.071G'S	0.061G'S	0.081G'S
HEADWAY REDUCTION RATIO	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	*****	0.00	0.00	*****	0.00	0.00	0.00
	3	*****	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	*****	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HAZARD TIME	1	7.3SEC.	7.6SEC.	7.4SEC.	7.5SEC.	7.6SEC.	7.6SEC.	7.6SEC.	7.7SEC.
	2	7.4SEC.	*****SEC.	7.5SEC.	7.6SEC.	*****SEC.	7.5SEC.	7.4SEC.	7.6SEC.
	3	*****SEC.	7.5SEC.	7.4SEC.	7.6SEC.	7.8SEC.	7.7SEC.	7.5SEC.	7.1SEC.
	4	*****SEC.	7.3SEC.	7.6SEC.	7.7SEC.	7.7SEC.	7.7SEC.	7.4SEC.	7.8SEC.
SIGN CONDITION		[illegible]	4	1	7	5	6	2	3

TABLE C-21. MAINE O/S-EAST-DAY SAMPLE SIZE AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER

	Week								
HEAD MOVEMENT	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
SPEED REDUCTION	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
MEAN SPEED NEAR CROSSING	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
RMS DECELERATION	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
HEADWAY REDUCTION RATIO	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
HAZARD TIME	1	90	16	18	34	58	102	77	63
	2	19	*******	22	50	*******	72	64	41
	3	*******	18	26	39	130	90	67	0
	4	*******	31	56	81	175	167	129	105
SIGN CONDITION		0	4	1	7	5	6	2	3

TABLE C-22. MAINE O/S-EAST-DAY 2*STANDARD DEVIATION AND WEEK NUMBER (WEEK 1, 3, AND 4 ARE GOOD WEATHER - WEEK 2 IS BAD WEATHER)

	WEEK								
HEAD MOVEMENT	1	9.9%	19.5%	17.6%	14.5%	11.0%	7.9%	8.0%	10.5%
	2	27.2%	******%	16.4%	12.4%	******%	9.1%	5.3%	10.2%
	3	******%	19.6%	14.2%	14.8%	8.7%	8.1%	7.5%	9.8%
	4	******%	12.0%	9.8%	9.7%	7.0%	6.3%	5.3%	7.0%
SPEED REDUCTION	1	0.5MPH	0.9MPH	0.9MPH	0.9MPH	0.9MPH	1.3MPH	1.0MPH	1.1MPH
	2	0.9MPH	*****MPH	0.7MPH	0.9MPH	*****MPH	1.0MPH	0.7MPH	1.5MPH
	3	*****MPH	0.8MPH	1.0MPH	0.9MPH	1.0MPH	1.0MPH	0.8MPH	0.7MPH
	4	*****MPH	0.6MPH	0.7MPH	0.8MPH	0.8MPH	0.8MPH	0.6MPH	0.7MPH
MEAN SPEED NEAR CROSSING	1	0.7MPH	1.3MPH	1.4MPH	1.2MPH	1.1MPH	1.2MPH	1.1MPH	1.1MPH
	2	1.3MPH	*****MPH	1.0MPH	1.2MPH	*****MPH	1.3MPH	1.0MPH	1.4MPH
	3	*****MPH	1.0MPH	1.4MPH	1.2MPH	1.0MPH	1.1MPH	1.0MPH	1.1MPH
	4	*****MPH	0.9MPH	0.8MPH	1.0MPH	0.8MPH	0.9MPH	0.7MPH	0.9MPH
RMS DECELERATION	1	0.002G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.010G'S	0.007G'S	0.005G'S
	2	0.004G'S	******G'S	0.003G'S	0.004G'S	******G'S	0.005G'S	0.004G'S	0.007G'S
	3	******G'S	0.004G'S	0.006G'S	0.004G'S	0.005G'S	0.005G'S	0.004G'S	0.003G'S
	4	******G'S	0.003G'S	0.003G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S	0.004G'S
HEADWAY REDUCTION RATIO	1	0.35	0.17	0.53	0.11	0.12	0.09	0.08	0.15
	2	0.25	*****	0.20	0.18	*****	0.14	0.21	0.32
	3	*****	0.15	0.50	0.67	0.19	0.10	0.20	0.33
	4	*****	0.24	0.43	0.11	0.32	0.19	0.24	0.18
HAZARD TIME	1	0.0SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.5SEC.
	2	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	*****SEC.	0.1SEC.	0.1SEC.	0.3SEC.
	3	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.
	4	*****SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.1SEC.	0.3SEC.
SIGN CONDITION		[illegible]	4	1	7	5	6	2	3

APPENDIX D
ANALYSIS TECHNIQUES

D.1 ANALYSIS OF VARIANCE (ANOVA)

The results in Sections 4.2.3 and 4.2.4 were analyzed as an incomplete unbalanced block design. The "treatments" were the signs --0 for the base sign and 1 through 7 for the new signs. The "blocks" were the sites, numbered 1 through 5.

The incomplete unbalanced block design was abstracted as follows:

Treatment		0	1	2	3	4	5	6	7
Block	1	1	0	0	1	0	0	1	1
	2	1	0	1	0	1	1	0	0
	3	1	0	0	0	0	0	0	0
	4	1	1	1	1	0	0	0	0
	5	1	1	0	0	1	0	1	0

This represented the incidence matrix according to the notation in Reference 2 and was interpreted by example as follows: The "1" at the intersection of column labeled 3 and row labeled 1 indicated that sign configuration 3 was tested at site 1. In the analysis in Reference 2, the treatment effects were represented by $\hat{\tau}_i$ and these quantities were determined by the second equation on page 229. The matrix to be inverted on page 229 is singular, but this was cured by replacing any row by the side condition on the $\hat{\tau}_i$'s (loc. cit.).

Relative treatment effects (referred to as relative mean estimates in the body of this report) were determined by $\hat{\tau}_i - \hat{\tau}_j$;. The value of $\hat{\tau}_i - \hat{\tau}_j$ was unaffected by the choice of which row to replace. The matrix inverse yielded the proper covariance factor for all contrasts as indicated on page 231 and this was invariant with respect to which row was chosen (verified by actual computation). The variance estimate was formed from the residual sum of squares defined in the analysis of variance table on page 229. In using $\hat{\tau}_i$ as the estimate of the effect of the ith treatment and the residual variance estimate as the estimate of the variance involved in the experiment, the following linear model was assumed:

$$Y_{ij} = \mu + \tau_i + \beta_j + e_{ij} \qquad \text{(Ref. 2, p. 228)}$$

where i represented the treatment; j the block; Y_{ij}, the "observation" (e.g., % head movement); τ_i the treatment effect; β_j the block effect; μ a constant; and e_{ij} normal variables with a common variance. The key assumption was the additivity of the effects. (i.e., the absence of a term γ_{ij} which would not have been "noise" - like e_{ij} - but a true interaction effect.) There were no reasons to suspect any interactions in this experiment and the analysis proceeded on the basis of such an assumption - a common practice. The redeeming aspect was that the measure of noise plus interaction, the residual variance, was used to form the denominator for the t tests. The treatment effects were not considered significant unless they were considerably larger than the square root of this variance. This, it is believed, gave fairly conservative results for the moderately sized experiment.

Table D-1 shows the ANOVA results for the head movement, Ohio - all vehicles - daytime category (corresponding to Table 11.3 on page 229 of Reference 2). It is a simple matter to show that the treatment effects as a whole are not significant at the 5 percent level. The variance estimate for treatments is 1619.38/7 = 231.34 while that for the residual (interaction) is 705.19/8 = 88.149. The ratio is 2.6244. For 7 and 8 degrees of freedom 2.62 is just significant at the 10 percent level. This lack of significance (i.e., at the 5 percent level) is because the new signs are all at about the same level of effectiveness.

The specific questions to be answered in Sections 4.2.3 and 4.2.4 were whether the new signs were more effective than the base. The answer was a clear "yes" if one tested the contrast of the base sign with the average of the seven new signs:

$$\hat{\tau}_o - \frac{1}{7} \sum_{i=1}^{7} \tau_i$$

TABLE D-1. HEAD MOVEMENT ANOVA RESULTS
OHIO - ALL VEHICLES - DAYTIME

	Sum of Squares	Degrees of Freedom
Blocks	5577.8125	4
Treatments	1,619.3836	6
Residual	705.1906	8

For this contrast, a variance correction factor (from the inverse matrix referred to above) of .5179 was used. Thus, the denominator for the t test was

$$.5179 \times \sqrt{\frac{705.19}{8}} = 4.862.$$

The difference between the average treatment effects for the new signs and the treatment effect for the base sign was 18.7% and the ratio was 3.85. This showed a highly significant result.

D.2 GROUP CONTRAST TESTS

Contrast tests were used to evaluate driver behavior by groups (Sections 4.3.1 and 4.3.2). For the Ohio data, in order to correct for any interaction of site effects with driver group effects in terms of the measures of effectiveness (MOE) - - e.g., a slow-speed site might have had an unusual preponderance of male drivers - - the average difference in the MOE's between driver groups for each site was found and averaged over sites. The relative means were calculated as follows:

$$\Delta A = \frac{\sum_{i}^{\text{sites}} N_{Hi}\, \Delta A_i}{\sum_{i}^{\text{sites}} N_{Hi}}$$

where ΔA_i was the difference in the MOE's between driver groups at site "i" and N_{Hi} was the harmonic mean at site "i" of the driver groups.

$$N_{Hi} \triangleq \frac{2}{N_1 + N_2}$$

where N_1 and N_2 were the respective number in each driver group.

The variance estimate was

$$\sigma^2 = \left(\sum_i^{sites} N_{Hi} \frac{1}{8} \sum_k^{signs} \sigma^2_{ik} \right) \Bigg/ \left(\sum N_{Hi} \right)^2$$

σ^2_{ik} was the total variance of the MOE at site "i" and for sign "k".

For the Maine data, the results were presented in terms of the means of the measures of effectiveness for each group averaged over all weeks (the entire experiment). The variance for each grouping was estimated as:

$$\sigma^2 = \frac{\sum_j^{weeks} N_{Hj} \; N_j \; \sigma^2_j}{\left(\sum_j^{week} N_{Hj} \right)^2}$$

where N_{Hj} was the harmonic mean of the driver groups for week "j", N_j the total population for week "j" and σ_j the total variance of the MOE for week "j".

D.3 "F" TESTS

The "F" ratio test for relative sign configuration effectiveness by different driver groups (Section 4.4.1) was constructed from the sum of the squares of the differences in relative sign effects. This was used to construct an "F" ratio type statistic for null hypothesis (i.e., zero differential response). It specifically had the form:

$$F = \frac{18 \sum_{i=1}^{7} \left(O_{1i} - O_{2i}\right)^2 / 2\, C(o,i)}{6 \left(Res_1 + Res_2\right)}$$

where O_{1i} was the relative treatment effect over the base sign for sign configuration "i" and for one respective driver group $(\hat{\tau}_i - \hat{\tau}_o)$, O_{2i} the same for the other driver group, C(o,i), the variance correction factor for contrasting sign i with the base sign o, and Res_1 and Res_2 the residual sums of squares for each respective driver group. The variance correction factors for the incomplete, unbalanced block design are given in Table D-2.

Significantly high values of the "F" statistic indicate a differential response effect. Nonsignificant (i.e., low) values tend to indicate no differential response.

TABLE D-2. CORRECTION FACTORS FOR CONTRASTING SIGN i WITH BASE SIGN o

Sign i	1	2	3	4	5	6	7
Correction Factor	.57	.81	.81	.81	.81	.81	.81

APPENDIX E

PARTICIPATING STATES OF PROGRAM ADVISORY COMMITTEE

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