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16. Abstract <p style="text-align: center;">A three-year study of motorist understanding of traffic control devices is currently in progress. The objective of the study is to conduct a detailed assessment of motorist comprehension of signs, signals, and markings utilizing a statistically valid survey of Texas motorists. Those traffic control devices determined to be less than adequately understood will be evaluated for possible improvement through revision to standards or public education.</p> <p style="text-align: center;">This interim report presents survey results and research directed to evaluation of motorist comprehension of selected traffic control devices. In-depth study findings and recommendations for improvement in understanding and response by motorists to specific traffic control devices will be addressed in the final report, to be published at the conclusion of the study.</p>			
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SI* (MODERN METRIC) CONVERSION FACTORS

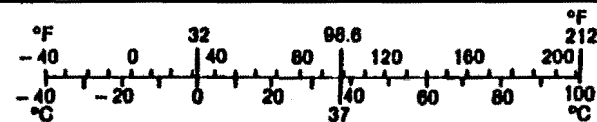
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimetres	mm
ft	feet	0.305	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in ²	square inches	645.2	millimetres squared	mm ²
ft ²	square feet	0.093	metres squared	m ²
yd ²	square yards	0.836	metres squared	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	kilometres squared	km ²
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft ³	cubic feet	0.028	metres cubed	m ³
yd ³	cubic yards	0.765	metres cubed	m ³
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

NOTE: Volumes greater than 1000 L shall be shown in m³.

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm ²	millimetres squared	0.0016	square inches	in ²
m ²	metres squared	10.764	square feet	ft ²
ha	hectares	2.47	acres	ac
km ²	kilometres squared	0.386	square miles	mi ²
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m ³	metres cubed	35.315	cubic feet	ft ³
m ³	metres cubed	1.308	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F



* SI is the symbol for the International System of Measurement.

(Revised April 1989)

Motorist Comprehension of Traffic Control Devices: Statewide Survey Results

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**Study No. 2-18-91-1261-2
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IMPLEMENTATION STATEMENT

The anticipated results of this study are a series of recommendations identifying corrections and modifications in design or application of existing traffic control devices. Implementation would be instituted through revision of standards and/or improved driver training and education programs.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation, and is not intended for construction, bidding or permit purposes.

ACKNOWLEDGEMENT

At the initiation of this study, an advisory committee was formed for consultation, review and approval of all research activities encompassed by this study. The researchers would like to acknowledge those individuals participating in this capacity for their time and efforts:

Technical Panel Chairman

- Mr. Lewis Rhodes, Safety/Traffic Operations (D-18), Texas Department of Transportation.

Technical Panel

- Lieutenant Dwain Cox, Law Enforcement, Texas Department of Public Safety.
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- Ms. Linda Smith, Research/Planning (D-10), Texas Department of Transportation.
- Mr. Jim Taylor, Safety/Traffic Operations (D-18), Texas Department of Transportation.

SUMMARY

This interim report documents the results of a statewide survey to determine motorist comprehension of traffic control devices (TCDs). These efforts included a compilation of supporting research, administration of a statewide motorist survey, analysis and evaluation of the survey results, and establishment of in-depth surveys for determination of improvement alternatives.

A thorough review of previous research documented evidence that a better understanding and knowledge of appropriate driving responses was needed for numerous TCDs currently in use. The results of these studies were used in conjunction with professional input in a ranking process to select TCDs to be included in the statewide survey. The survey instrument was comprised of 46 questions on a 17 minute videotape.

The statewide survey was conducted in 12 driver licensing stations located in six geographic regions of Texas. A quota sample of 1,745 respondents was selected to be representative of the driving population with respect to age, gender, and ethnicity.

The mean score for the 46 questions was 64 percent. The single question that elicited the highest correct response rate was the **REDUCED SPEED AHEAD** sign (R2-5a), with 93.2 percent selecting the correct answer. The TCD that elicited the lowest correct response rate was the **PROTECTED LEFT ON GREEN** signal sign (R10-9a), with 15.5 percent selecting the correct answer.

In general, the respondents with higher comprehension levels were younger (25-34 years), male, Anglo, English-speaking, and had more education. Additionally, professional drivers, drivers who reported a greater level of exposure, and those who had taken a driver education course were more knowledgeable in general of the TCDs.

The TCDs included in the survey and their response percentages are provided in Tables S-1 and S-2. These results will be used in a third phase of this study to determine appropriate methods to improve comprehension.

Table S-1. Response Percentages for Signs Surveyed

Traffic Control Devices	MUTCD Designation	Percent Correct	Percent Incorrect	Percent Not Sure
YIELD	R1-2	79.4	19.8	0.8
REDUCED SPEED AHEAD	R2-5a	93.2	5.6	1.1
SPEED ZONE AHEAD	R2-5c	55.0	37.3	7.7
Mandatory Movement	R3-7L	79.5	18.9	1.6
Double Turn	R3-8L	65.0	31.3	3.7
Two-Way Left Turn	R3-9b	58.6	50.4	5.0
HOV Restriction	R3-14	45.7	21.1	33.2
SLOWER TRAFFIC KEEP RIGHT	R4-3	70.8	27.7	1.5
DO NOT CROSS DOUBLE WHITE LINE	R4-3B	72.6	21.3	6.1
Keep Right	R4-7	69.9	25.1	5.0
PROTECTED LEFT ON GREEN ARROW	R10-9	53.0	43.7	3.3
PROTECTED LEFT ON GREEN	R10-9a	15.5	82.2	2.3
LEFT TURN YIELD ON GREEN Ball	R10-12	74.5	17.9	7.6
Warning Sign Shape & Color	---	58.1	32.6	9.4
Turn	W1-1R	31.9	55.9	12.2
Curve	W1-2L	32.4	66.7	0.9
Reverse Turn	W1-3L	66.5	30.8	2.7
Stop Ahead	W1-3a	87.4	9.7	2.9
Lane Reduction Transition	W4-2R	61.2	34.2	4.6
LANE ENDS MERGE LEFT	W9-2L	64.0	28.4	7.6
Narrow Bridge	W5-2a	81.7	14.6	3.7
Divided Highway Ends	W6-2	50.7	43.7	5.6
Slow Down on Wet Road	W8-5	62.3	26.5	1.1
ROUGH ROAD	W8-8	88.7	9.7	1.7
GROOVED PAVEMENT AHEAD	W8-12	29.2	56.0	14.7
Truck Crossing	W11-10	66.1	30.7	3.2
LIMITED SIGHT DISTANCE	W14-4	44.9	40.3	14.8
WATCH FOR ICE ON BRIDGE	W19-2	84.0	13.9	2.1
RAMP METERED WHEN FLASHING	W19-3	45.7	27.5	26.8
Guide Sign Color	---	75.1	10.5	14.3
School Speed Limit	S5-1	79.0	16.2	4.8
Railroad Advance Warning	W10-1	77.8	20.9	1.3
Parallel Railroad Advance Warning	W10-3	69.3	22.6	8.1

Table S-2. Response Percentages for Markings and Signals Surveyed

Traffic Control Devices	MUTCD Designation	Percent Correct	Percent Incorrect	Percent Not Sure
Single Broken Yellow Center Line	---	76.8	20.4	2.8
Two-Way Left Turn Lane Marking	---	58.6	33.8	7.6
Single Broken White Lane Line	---	50.3	46.4	3.3
Double Solid White Lane Line	---	61.0	29.0	10.0
No-Passing Zone	---	88.0	9.0	3.0
Solid White Edge Line	---	74.7	6.8	5.3
Preferential Lane Marking	---	65.3	6.8	27.9
Type 3 Object Marker	---	61.9	18.7	19.4
Yellow Arrow - Traffic Signal	---	80.4	13.2	6.4
Flashing Yellow Ball - Traffic Signal	---	80.7	18.1	1.2
Flashing Red - Intersection Beacon	---	41.1	54.8	4.1
Flashing Yellow - Intersection Beacon	---	54.0	40.8	5.2
Steady Red X - Lane-Use Control Signal	---	74.9	6.1	19.0

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SIGNS (continued)

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CHAPTER 1 BACKGROUND

Traffic control devices (TCDs) are a vital element of the highway environment. They provide a means of communicating important information about the highway to the driver. Since the beginning of the twentieth century, traffic control devices have continually grown in number and complexity. Today, there are a large number of signs, markings, and symbols which utilize shape, color, symbols, and/or words to convey the information needed by a driver. However, these devices serve little purpose if they are not understood. Therefore, this research study was initiated to determine how well motorists understand some of the most critical traffic control devices.

Previous research in Texas (1, 2) documented drivers' lack of operational knowledge and appropriate driving response to many commonly used TCDs. Limited national studies, (3, 4, 5, 6, 7) as well as the Transportation Research Board Committee on Traffic Control Devices (8), have also identified and highlighted driver difficulty in understanding a high proportion of possibly critical TCDs.

Confusion, misunderstanding, and lack of familiarity with TCDs may be attributed to the following:

- The increasing age of the driving population;
- The increasing complexity of the driving task in urban areas;
- Specialized TCDs utilized with priority transportation facilities;
- The increased proportion of Hispanic drivers in Texas;
- A limited explanation of TCDs given in the driver education and licensing process; and
- Non-uniform and non-standard use of some TCD's in Texas.

The overall objective of the study was to conduct an assessment of traffic control devices currently in use in Texas including signs, signals, and pavement markings applied in various roadway contexts (urban/rural, etc.). This assessment was made through administration of a survey of Texas motorists with analysis of comprehension by age, sex, education, driving experience, ethnic background, linguistic ability, and geographic region.

Research Report No. 1261-1 (9), previously published as the initial interim report of the study, described the selection methodology establishing those traffic control devices deemed critical for assessment of motorist comprehension. Report 1261-1 also discussed the development of the TCD survey instrument and administration procedures. Detailed explanation was given regarding the statewide sampling plan and statistical validation. Finally, results of the pilot survey of motorists conducted at the Houston, Texas Auto Show were presented.

Further research reported herein focuses on two areas: (1) supporting research on motorist comprehension of traffic control devices; and (2) results from the statewide survey on motorist comprehension of selected traffic control devices. In addition, based on the survey results, discussion is given to the development of in-depth surveys of specific TCDs which require additional evaluation to determine alternative improvement techniques.

CHAPTER 2

SUPPORTING RESEARCH

The question of how well drivers understand traffic control devices has been a concern for many years and has led to numerous research studies intended to evaluate driver comprehension of traffic control devices. These studies have addressed many different traffic control devices in a wide variety of study approaches. Therefore, it is not surprising that the findings of these studies are also widely varied. Driver understanding of some signs has been established on the basis of numerous studies where the results agree. Other signs have been addressed in several studies, but the results of those studies have conflicting findings. It may be that many of the earliest highway signs were included in the *Manual on Uniform Traffic Control Devices* (MUTCD) on the basis of engineering judgement, without an exhaustive evaluation of driver understanding of the signs. Much of the early research and evaluations of traffic control devices is difficult to isolate. Even when the existence of early research could be identified, findings were often difficult to obtain for reasons such as age, limited distribution, or lack of professional journal papers describing the research results. Therefore, the findings of previous research described in this chapter are not intended to be a complete and exhaustive treatment of driver comprehension of every traffic control device. Additional research may, and probably does, exist for some of the traffic control devices described in this chapter.

The traffic control devices described in this chapter are listed in the order that they appear in the Texas MUTCD ([10](#)). The sign designation is centered in the heading, and the Texas MUTCD section number is on the right side of the heading for each device. The information included in this chapter about each traffic control device briefly describes the development of that device in the various MUTCD editions. Information on the development of devices prior to the first MUTCD in 1935 is not included. Additional information about the history of traffic control device standards can be found in other references ([11](#), [12](#), [13](#), [14](#), [15](#), [16](#)).

MAJOR RESEARCH EFFORTS

Much of the most useful information on motorist understanding of traffic control devices comes from a few driver surveys which have been conducted during the last 15 years. Driver surveys from seven research studies provided most of the information contained in this chapter. These studies are described in Tables 2-1 and 2-2. This chapter contains extensive excerpts

from these seven reports. In many cases information from these reports has been integrated directly into this document. Quotation marks have been omitted for ease of reading. There are also several research studies which evaluated driver comprehension of one or a limited number of devices. These limited studies are referenced within the chapter where they apply to a particular device.

Table 2-1. Major Research Studies on Understanding of Traffic Control Devices

Performing Organization	Report Title	Date	Reference Number
Texas Transportation Institute	Public Understanding of Traffic Control Devices in Texas	1978	1
American Automobile Association	Motorists' Understanding of Traffic Control Devices	1979	3
American Automobile Association	Motorists' Understanding of Traffic Control Devices: Test II	1980	4
Texas Transportation Institute	Measuring the Effectiveness of Traffic Control Devices: An Assessment of Driver Understanding	1981	2
Biotechnology	Motorists' Comprehension of Regulatory, Warning, and Symbol Signs	1987	5
University of Maryland (Paniati M.S. Thesis)	Legibility and Comprehension of Traffic Sign Symbols	1988	6
Rice University	Road Sign Comprehension: Age and Sex Effects	1991	7

Table 2-2. Research Approaches for Major Research Studies

Report	No. of Devices	No. of Subjects	Presentation Format	Form of Response	Testing Area	Precision ¹ (percent)
1980 TTI	27	422	color picture ²	multiple choice	Texas	±4.0
1979 AAA	16	3,162	film ³	multiple choice	Nationwide	±1.5
1980 AAA	19	1,748	film ³	multiple choice	Nationwide	±2.0
1981 TTI	1) 39 2) 31 3) 43	1) 94 2) 94 3) 375	1) color picture ² 2) film ³ 3) color picture ²	1) open-ended 2) open-ended 3) multiple choice	Texas	±8.5 ±8.5 ±4.2
Biotechnology ⁴	28+45 ⁵	243	color picture ³	open-ended	VA	±5.3
Paniati thesis	22 ⁶	32	color picture ²	open-ended ⁷	D.C. area	±14.5
Rice University	35	96	color picture ²	multiple choice	Texas	±8.4

- Notes:
- ¹Based on 90 percent level of significance.
 - ²Isolated picture of only the device.
 - ³In-context picture of device.
 - ⁴Survey procedure included alternatives to standard signs.
 - ⁵Standard signs plus alternative designs in selection evaluation.
 - ⁶Only symbol warning signs included.
 - ⁷Responses categorized as: correct, substantially correct, special, dangerous, incorrect, no answer.

REGULATORY SIGNS

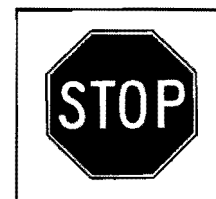
Regulatory signs are contained in Chapter 2B of the MUTCD. They inform highway users of traffic laws or regulations and indicate the applicability of legal requirements that would not otherwise be apparent. Some regulatory signs are related to operational controls, but do not impose any obligations or prohibitions. Regulatory signs are rectangular, with the longer dimension vertical. Most regulatory signs have a black legend on a white background, although some regulatory signs use other colors, with red being the most common.

STOP

R1-1

2B-4

The **STOP** sign is one of the most well established of all traffic control devices. The **STOP** sign has been in the national MUTCD since the 1935 edition (17). From 1935 to 1954, the **STOP** sign had a black on yellow appearance. The color of the sign was changed to white on red in the 1954 MUTCD revision (18).

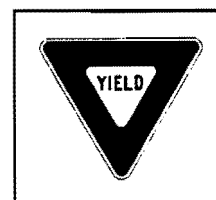


R1-1

The 1981 Texas Transportation Institute (TTI) (2) study tested the **STOP** sign for shape and color recognition. Respondents knew the background color of the **STOP** sign more than any other color in the study, with 87 percent giving red as the color of the sign. When asked to draw the shape of a **STOP** sign, only 56 percent were able to draw the correct octagon shape. However, when shown a red octagon without a legend, 78 percent were able to identify it as a **STOP** sign. A study of color in traffic control revealed 86 percent of the drivers tested did not notice the word **STOP** misspelled as **TOPS** on the **STOP** sign. The primary reaction was found to be to the color and shape of the **STOP** sign (19). In the Rice University study (7), 96 percent selected the correct meaning of the sign from the three responses. However, only 82 percent were able to correctly identify the meaning of the **STOP** sign shape when the word **STOP** was not included.

Driver elements in **STOP** sign recognition have also been studied. One study (20) found that once a sign has been detected, driver errors in recognizing the sign are lower for signs requiring a stop than for signs which require slowing or lateral movement. It was concluded that a failure to respond to a stop message was not likely to be the result of perceptual problems.

The **YIELD** sign was introduced in Tulsa, Oklahoma in 1951 (21). It was incorporated into the 1954 revision of the national MUTCD as an equilateral triangle with one corner pointed downward with black lettering on a yellow background. The legend of the 1954 sign was **YIELD RIGHT-OF-WAY** (18). The 1961 national MUTCD (22) simplified the legend of the sign to **YIELD**. The 1971 national MUTCD (23) changed the color of the sign from the black on yellow to the modern red on white, with a large red border.



R1-2

A 1966 study (24) showed that driver understanding of the **YIELD** sign was related to its application. At an intersection, 100 percent of those surveyed recognized the yield situation. According to four percent, a full stop was required, and another 24 percent said a 15 mph entry speed should not be exceeded. Both answers were considered "safe." The correct meaning was given by 72 percent of those surveyed, and acceptable or safe answers were given by 100 percent. However, understanding of **YIELD** signs and their application at freeway entrance ramps was poor. Seventy-seven percent believed the intended message was slow down while entering the freeway, and eight percent said to slow to less than 25 mph. Only 23 percent gave a correct or acceptable response to this particular situation.

The 1980 AAA (4) study found that only 45 percent of drivers selected the correct response ("be prepared to let other drivers pass in front of you, even if you arrive first, or are coming from their right"). Other responses which were often selected included "look at the situation and proceed with caution" (31 percent) and "prepare to merge with other traffic" (22 percent).

The 1981 TTI study (2) tested the **YIELD** sign for shape and color and found that understanding of the **YIELD** sign symbol is not as thorough as would be expected. When asked to draw the shape of the sign, 40 percent drew the correct shape. However, only 25 percent identified the correct color of the **YIELD** sign. Most (62 percent) stated that **YIELD** signs were yellow, which had been the case less than ten years before this survey was given. When shown a **YIELD** sign without the legend, 83 percent identified the correct meaning of the sign. But in the Rice University study (7), 98 percent identified the correct meaning of the **YIELD** sign.

Some type of speed limit signs have been in the MUTCD since the first edition in 1935. The current **SPEED LIMIT** sign first assumed its present appearance in the 1948 national MUTCD (25).



R2-1

The 1981 TTI study (2) showed that a majority of respondents recognized both the **SPEED LIMIT**(R2-1) sign and the **Advisory Exit Speed** sign (W13-2) as signs indicating driving speeds, but they did not distinguish between the two signs. Eighty-two percent correctly identified the color of the **SPEED LIMIT** sign as white, and 87 percent drew a vertical rectangle or square as the shape of the sign. In that study, the **SPEED LIMIT** sign was the second best known sign, behind the **STOP** sign. Fifteen percent identified the **Advisory Exit Speed** sign as a speed limit, indicating confusion over the difference between these two signs. In the Rice University study (7), 99 percent of the drivers tested identified the correct meaning of the R2-1 **SPEED LIMIT** sign.

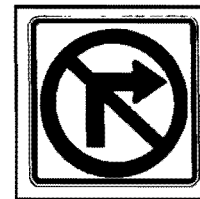
Turn Prohibition signs can be either symbol or word message signs. Table 2-3 lists the signs that are included in this family. The two **No Right Turn** signs are illustrated here. Similar signs are used for the **No Left Turn** sign. The **No Turns** sign is a word message sign only. The prohibitory symbol (red circle and slash) used in these signs was first introduced in the 1971 national MUTCD (23). The prohibitory symbol has been used internationally to convey the message that the item behind the symbol is not allowed. Although its adoption for use on roads has become more widespread and includes a variety of prohibited actions, the symbol meaning as applied to traffic movement is not widely understood by all drivers. One study (26) found that the red slash used to convey a prohibitive message obscures the symbol. In terms of the glance legibility of the sign, use of no slash or only a partial slash was recommended.

The 1978 TTI study (1) showed a picture of a **No Right Turn** (R3-1) sign mounted below a R6-1L **ONE WAY** sign pointed to the left and asked what the sign meant. A total of 91 percent selected the correct response to this question. In the 1981 TTI study (2), the prohibitory symbol was presented with no picture behind it to determine if motorists could identify the

concept of the symbol as it applies to the driving situation. The most frequently checked response was "don't know" (37 percent). Only 34 percent identified the red circle/slash as indicating a prohibition. The prohibitory meaning of the red circle/slash was better understood when the prohibited action was pictured behind it. However, the study also found that approximately seven percent of drivers held the opposite interpretation of **only** instead of **no**. In the same study (2), an average of 66 percent correctly explained the meaning of the **Right Turn Prohibition** symbol sign in both of the surveys with open-ended responses, and 89 percent checked the correct response for this sign in the multiple choice survey. It is worth noting that seven percent of those responding to the sign only and five percent of those viewing a film showing the sign in-context thought that this sign meant right turns are permitted, which is exactly opposite of the correct meaning.

Table 2-3. Turn Prohibition Signs

Sign Name	Sign Type	TMUTCD Designation
No Right Turn	symbol	R3-1
NO RIGHT TURN	word message	R3-1a
No Left Turn	symbol	R3-2
NO LEFT TURN	word message	R3-2a
NO TURNS	word message	R3-3



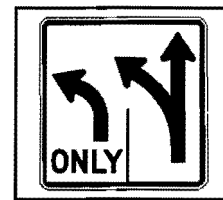
R3-1



R3-1a

In the 1979 AAA study (3), 90 percent of the drivers selected the correct meaning of a **No Left Turn** symbol sign (R3-2) when shown a film of the sign. However, none of the alternative choices included "left-turn only" or a similar response. Therefore, this question did not test whether the prohibitory message of this sign is confused with a permitted message. However, another question in the same study showed a film of a **No Right Turn** symbol sign (R3-1) and asked drivers to indicate the meaning of the sign. This question did include a "right turn okay" response, which was selected by four percent. The correct answer to this question was selected by 93 percent. In addition to the **Turn Prohibition** signs, the 1979 AAA study (3) also tested the **No U-Turn** symbol sign and found that 97 percent selected the correct answer.

The **Lane-Use Control** signs include a number of signs which are commonly used at intersections to inform drivers of turning movements that are prohibited or permitted. Table 2-4 lists the signs which are included in this category. These signs were introduced in the 1961 MUTCD (22). Research on driver comprehension was identified only for the **Double Turn** sign (R3-8), which is illustrated here.



R3-8

Table 2-4. Lane-Use Control Signs

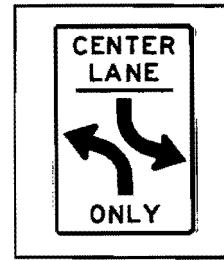
Sign Name	Sign Type	TMUTCD Designation
Mandatory Movement	symbol	R3-5
Optional Movement	symbol	R3-6
Mandatory Turn	word message	R3-7
Double Turn	symbol	R3-8
U-Turn Only	symbol	R3-8U

Drivers were asked two questions about the **Double Turn** sign in the 1978 TTI study (1). The first question asked which lane the driver needed to be in to turn left and the second question asked if the driver was in the left lane, did the driver have a choice between turning left or going straight. The correct response rates were 66 and 79 percent for the first and second questions, respectively. For the first question, 28 percent stated that only the left lane could be used for turning left. For the second question, 20 percent thought that a driver in the left lane also had the option to continue forward through the intersection.

The **Double Turn** sign was addressed again in the 1981 TTI study (2). In open-ended responses to a picture of the sign, 70 percent described appropriate driving responses. In an open-ended question based on a film of the approach to an intersection with the sign, 81 percent described a correct driving reaction. The same study also asked a multiple choice question about this sign. When given several choices, comprehension of the sign dropped to 53 percent, leading the authors to conclude that there were some difficulties in reading and interpreting written responses to a question about this sign.

In the Rice University study (7), 86 percent of the drivers identified the correct meaning of the **Double Turn** sign.

There are two versions of the **Two-Way Left-Turn Only** sign. The R3-9a sign is an overhead sign while the R3-9b is a post-mounted sign. The post-mounted sign is illustrated to the right. This sign was first introduced in the 1971 MUTCD (23) as a word message sign with the legend **CENTER LANE LEFT TURN ONLY**. The symbol version of the sign was introduced in a November 1971 revision to the MUTCD (27).



R3-9b

The **Two-Way Left-Turn Only** sign is confusing to a significant segment of the driving population because of a few common misconceptions. The two primary misconceptions revolve around where to turn and the proper direction of the turning maneuver. In the 1981 TTI study (2), 74 percent comprehended the information displayed on the overhead version of the sign (R3-9a) in the film survey. A very low percentage (20 percent) understood the sign out of context when shown as a picture of the sign itself. This was the second most misunderstood of the regulatory signs in the absence of situational clues. The Biotechnology study (5) also evaluated the overhead version (R3-9a) of this sign and found that 79 percent correctly identified the sign.

The **DO NOT PASS** sign (R4-1) is intended to be used at the beginning of a no-passing zone to indicate to the driver that passing is prohibited. It may be used in place of no-passing zone pavement markings or as a supplement to the pavement markings. The **DO NOT PASS** sign was first introduced in the 1948 MUTCD (25) with the legend **NO PASSING**. The legend was changed to its current form in the 1954 MUTCD Revisions (18). One study (28) concluded that the **DO NOT PASS** sign appeared to improve driver compliance with passing regulations and to encourage safer driver passing decisions when used together with appropriate pavement markings.



R4-1

The **SLOWER TRAFFIC KEEP RIGHT SIGN** (R4-3) is used on multilane highways to reduce unnecessary weaving. It first appeared in the 1948 national MUTCD (25) with the

legend **KEEP RIGHT EXCEPT TO PASS**. The legend changed to the current wording in the 1961 MUTCD (22). In the Rice University study (7), 90 percent identified the correct meaning of the **SLOWER TRAFFIC KEEP RIGHT** sign.



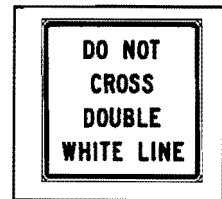
R4-3

DO NOT CROSS DOUBLE WHITE LINE

R4-3B

2B-23.2

The **DO NOT CROSS DOUBLE WHITE LINE** sign (R4-3B) is intended to restrict lane changes of vehicles traveling in the same direction. This sign appears only in the Texas MUTCD (10) and not in the national MUTCD. In the Rice University study (7), 51 percent identified the correct meaning of the **DO NOT CROSS DOUBLE WHITE LINE** sign.



R4-3

Keep Right

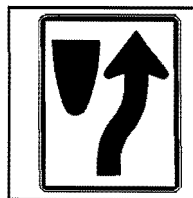
R4-7, R4-7a, R4-7b

2B-25

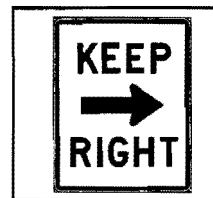
There are several versions of the **Keep Right** sign as shown in Table 2-5 and the illustrations below. The R4-7a sign first assumed its modern appearance in the 1948 MUTCD (25). The 1961 MUTCD (22) permitted the diagonal arrow in the sign, and the symbolic sign (R4-7) was introduced with the 1971 MUTCD (23).

Table 2-5. **Keep Right Signs**

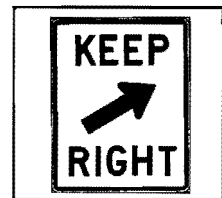
TMUTCD Designation	Sign Type	Arrow Direction
R4-7	symbol	---
R4-7a	word message	horizontal
R4-7b	word message	diagonal



R4-7



R4-7a



R4-7b

The 1980 AAA study (4) found that only 35 percent recognized the correct meaning of the symbolic **Keep Right** sign. However, there were 38 percent who thought the sign meant that there was a traffic island ahead, which is the application in which this sign is normally used. Another 23 percent thought the sign indicated that the lane was ending.

Confusion between the **Keep Right** and **Divided Highway** signs was found in the 1978 TTI study (1) and pointed out in the Biotechnology study (5). One of the questions in the TTI study showed both signs together and asked if they were the same. A total of 47 percent incorrectly

stated that the **Divided Highway** and the **Keep Right** symbol signs were equivalent. Another question showed the symbolic **Keep Right** sign with a **KEEP RIGHT** educational plaque. The correct response chosen by 74 percent was "divided roadway with center median ahead; keep right." A total of 73 percent correctly identified the sign in the Biotechnology study. The Rice University study (7) also tested the **Keep Right** symbol sign (R4-7) used in conjunction with a **KEEP RIGHT** educational plaque and found that 94 percent of the drivers identified the correct meaning of the sign.

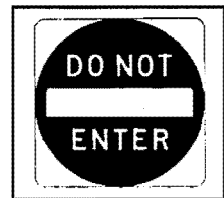
The 1981 TTI study (2) also found confusion between the **Keep Right** and the **Divided Highway** symbol signs. When asked to give the color of the sign, 55 percent said yellow. And 20 percent drew a diamond when asked to give the shape of the sign. When asked to describe the meaning of the sign, 23 percent confused the **Keep Right** sign with the **Divided Highway** sign while 41 percent correctly indicated that there is an island, median, or obstruction requiring the driver stay to the right. When provided with several possible responses in the multiple choice survey, 67 percent selected the correct response and there was no confusion with the **Divided Highway** sign.

DO NOT ENTER

R5-1

2B-26

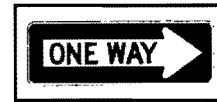
The **DO NOT ENTER** sign (R5-1) has a red circle on a white square with a wide white band placed horizontally across the center of the circle. The words **DO NOT ENTER** make up the legend of the sign, as shown here. The design of the sign is supposed to make recognition very easy for the driver, even at a distance. The red color alerts the driver to a prohibitory regulation. The symbolic **DO NOT ENTER** sign first appeared in the 1971 national MUTCD (23).



R5-1

In the 1981 TTI study (2), the **DO NOT ENTER** symbol was presented without the words on it to determine the level of understanding of the symbol itself. Forty-five percent correctly recognized the symbol. Another 34 percent did not know what the symbol was, and 20 percent thought the symbol related to emergency facilities. Apparently the symbol itself is not effectively communicating the message printed on it. Those who understood the **DO NOT ENTER** sign tended to be young, newly licensed drivers who had taken driver education. A significant number of those who had not had driver education checked the "don't know" category.

There are two different versions of the **ONE WAY** sign. The R6-1 has a white arrow on a black background and the R6-2 has a black arrow on a white background. A sign very similar to the R6-1 sign was included in the 1935 national MUTCD (17). The R6-2 sign was introduced in the 1961 MUTCD (22) in response to the request of city traffic engineers to provide a more narrow version of the sign. It should be noted that the R6-2 sign is very similar in appearance to the **KEEP RIGHT** sign. In the **ONE WAY** sign, the arrow is below the two words. In the **KEEP RIGHT** sign, the arrow is between the two words.



R6-1R



R6-2R

The 1978 TTI study (1) showed a R6-1 **ONE WAY** sign mounted below a **YIELD** sign and asked what the sign meant. Eighty-one percent selected the correct meaning. The 1981 TTI study (2) evaluated the R6-1 sign without the **ONE WAY** legend. When shown the one-way arrow without the legend and asked to define it, 48 percent correctly described it as a **ONE WAY** sign. Other common responses included detour, sharp turn, and not sure. In the multiple choice survey, the correct response rate increased to 72 percent, although 18 percent thought it was a **DETOUR** sign. Confusion of this sign was primarily with the **DETOUR** sign (M4-10), with 12 percent of the responses to the **ONE WAY** sign suggesting that this sign meant "detour." Another 11 percent gave "sharp turn" as a response. Twenty percent did not know what the arrow meant when the words were omitted and no written choices were provided for them. Less than half of the respondents correctly identified the **ONE WAY** sign in the open-ended picture presentation.

The Rice University study (7) found that 88 percent of the drivers tested identified the correct meaning of the R6-1 **ONE WAY** sign. Eighty-one percent of the drivers tested identified the correct meaning of the R6-2 **ONE WAY** sign.

WARNING SIGNS

Warning signs are contained in Chapter 2C of the MUTCD. They are used to warn traffic of existing or potentially hazardous conditions on or near a roadway. Warning signs require

driver caution and may call for a speed reduction or a maneuver to insure driver safety and/or the safety of others, including drivers, pedestrians, or highway workers. Generally, all warning signs are diamond shaped (with one diagonal vertical) with a black legend on a yellow background. However, there are specific exceptions to this rule including rectangular, circular, and pennant shaped warning signs.

The lack of understanding of the basic color coding of warning signs was shown in the 1979 AAA study (3) in which one question asked the difference between yellow and orange signs. Only 53 percent knew that orange signs meant road work. Incorrect response rates included "there is no difference" (31 percent) and "yellow signs are out-of-date" (10 percent). In the second AAA study (4), the percent of drivers who thought that orange and yellow signs were the same decreased to 18 percent.

Warning signs make greater use of symbols than any other type of sign. However, the 1981 TTI study (2) found that symbol signs posed a problem for certain segments of the driving population. Ethnic minorities, older drivers, and the lower educated have been found to be more likely to misinterpret the intended meaning of the symbols. Some of the newer symbol signs pose problems for drivers with more years of driving experience. On the other hand, less experienced drivers showed more difficulty with symbol signs that have been in existence longer.

Curve and Turn

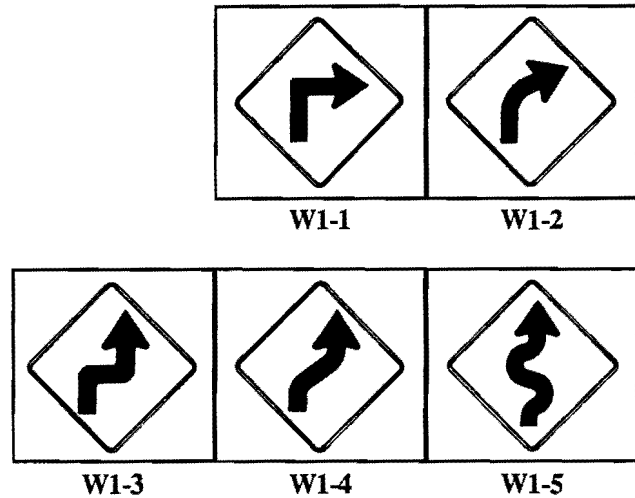
W1-1 to W1-5

2C-4 to 8

The **Curve and Turn** family of signs include a number of different signs which are often equated with each other. Typically, research addressing one of these signs often relates to all the signs. Therefore, these signs are addressed together here. Table 2-6 indicates the signs which are a part of this family. The **Turn and Curve** signs (including the reverse versions) have been in the MUTCD since the first edition in 1935 (17). The stroke width of the arrow was increased in the 1948 MUTCD (25). The **Winding Road** sign was changed from a word message sign to a symbol sign in the 1948 MUTCD (25). The use of the arrow to indicate a turn or curve was the first use of symbols in signs in the United States. In fact, a very early study (1934) on driver comprehension of signs (29) found that the black arrow symbol was the most effective method of warning drivers of a turn or curve. This sign required a shorter reaction time than any other sign tested. Words were determined to be ineffective in warning of turns or curves.

Table 2-6. Curve and Turn Signs

Sign Name	MUTCD Designation	MUTCD Section
Turn	W1-1	2C-4
Curve	W1-2	2C-5
Reverse Turn	W1-3	2C-6
Reverse Curve	W1-4	2C-7
Winding Road	W1-5	2C-8



A 1981 study conducted by the Transportation Research Board Committee on Traffic Control Devices (30) suggested that descriptions of roadway curves vary widely from one person to the next. Turn or curve may be used by two different people to describe the same section of highway. When a driver was asked to explain the difference between the two, he would say, "Well they're both turns, but this one (the **Curve** sign) is a longer turn." Asked to elaborate on what a longer turn was, he would reply, "It is not as hard as the other one (the **Turn** sign)." The researcher noted that drivers may be aware of the difference between the signs, but that nomenclature makes it difficult to measure how well they understand the difference.

The 1978 TTI study (1) displayed both the **Turn** and **Curve** signs to the survey participant and asked if the signs mean the same thing. While 79 percent stated they were different, a total of 20 percent stated they were the same.

The 1981 TTI study (2) also addressed both the **Turn** and the **Curve** signs. On the multiple choice question about the **Turn** sign, 62 percent selected the correct answer. In open-ended responses to a film showing the **Turn** sign, 80 percent correctly described the sign. Responses to the questions indicate that drivers have difficulty interpreting the severity of the intended message and the speed associated with the sign. The **Curve** sign was better understood, with 95 percent selecting the correct response in the multiple choice survey, and 75 percent selecting the correct response in open-ended responses to the sign. In comparing the responses to the **Curve** and **Turn** signs, one observation was that a portion of the respondents were not able to correctly distinguish the two signs. Drivers did not confuse the **Turn** sign with the **Curve** sign

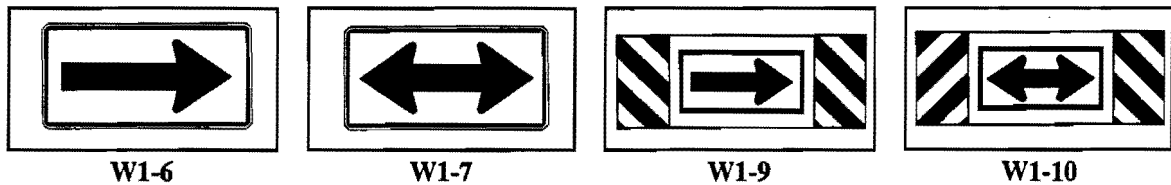
and vice versa; rather, they tended to equate one sign with the other. Since as many as 35 percent selected a **Curve** definition for the **Turn** sign, and 15 percent verbally described the **Turn** sign as a **Curve** sign, it was suggested that the advisory speed plate should be used on all **Turn** signs.

All five of the diamond-shaped signs (along with alternative designs) were tested in the Biotechnology study (5). The evaluation used open-ended responses to an in-context picture of the signs. The **Turn**, **Curve**, **Reverse Turn**, **Reverse Curve**, and **Winding Road** signs were correctly identified by 90, 84, 69, 61, and 75 percent, respectively. The respective correct responses for the selection procedure were 90, 84, 69, 61, and 75 percent. In the Rice University study (7), 91 percent of the drivers tested identified the correct meaning of the **Curve** (W1-2) sign. Eighty percent of the drivers tested identified the correct meaning of the **Reverse Turn** (W1-3) sign. Sixty-nine percent of the drivers tested identified the correct meaning of the **Reverse Curve** (W1-4) sign.

In his thesis (6), Paniati tested the **Turn** (W1-1R), **Reverse Curve** (W1-4R), and **Winding Road** (W1-5) signs. Correct response rates for the **Turn**, **Reverse Curve**, and **Winding Road** signs were 91, 41, and 72 percent, respectively. Substantially correct response rates were 6, 59, and 28 percent, respectively. Although 59 percent of the responses for the **Reverse Curve** sign fell into the substantially correct category, Paniati felt that there did not appear to be any problems with this sign. The high percentage of substantially corrects resulted from an incomplete response indicating one curve instead of two curves. Paniati stated that there was no doubt that the subjects understood the primary intent of the sign, and this incomplete response should not result in a dangerous driving maneuver.

Large Arrow and Large Arrow Board W1-6, W1-7, W1-9, W1-10 2C-9

The **Large Arrow** signs (W1-6 and W1-7) are used to give notice of a sharp change in alignment. The Texas MUTCD (10) also includes the **Large Arrow Board** (W1-9 and W1-10) signs, which are used at locations where additional emphasis is needed. The **Large Arrow** sign first appeared in the 1948 national MUTCD (25). The W1-6 and W1-9 signs use a single headed arrow, while the W1-7 and W1-10 use a double headed arrow. Also, the diagonal stripes on both sides of the W1-9 are in the same direction, while the diagonal stripes on the W1-10 sign are in opposite directions.



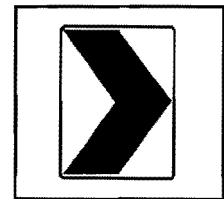
The W1-6 sign was included in the multiple choice survey as a part of the 1981 TTI study (2). A relatively insignificant portion (three percent) responded "don't know" and "dead end" (four percent). The majority of the respondents, however, interpreted the **Large Arrow** sign as indicative of a detour or one-way traffic. These two interpretations accounted for 75 percent of the responses. The remaining 18 percent correctly identified the arrow as indicative of a sharp turn.

Chevron Alignment

W1-8

2C-10

The **Chevron** sign was first added to the MUTCD in Volume 8 of the revisions to the 1971 national MUTCD (31). It is used to indicate a sharp change in alignment and provide guidance for drivers. In the studies that led to this sign's introduction into the MUTCD, the Oregon Department of Transportation (32) found that this sign was universally understood and provided a basis for a single uniform device to be used where emphasis is needed in communicating change in direction of alignment. The Georgia Department of Transportation conducted research (33) for two case problems using the chevron design and concluded that the chevron marker met a previously unfilled need in delineation.



W1-8

The 1980 AAA study (4) found that less than half of those surveyed (46 percent) selected the correct response to a question on the **Chevron** sign. However, the film showing the **Chevron** signs also included a **Keep Right** (R4-7) sign, and 33 percent selected a "keep right" response when asked the meaning of the **Chevron** sign. Another 19 percent thought the **Chevron** sign meant "sharp curve," which is a common application of this sign. Another study (34) determined that the chevron is effective in encouraging drivers to move away from the centerline on horizontal curves. It also appeared to reduce vehicle speed and placement variability.

In the 1981 TTI study (2), 37 percent recognized the meaning of the sign from the physical characteristics of the sign alone. In the multiple choice survey, 23 percent selected the response

that it showed the direction of the road. In open-ended responses to this sign, 37 and 62 percent gave correct descriptions of the meaning of the sign to a picture and film, respectively. The participants in the multiple choice survey had a tendency to interpret the **Chevron Alignment** sign as an indication to lane changes. Twenty-one percent checked this response. In the open-ended surveys, 17 percent said "change lanes" or "detour." The researchers felt these misinterpretations may be explained by the use of orange chevron signs in work zones.

Intersection Diagrams

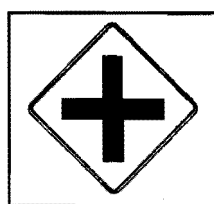
W2-1 to W2-5

2C-11 to 14

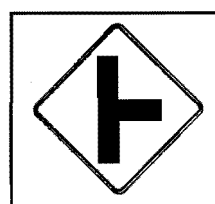
Intersection signs have been a part of the MUTCD since the first edition in 1935 (17), although the original shape of these signs was square. The shape was changed to a diamond in the 1948 MUTCD (25). There are several different signs which make up the intersection family of warning signs. These signs are described in Table 2-7.

Table 2-7. Intersection Signs

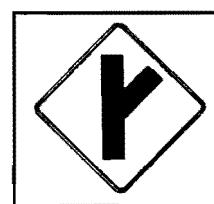
Sign Name	MUTCD Designation	MUTCD Section
Cross Road	W2-1	2C-11
Side Road	W2-2, W2-3	2C-12
T Symbol	W2-4	2C-13
Y Symbol	W2-5	2C-14



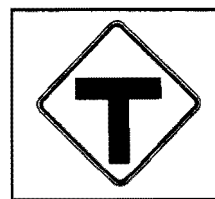
W2-1



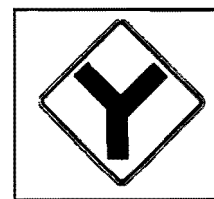
W2-2



W2-3



W2-4



W2-5

A 1966 study (24) found that comprehension of the **T Symbol** sign (W2-4) was 86 percent. However, only 70 percent could identify the nature of the intersecting roadways. Twelve percent had no understanding of this sign. In the 1981 TTI study (2), respondents did well in giving the correct meaning of the **Cross Road** sign, with 92 percent selecting the correct response in the multiple choice survey. Relative to other signs tested, the **Cross Road** sign was well comprehended. It was the third most comprehended warning sign, with only the **Two-Way Traffic** and the **Signal Ahead** signs being better understood.

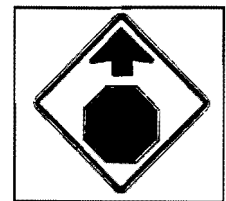
The standard **Cross Road** sign (W2-1) and several alternatives were evaluated in the Biotechnology study (5). The standard sign was correctly identified by 92 percent of the respondents. The Rice University study (7) found that 99 percent of the drivers tested identified

the correct meaning of the **Cross Road** sign with the relative importance of the intersecting roads shown by different widths of the line in the diagram. The **T Symbol** (W2-4) sign was correctly identified by 68 percent of the tested drivers.

Paniati (6) studied three of these signs in his thesis -- the **Cross Road** (W2-1), **Side Road** (W2-2), and **T Intersection** (W2-4) signs. The correct response rates were 94, 75, and 84 percent, respectively. The substantially correct response rates were three, 25, and 16 percent, respectively. The responses indicate that these signs are very well understood, with the total of the correct and substantially correct response rates for all three signs being over 95 percent.

Stop Ahead**W3-1a****2C-15**

The **Stop Ahead** sign is used when the **STOP** sign is not visible for sufficient distance for the driver to react accordingly. The symbol version of the **Stop Ahead** sign (W3-1a) was added to the MUTCD in Volume 7 of the revisions to the 1971 MUTCD (35). Prior to this, it was a word message sign (W3-1). The word message sign is now an alternate to the symbol sign. It should be noted that the red octagon does not contain the word **STOP**.

**W3-1a**

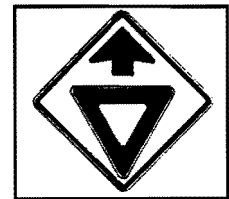
A study of driver behavior at partially concealed or obscured **STOP** signs with and without this signing treatment (36) showed that it may not provide an adequate visual stimulus to prepare drivers to stop. Many drivers approached the **STOP** sign with lower average velocities and decelerations when the warning sign was present than when it was absent, but some were unable to stop properly at the intersection despite its presence.

A common incorrect interpretation of the **Stop Ahead** symbol sign in the 1981 TTI study (2) was that the combination of the **STOP** sign shape and the arrow indicates that the driver should stop and then go straight. It should be noted that at the time of this study, many of the drivers who participated in the survey had never seen these signs, as they were relatively new. In the multiple choice survey, 42 percent selected the correct answer, while 45 percent selected "stop, then go straight ahead." In open-ended responses to a picture of the sign, only 30 percent described the proper answer.

In the 1980 AAA study (4), 84 percent selected the correct response to this sign. This was despite the fact that most had probably never seen it, as it was relatively new at the time. In the Biotechnology study (5), 90 percent correctly identified this sign. In Paniati's thesis (6), 97 percent gave a correct response to the **Stop Ahead** symbol sign.

Yield Ahead**W3-2a****2C-16**

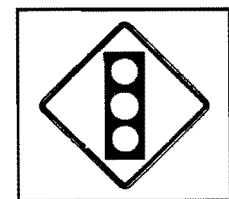
The **Yield Ahead** symbol sign (W3-2a) is closely related to the **Stop Ahead** symbol sign, except that the **YIELD** sign shape replaces the **STOP** sign shape. The symbolic version was introduced at the same time as the symbolic **Stop Ahead** sign. A word message version of the sign (W3-2) is permitted as an alternate.

**W3-2a**

The 1980 AAA study (4) found that the symbolic **Yield Ahead** sign, which was relatively new at the time of the study, was apparently well understood. The percent of drivers that selected the correct response ("prepare to yield to cross traffic if you see any") was 86 percent. In the Biotechnology study (5), 72 percent correctly identified this sign in an open-ended response to an in-context picture of the sign. In Paniati's thesis (6), 84 percent gave the correct response to the **Yield Ahead** symbol sign and nine percent gave a substantially correct response.

Signal Ahead**W3-3****2C-17**

This sign was first introduced in the 1948 MUTCD (25) as a word message sign with the legend **SIGNALS AHEAD**. The 1961 MUTCD (22) changed the legend to **SIGNAL AHEAD**. The symbol version **Signal Ahead** sign (W3-3) was introduced in the 1971 MUTCD (23).

**W3-3**

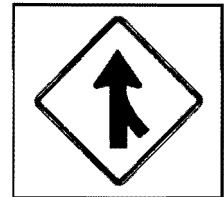
Contrary to the **Stop Ahead** symbol sign, the **Signal Ahead** symbol sign appeared to be well understood in most research studies. The ability of the signal ahead sign to convey the concept of "ahead" without using a directional arrow has been questioned in one study (37). However, except for some minor interpretation problems, another study (38) found that the **Signal Ahead** symbol sign appears to be well understood. Eighty-two percent of those tested gave a correct definition for this sign when presented with the sign alone, and another 11 percent gave a definition close to the correct one. When presented with the sign in its environment, 81

percent correctly defined it, and seven percent gave a close definition. Seventy-three percent were able to identify the appropriate behavior associated with the sign when presented as a legend sign only, and 69 percent for the sign in its environmental setting. Deletion of the directional arrow which conveys the "ahead" message did not appear to diminish understanding of this sign (37).

The 1979 AAA study (3) included the symbolic **Signal Ahead** sign (W3-3) and found that 94 percent were able to select the correct meaning. The **Signal Ahead** sign was very well understood in the 1981 TTI study (2). The **Signal Ahead** sign was the second most understood of all the signs in the multiple choice survey, with 94 percent choosing the correct meaning of this sign. In Paniati's thesis (6), 97 percent gave a correct response to the **Signal Ahead** symbol sign.

Merge**W4-1****2C-18**

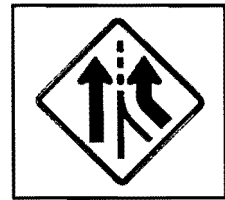
The **Merge** symbol sign (W4-1) was first introduced in the 1971 MUTCD (23). It is intended to indicate that two traffic streams will merge into one lane. Prior to 1971, it was a word message sign using the legend **MERGING TRAFFIC**.

**W4-1**

In the 1978 TTI study (1), the **Merge** symbol sign was accurately perceived by 79 percent, with the most common incorrect response being "a major roadway to the right merging with the highway." In the 1981 TTI study (2), the correct response rate for the multiple choice survey was 76 percent. Open-ended responses to a picture of the sign had a 63 percent correct response rate and open-ended responses to a film of the sign had a 83 percent correct response rate.

The Biotechnology study (5) tested the standard **Merge** sign and found that 100 percent of the drivers correctly identified the sign. In the Rice University study (7), 99 percent of the drivers tested identified the correct meaning of the **Merge** sign used in conjunction with the **MERGE** educational plaque. In Paniati's research (6), there did not appear to be any serious comprehension problems with this sign. The high number of substantially correct responses, 53 percent, resulted from people indicating "...a road comes in from the right" rather than the completely correct response of "...merging traffic," which had a response rate of 47 percent.

The **Added Lane** sign (W4-3) was first introduced in the first revision to 1978 MUTCD (39). It is intended to warn the driver that two roadways will converge, but each roadway has its own lane and will not merge together.



W4-3

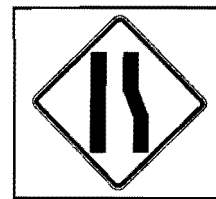
In the 1980 AAA study (4), the **Added Lane** sign was the most poorly recognized and understood sign of all signs tested. The correct response ("no need to merge left") was selected by only seven percent, and 59 percent thought the sign meant "merging traffic." Another 14 percent thought the sign meant "no lane changing ahead" and 12 percent thought the sign meant "two lanes ahead".

The **Added Lane** was also found to be poorly understood in the Biotechnology study (5), as only 19 percent correctly identified the sign. Paniati (6) found that many subjects exhibited a lack of understanding of the meaning for this sign. The incorrect response rate was 22 percent, with the most prevalent incorrect response being "merge ahead." Fifty percent selected substantially correct responses for this sign. The majority of these substantially correct responses were "...road coming in from the right." While this was classified as substantially correct, it was not clear that the subject understood that a lane was being added. Only 28 percent correctly responded to the sign. Paniati (6) also found that while the legibility distance of this symbol sign is high, the comprehension level is not acceptable. Many drivers either fail to comprehend the message at all or do not perceive the difference in meaning between this sign and the **Merge** sign (W4-1).

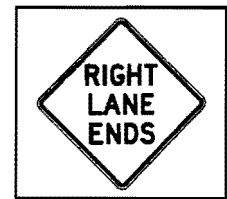
The family of lane reduction transition signs includes the three signs described in Table 2-8. The **Lane Reduction Transition** sign (W4-2) was first introduced in the 1961 MUTCD (22), although it was called the **Pavement Width Transition** sign. The name of the sign was changed to the **Lane Reduction Transition** sign in Revision 2 to the 1978 MUTCD (40). The **RIGHT LANE ENDS** (W9-1) and **LANE ENDS MERGE LEFT** (W9-2) signs were introduced in the 1971 MUTCD (23).

Table 2-8. Lane Reduction Transition Signs

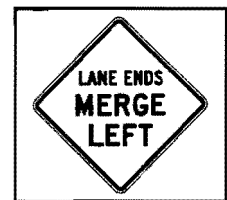
Sign Name	MUTCD Designation	MUTCD Section	Sign Type
Lane Reduction Transition	W4-2	2C-19	symbol
RIGHT LANE ENDS	W9-1	2C-19	word message
LANE ENDS MERGE LEFT	W9-2	2C-19	word message



W4-2



W9-1



W9-2

In the 1978 TTI study (1), 61 percent accurately interpreted the warning message denoting the right lane was ending. However, 21 percent responded that the sign referenced a single lane of traffic ahead while seven percent were unsure of the appropriate response. The primary alternative response chosen is appropriate in the scene depicted in the survey, so that misinterpretation in this case would have no detrimental consequences. The **Lane Reduction Transition** sign was also tested in a second question in the 1978 TTI study (1). Left and right versions of the sign were shown on either side of the road and the driver was asked if they meant the same thing. Despite, or maybe because of, the fact that the signs were mirror images of one another, 60 percent correctly stated that the two signs did not mean the same thing.

The 1979 AAA study (3) contained a question on a **Lane Reduction Transition** sign indicating the left lane was ending and found that 87 percent selected the correct answer from among a list that included "right lane ends ahead" (eight percent) and "narrow bridge ahead" (five percent).

There was a great deal of variability in the interpretation of this sign in the 1981 TTI study (2). For instance, open-ended responses to a filmed approach to the **Lane Reduction Transition** sign (W4-2) included such diverse interpretations as divided highway ends, two-way road becomes one-way, side street merging into main street, curve, and two way traffic. The correct meaning was given by 46 percent of those viewing the film. When given a choice of several responses to this sign, 68 percent selected the correct response. When asked to provide an open-ended response to the sign, 55 percent gave the correct meaning. The study (2) recommended that this sign be accompanied by an educational plaque in order to improve comprehension.

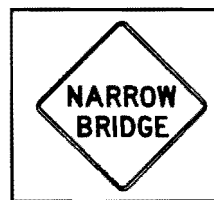
In the Biotechnology study (5), 75 percent correctly identified the sign. Paniati (6) performed detailed tests on the **Lane Reduction Transition** sign and alternatives to the sign. Comprehension of the standard sign was found to be poor, with many drivers thinking the lines in the sign represented lanes instead of the edge of the road. Only 22 percent of the drivers provide a correct response, 66 percent gave a substantially correct response, and 12 percent gave an incorrect response.

Narrow Bridge

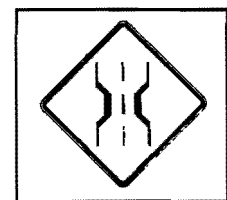
W5-2, W5-2a

2C-21

The **Narrow Bridge** signs include both a word message (W5-2) and a symbolic (W5-2a) legend. Both signs are intended to warn of a bridge or culvert having a roadway clearance less than the width of the approach pavement or a two-way clear roadway width of 16 to 18 feet. The word message legend version of the sign has been in the MUTCD since the 1935 edition (17). The symbolic legend version was added to the MUTCD in Volume 8 of the revisions to the 1971 MUTCD (31).



W5-2



W5-2a

One study (37) found that this sign was generally well understood, but that the "narrow" or "bridge" concepts were not always interpreted correctly. Correct definitions were given by 51 percent and 67 percent for sign and sign in its environment presentations, respectively. Close definitions were given by 33 percent and 25 percent. Correct behavior responses were given by 32 percent for sign alone and 40 percent for sign plus environment. Close responses were given by 48 percent and 46 percent, respectively. In the Rice University study (7), 86 percent identified the correct meaning of the **NARROW BRIDGE** word message sign (W5-2).

The Biotechnology study (5) evaluated the symbolic **Narrow Bridge** (W5-2a) sign by showing the driver an in-context picture of the sign in its appropriate highway environment. The driver was then asked to describe the meaning of the sign in an open-ended response. A total of 60 percent of the respondents correctly identified the sign.

In Paniati's thesis (6), only 31 percent have a correct response to the **Narrow Bridge** symbol sign, although 60 percent gave a substantially correct response. Paniati asserted that the high percentage of substantially correct responses was a result of subjects responding

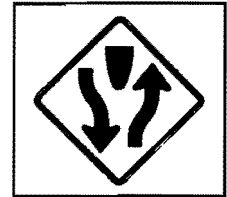
"...roadway narrows" rather than with the completely correct response, but since they are grasping the most important part of the information, this does not seem to be a problem.

Divided Highway

W6-1

2C-23

The **Divided Highway** sign (W6-1) is intended to warn drivers of an approach to a section of highway where the opposing flows are separated by a physical barrier. The word message **DIVIDED HIGHWAY** sign (W6-2a) may be used as an alternate. The symbolic version of the sign was introduced in the 1971 MUTCD (23). The word message version was introduced in the 1948 MUTCD (25) with the legend **DIVIDED HIGHWAY AHEAD**. This was changed to the legend **DIVIDED HIGHWAY** in the 1961 MUTCD (22).



W6-1

When drivers were shown both the **Divided Highway** (W6-1) and **Keep Right** (R4-7) symbols signs in the 1978 TTI study (1) and asked if they meant the same thing, 47 percent incorrectly suggested that the signs were equivalent.

This sign had a high comprehension level in the multiple choice survey of the 1981 TTI study (2), with 88 percent selecting the correct response. A lower percentage (65 percent) provided the correct meaning of the sign in the open-ended survey. Although the **Keep Right** sign is often confused with the **Divided Highway** sign, the reverse was not found to be true.

Paniati (6) found that 72 percent of the test subjects gave a correct response to the **Divided Highway** sign and that 25 percent gave a substantially correct response.

Divided Highway Ends

W6-2

2C-24

The **Divided Highway Ends** sign (W6-2) is intended for use at the end of a section of physically divided highway, warning the driver of two-way traffic ahead. The history of this sign is the same as the **Divided Highway** sign (W6-1), except that the legend of the word message sign has always been **DIVIDED HIGHWAY ENDS** (W6-2a).

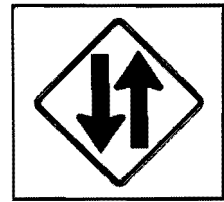


W6-2

This sign was included in the Biotechnology study (5) due to the potential for confusion with the **Divided Highway** sign (W6-1). The sign was correctly identified by 71 percent of the drivers. In the Rice University study (7), 91 percent of the drivers tested identified the correct meaning of the symbolic **Divided Highway Ends** sign (W6-2) used in conjunction with the alternate **DIVIDED HIGHWAY ENDS** educational plaque.

Two-Way Traffic**W6-3****2C-25**

The **Two-Way Traffic** sign (W6-3) warns the driver that there is no separation between opposing traffic. This sign is intended for use at the transition from a separated one-way highway to a two-way highway or at periodic intervals on a two-lane highway. A word message version of the sign (W6-3a) can be used as an alternate. This sign was first introduced in the 1971 MUTCD (23) as both a symbol and word message sign.

**W6-3**

In the 1978 TTI study (1), this warning sign depicting two-way traffic was correctly interpreted by 93 percent of the study participants. There was no alternative consistently considered as an accurate response by the remaining seven percent. The 1979 AAA study (3) asked drivers what a symbolic **Two-Way Traffic** sign (W6-3) meant and 93 percent were able to select the correct answer.

In the 1981 TTI study (2), this sign was comprehended very well relative to other warning signs. In the multiple choice format, **Two-Way Traffic** was the most understood sign with 98 percent of the respondents answering correctly. In open-ended responses to a picture of the sign, 79 percent responded correctly to a picture of the sign. Paniati (6) found that 91 percent of the test subjects gave a correct response to the **Two-Way Traffic** sign and that six percent gave a substantially correct response. In the Rice University study (7), 92 percent of the drivers tested identified the correct meaning of the symbolic **Two-Way Traffic** (W6-3) sign with the word message **TWO WAY TRAFFIC** as a supplemental educational plaque.

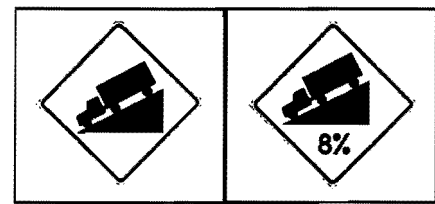
Hill**W7-1 to W7-4a****2C-26**

The **Hill** sign is intended for use in advance of a downgrade where the length, percent of grade, horizontal curvature, or other physical features require special precautions on the part of

drivers. Although the name of the sign is **Hill**, the sign refers to a downgrade. The **HILL** word message sign (W7-1a) has been in the MUTCD since the 1935 edition (17). The symbolic legend **Hill** sign (W7-1) was introduced in the 1971 MUTCD (23). The **Hill** family of signs includes several different signs as shown in Table 2-9. There are three **Hill** signs and there are also six supplemental plates intended for use below the **Hill** sign. In addition, there are two hill signs for truck ramps (W7-4 and W7-4a). A few of these signs are illustrated next to Table 2-9.

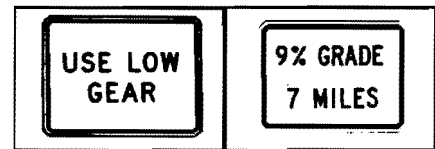
Table 2-9. Various Hill Signs

Sign Type	MUTCD Designation	Shape	Legend
Hill sign	W7-1	diamond	Hill symbol
	W7-1a	diamond	HILL
	W7-1b	diamond	Hill symbol with X%
Hill Supplemental Plaque	W7-2	rectangle	USE X GEAR
	W7-2a	rectangle	USE LOW GEAR
	W7-2b	rectangle	TRUCKS USE LOWER GEAR
	W7-3	rectangle	X% GRADE
	W7-3a	rectangle	NEXT X MILES
	W7-3b	rectangle	X% GRADE X MILES
Truck Ramp	W7-4	rectangle	RUNAWAY TRUCK RAMP X MILE
	W7-4a	rectangle	RUNAWAY TRUCK RAMP with Arrow



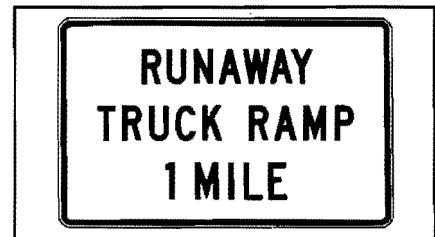
W7-1

W7-1b



W7-2a

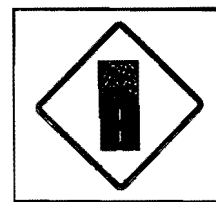
W7-3b



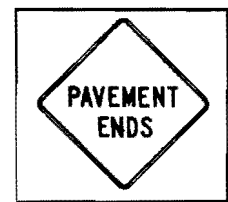
W7-4

The **Hill** sign (W7-1) tested in Paniati's study (6) had correct, substantially correct, and incorrect response rates of 66, 22, and 12 percent, respectively. Paniati felt that the confusion for this sign results from the presence of the truck on the sign. All of the incorrect responses were either "truck crossing", truck route", or "...watch out for trucks." The majority of the substantially correct responses were a result of the person identifying the steepness of the grade, but relating it to trucks; "...trucks shift to lower gear." The use of a truck on this symbol causes many motorists to believe the signs are intended for trucks only. In the Rice University study (7), 92 percent of the drivers tested identified the correct meaning of the **Hill** sign (W7-1). The Biotechnology study (5) tested the **Hill** sign (W7-1) and found that 96 percent correctly identified the sign.

The **Pavement Ends** sign is intended to warn drivers where a pavement surface changes from a hard-surfaced pavement to a low-type pavement or earth road. There is a word message version of the sign (W8-3) and a symbolic version of the sign (W8-3a). The word message version of the sign has been in the MUTCD since the 1935 edition (17). The symbolic version was introduced in Volume 8 of the revisions to the 1971 MUTCD (31).



W3-3a

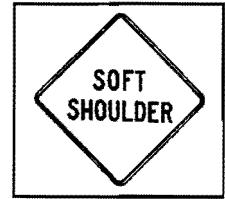


W3-3

The 1978 TTI study (1) found that 84 percent correctly depicted the word message version of the sign as pointing to a change from the hard surface facility to gravel or earth pavement. In the 1981 TTI study (2), 75 percent of the respondents were able to explain the meaning, or give an appropriate driving response to the **PAVEMENT ENDS** word sign (W8-3) in an open-ended response to a picture of the sign. Misinterpretation of the **PAVEMENT ENDS** sign was that the road stops completely, as in a dead end. This misconception was held by 17 percent of the respondents. It was suggested that a symbol representation of the changes on the road's surface might be a more effective communication of the intended meaning, but a pavement ends symbol was not tested. In the Rice University study (7), 96 percent of the drivers tested identified the correct meaning of the **PAVEMENT ENDS** word message sign.

In the Biotechnology study (5), 82 percent were able to correctly identify the sign. In comparison to the word message version, Paniati (6) found that the meaning of the symbol sign was not clear to many of the subjects. This resulted in its high percentage of incorrect (25 percent) and substantially correct responses (34 percent). The correct response rate was only 41 percent. During the testing, it was also evident that many of those who gave a correct reply could not do so without considerable scrutiny of the sign. This is not desirable since in a real situation the driver does not have unlimited time to try and decipher the intended message of the sign. Both the legibility distance and comprehension of this sign were determined to be poor. The current design is ineffective in communicating the intended message to the driver. Paniati recommended that alternatives to the existing design be tested.

The **SOFT SHOULDER** sign is intended to warn of a shoulder condition that presents a hazard to vehicles that may get off the pavement. The **SOFT SHOULDER** word message sign (W8-4) was included in the 1935 MUTCD (17), although it was classified as a caution sign and used a square shape with vertical sides. The **SOFT SHOULDER** sign was changed to a diamond shaped warning sign in the 1948 MUTCD (25). There is no symbolic version of the sign.



W8-4

There were no particular difficulties in interpreting this sign in the 1978 TTI study (1), with 88 percent selecting the correct response. Of those who missed the question, seven percent of the total thought soft spots would be encountered in the pavement.

The **SOFT SHOULDER** sign was tested again in the 1981 TTI study (2). Eighty-five percent of the respondents could explain this warning sign with acceptable accuracy in open-ended responses to a picture of the sign. Responses showed some variability such as: "The shoulder is not a paved surface," "You might get stuck if you drive on the shoulder," or "Don't drive on the shoulder." Basically, these 85 percent who responded correctly were receiving the intended message of the sign. However, the remaining 15 percent of the driver sample gave various incorrect identifications, said they did not know the meaning of the sign, or gave the inappropriate driving response.

The **SOFT SHOULDER** sign was tested in an early evaluation in the Biotechnology study (5), where 75 percent of the respondents correctly identified the sign. The sign was not tested in the further evaluations in that study. In the Rice University study (7), 97 percent of the drivers tested identified the correct meaning of the **SOFT SHOULDER** sign.

The W8-5 sign is named the **Slow Down on Wet Road** sign in the Texas MUTCD and is known as the **Slippery When Wet** sign in the national MUTCD. The sign name in Texas was changed to **Slow Down on Wet Road** in 1988 with the fourth revision to the 1980 Texas MUTCD (10). The symbol used in the W8-5 sign was introduced in the 1971 MUTCD (23). The



W8-5

word message version of the sign was included in the 1935 MUTCD (17), although it was classified as a caution sign and used a square shape with the sides vertical. The sign was changed to a diamond shaped warning sign in the 1948 MUTCD (25). A word message version of the sign (W8-5a) is also used in Texas with the legend **SLOW DOWN ON WET ROAD**.

In the 1978 TTI study (1), 77 percent selected the correct choice. However, 21 percent selected the response that suggested the sign referred to curves in the road. This misunderstanding is potentially hazardous, as were other incorrect responses, in that the driver would be unprepared for possible sliding in wet conditions.

The 1981 TTI study (2) also found that a common misinterpretation of the **Slippery When Wet** symbol sign is its association with a winding road or curves ahead, although this misinterpretation was limited to about 16 percent of the multiple choice responses and the open-ended responses to a film. This misconception poses a hazard for misguided motorists who do not respond appropriately to a more dangerous road condition. The correct choice was selected by 81 percent of the respondents in the multiple choice survey, 54 percent in open-ended responses to a picture of the sign, and 74 percent in open-ended responses to a film of the sign. Another common misinterpretation in the surveys with open-ended responses was that the sign indicated a constant slippery condition.

Driver responses to the standard **Slow Down on Wet Road** sign demonstrated that 66 and 94 percent correctly identified the sign in the screening and selection evaluations, respectively. In Paniati's study (6), the correct, substantially correct, and incorrect response rates for the **Slippery When Wet** symbol sign was 28, 63, and nine percent, respectively. While it was apparent that the vast majority of the subjects understood that the pavement was slippery ahead, those that had a substantially correct answer failed to respond with the completely correct answer of "...slippery when wet."

In the Rice University study (7), 90 percent of the drivers tested identified the correct meaning of the **Slow Down on Wet Road** symbol sign when used with the **SLIPPERY WHEN WET** educational plaque. Other research (38) showed that the symbol message can be improved by providing a few simple additions to the existing symbol. Only 66 percent of drivers understand the standard slippery when wet symbol. When a line depicting the horizon is put

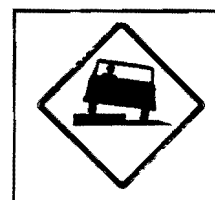
under the vehicle, the comprehension increased to 88 percent. Adding a few raindrops increases the understanding to 96 percent.

Low Shoulder

W8-9, W8-9a

2C-30.3

The **Low Shoulder** sign is intended to warn of a 3-inch or greater drop from the pavement edge to the shoulder. This sign is included in the Texas MUTCD (10), but is not in the national MUTCD. There are two versions of this sign. One is the word message **LOW SHOULDER** sign (W8-9) and the other is the **Low Shoulder** symbol sign (W8-9a).



W8-9a

One study (38) found that only 29 percent knew the meaning of the symbol sign shown by itself. When an environmental context was added to the sign, the comprehension increased to 39 percent. Another 47 and 34 percent, for sign only and sign in its environment, respectively, had close responses to the meaning of the sign.

The 1981 TTI study (2) found that although the **Low Shoulder** symbol sign is distinct from the **Uneven Lanes** sign (CW21-14), it is most often confused with it. A total of 63 percent selected the correct response to this sign in the multiple choice survey. In open-ended responses to a picture of the sign, only 6 percent were able to provide the correct meaning. The study showed that the **Low Shoulder** symbol sign is not an easy one for drivers to interpret, with 10 percent giving "don't know" responses when asked for a meaning of this sign.

The comprehension levels of the **Low Shoulder** symbol sign in both the Biotechnology (5) and Paniati's (6) studies were poor. In the Biotechnology study, 28 percent of the survey respondents correctly identified the sign. In Paniati's study, the correct, substantially correct, and incorrect response rates were 16, six, and 78 percent, respectively. The three alternatives that Paniati developed for the **Low Shoulder** symbol sign displayed little improvement in comprehension levels.

Crossing and Advance Crossing

W11 and W11A Series

2C-31, 2C-32

The **Crossing** and **Advance Crossing** signs include a number of different signs which are used to alert drivers to unexpected entries into the roadway. Table 2-10 lists some of the

potential hazards for which these signs provide a warning. The **Advance Crossing** signs are used in advance of the crossing area. **Crossing** signs are used to supplement **Advance Crossing** signs as a means of assisting the driver in defining the specific point of crossing. **Crossing** signs should be located immediately adjacent to the crossing location. **Crossing** signs are distinguished from the **Advance Crossing** signs by the addition of crossing lines on the sign. The **Pedestrian Advance Crossing** (W11-2) and **Pedestrian Crossing** (W11A-2) signs are the two most common and most studied signs of these categories.

Paniati (6) evaluated the **Bicycle Crossing** (W11-1), **Pedestrian Crossing** (W11A-2), and **Deer Crossing** (W11-3) signs. The **Pedestrian Crossing** sign was the only sign of the 22 in the study that had a 100 percent correct response rate. The **Bicycle Crossing** sign had a correct response rate of 91 percent and a substantially correct response rate of nine percent. The correct and substantially correct response rates for the **Deer Crossing** sign were 81 and 19 percent, respectively.

Table 2-10. Advance Crossing Signs

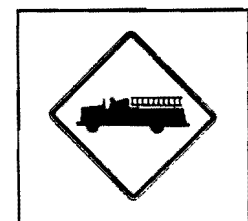
Sign Name	MUTCD Designation	Sign Type
Bicycle	W11-1	symbol
Pedestrian	W11-2	symbol
Deer	W11-3	symbol
Cattle	W11-4	symbol
Tractor	W11-5	symbol
Equestrian	W11-7	symbol
Fire Truck	W11-8	symbol
Handicapped	W11-9	symbol
Truck	W8-6	word
Truck	W11-10	symbol
Emergency Vehicles	W11-11	word message



W11-2



W11A-2



W11-8

Several of the crossing signs were included in the 1981 TTI study (2), including the **TRUCK CROSSING** (W8-6), **Deer Crossing** (W11-3), **Fire Truck** (W11-8), and **Pedestrian Crossing**

(W11A-2). The **Fire Truck and Pedestrian Crossing** were both in the multiple choice survey, with correct response rates of 42 and 86 percent, respectively. The **TRUCK CROSSING, Fire Truck, and Pedestrian Crossing** signs were included in the film survey with open-ended responses. Correct responses were 95, 74, and 86 percent, respectively. The **Deer Crossing, Fire Truck, and Pedestrian Crossing** signs were also in another survey in which drivers gave open-ended responses to a picture of the sign. Correct response rates in this survey were 96, 70, and 81 percent, respectively. The **Fire Truck Advance Crossing** sign (W11-8) was associated with a fire truck route or crossing at the point of the sign, rather than a nearby fire station.

The Biotechnology study (5) evaluated both the **Advance Pedestrian Crossing** and **Pedestrian Crossing** signs. The **Advance Pedestrian Crossing** sign was correctly identified by 39 percent of the respondents and the **Pedestrian Crossing** sign was correctly identified by 71 percent.

In the Rice University study (7), 98 percent of the drivers tested identified the correct meaning of the **Pedestrian Advance Crossing** sign (W11-2) when used in conjunction with the optional **PED XING** educational plaque.

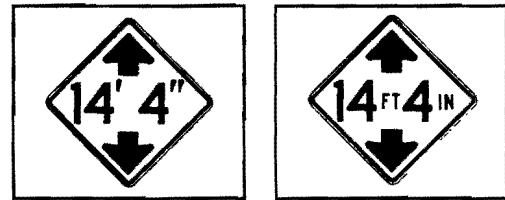
Clearance	W12-2 to W12-4	2C-34
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There are a number of clearance signs which are used to indicate the distance between the pavement and overhead structures. Table 2-11 describes the different types of **Clearance** signs. The W12-2 and W12-2T are the diamond shaped **Clearance** signs used in advance of a structure. The W12-2T, which uses **FT** and **IN** is the more common of these two signs in Texas. The W12-2P plaque is intended for use below the W12-2 or W12-2T signs where the clearance is low. The W12-3 sign is intended for use on or at every structure that spans a State maintained roadway. The W12-3P is a downward pointing arrow which is intended to indicate the lane to which the clearance distance applies. The W12-4 sign is intended to warn drivers of a low clearance ahead so that they may take the appropriate detour.

Some version of the **Clearance** sign has been in the MUTCD since the first edition (17). The W12-2 and W12-2T signs were introduced in the 1971 MUTCD (23). In the 1948 and 1961 MUTCDs (25, 22), the **Clearance** sign was a word message sign with the legend **LOW CLEARANCE XX FT X IN**.

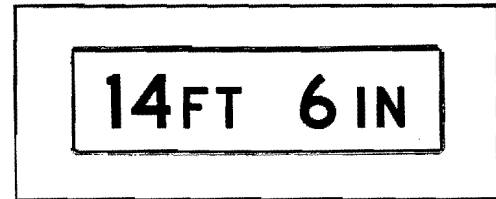
Table 2-11. Clearance Signs

Texas MUTCD Designation	Sign Shape	Sign Legend
W12-2	diamond	Clearance with Arrows (' ")
W12-2T	diamond	Clearance with Arrows (FT IN)
W12-2P	plaque	LOW CLEARANCE
W12-3	rectangle	Clearance (FT IN)
W12-3P	plaque	Downward Arrow
W12-4	rectangle	LOW CLEARANCE XX MILES AHEAD



W12-2

W12-2T



W12-3

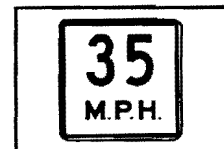
The diamond-shaped **Low Clearance** sign was evaluated in both the Biotechnology and Rice University studies. In the Biotechnology study (5), 92 percent correctly identified this sign. In the Rice University study (7), 98 percent of the drivers tested identified the correct meaning of the W12-2 **Clearance** sign and W12-2P supplementary **LOW CLEARANCE** plaque.

Advisory Speed Plate

W13-1

2C-35

The **Advisory Speed Plate** (W13-1) is intended for use as a supplement below warning signs to indicate the maximum recommended speed. This sign is not intended to be used alone or with any type of sign other than warning signs. This sign was first introduced in the 1948 MUTCD (25), and has maintained the same appearance since that time.



W13-1

Compliance problems have been noted to exist with this sign, due to its misapplication (41). One study (42) found that this compliance problem, which involves exceeding the advised speed on curves, exists primarily in rural areas and at locations with less severe curves. Drivers often ignored the safe speed for curves, exceeding it by an average of 5 to 6 mph. Some factors which seemed to affect compliance are the use of curve versus turn signs, the degree of horizontal curvature, and the existence of pedestrian facilities.

Another study (43) determined that advisory speeds do have an influence upon driver behavior. The rate of deceleration on the curve approach was linked to the posted advisory

speed, but speeds on the curve were more a function of driving habits and the roadway geometry.

Other research (44) concluded that the use of the **Advisory Speed Plate** with curve and turn signs is not more effective than the use of curve and turn signs alone. This was attributed to the strong visual stimulus provided by curve and turn signs. Advisory speeds did not appear to provide much additional information to aid the driver that they did not already have.

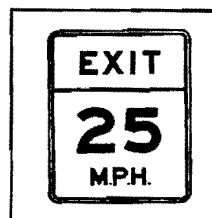
In terms of comprehension of this sign, 74 percent of the participants in one study (24) recognized the advisory speed as the maximum safe speed. Another 22 percent believed the advisory speed was regulatory. Thus, 96 percent of the responses were considered "acceptable."

Advisory Exit Speed

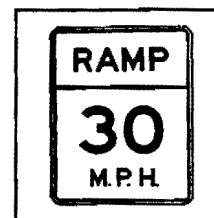
W13-2, W13-3

2C-36

There are two **Advisory Exit Speed** signs, the **Exit Speed** sign (W13-2) and the **Ramp Speed** sign (W13-3). These two signs first appeared in the MUTCD in the 1971 edition (23). However, their origins can be traced to the 1958 AASHO *Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways* (45). That manual introduced a regulatory sign with the legend **EXIT SPEED 30**. The 1961 edition (46) of the AASHO manual changed the sign to a warning sign with the same appearance as the W13-2 sign.



W13-2



W13-3

The 1981 TTI study (2) showed that all but five percent identified both the **SPEED LIMIT** sign and the **Advisory Exit Speed** sign (W13-2) as being speed limit signs. Fifteen percent identified the **Advisory Exit Speed** sign as a speed limit, while 80 percent specified that this sign pertained to speed going off a freeway ramp. In defining the **Advisory Exit Speed** sign, no respondents mentioned its advisory nature. Only 24 percent correctly distinguished the yellow **Advisory Exit Speed** sign from the white regulatory **SPEED LIMIT** sign. In the Rice University study (7), 93 percent of the drivers tested identified the correct meaning of the **Advisory Exit Speed** sign (W13-2).

The **NO PASSING ZONE** sign (W14-3) is the only pennant shaped sign. It is used to warn drivers of the beginning of no-passing zones. It is only located on the left side of the roadway at the beginning of the no-passing zone. The no-passing zone must be identified by pavement markings, the **DO NOT PASS** sign, or both. It first appeared in the MUTCD in the 1971 edition (23). However, it was used in Iowa as early as 1962 (47).



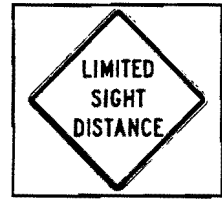
W14-3

An early study of this sign (47) showed a favorable driver reaction to the sign. This study concluded that the sign does not influence driver's passing maneuvers, but does decrease erratic driver behavior, such as aborted pass attempts. A more recent study (28) found that this sign appeared to improve driver compliance with passing regulations and to encourage safer driver passing decisions when used together with appropriate pavement markings.

The 1981 TTI study (2) evaluated both the shape and the meaning of the **NO PASSING ZONE** sign. Only one percent could provide the correct shape of the sign. However, this was not unexpected as the sign was still relatively new at the time of the survey. In the multiple choice survey, only 27 percent were able to select the correct response for this sign. The correct response rate increased dramatically to 81 percent in the open-ended response to a film of the sign. The **NO PASSING ZONE** sign was interpreted as designating a construction area by 14 percent of the respondents to the film. Respondents to the film were asked, "how do you know when it is safe to pass?" A surprising finding was that 49 percent said they would look for an equivalent sign at a later point stating that passing was permitted or the zone had ended. This sign elicited a high "don't know" response (43 percent) in the multiple choice survey. Unfamiliarity with this sign was evidenced in other responses: 10 percent identified the sign as a **YIELD** sign, 17 percent indicated "drive friendly", three percent gave an interpretation of a deer crossing, while 27 percent said no passing.

The **LIMITED SIGHT DISTANCE** sign (W14-4) was added to the MUTCD in Volume 8 of the revisions to the 1971 MUTCD (31). An FHWA study (48) found that most drivers neither understood the meaning of the sign nor knew the appropriate action they should take in

response to the sign. Another problem was that the lack of criteria for the use of the sign led to its proliferation. Therefore, this sign was removed from the national MUTCD in the 1988 edition (49). However, it continues to be in the Texas MUTCD.



W14-4

PAVEMENT MARKINGS

Standards for pavement markings are contained in Chapter 3B of the MUTCD. Markings can be used to supplement the meaning of other traffic control devices, or they can be used alone to convey certain regulations or warnings that would not otherwise be clearly understandable. Pavement markings are the most common form of markings, although this type of traffic control device also includes object markings, delineators, and barricades and channelizing devices.

Pavement markings are yellow or white and consist of various combinations of broken and solid lines of various widths. Yellow is used to separate opposing traffic or mark the left edge of the pavement on divided highways or one-way streets. White is used to separate traffic moving in the same direction or to mark the right edge of the pavement. Broken lines are permissive in nature and solid lines are restrictive. The width of the line indicates the degree of emphasis, with four inches being the normal width of a pavement marking. Double lines indicate maximum restrictions. A few of the uses of pavement markings include center lines, lane lines, pavement edge, no-passing zones, left-turn lanes, stop lines, and crosswalks, among others. The use of words in pavement markings is limited to just a few words such as **ONLY**, **LEFT TURN ONLY**, **RR**, **SCHOOL XING**, and **PED XING**.

Center Lines

3B-1

A center line separates traffic traveling in opposite directions and provides important guidance to motorists. There are three forms of center lines as shown in Table 2-12. In the 1935 MUTCD (17), center lines could be white, yellow, or black, depending on which color provided the greatest contrast with the pavement. White center lines continued to be permitted as recently as the 1961 MUTCD (22), and it was not until the 1971 MUTCD (23) that yellow became the standard color for all center lines.

The 1978 TTI study (1) contained a picture of a double yellow center line with a **DO NOT CROSS DOUBLE YELLOW LINE TO PASS** sign on the side of the roadway. When asked what that marking and sign meant, 76 percent correctly responded that they could not cross the center line to pass. However, an additional 14 percent thought that the double center line could not be crossed for any reason, including turning into a driveway.

Table 2-12. Types of Center Lines

Form of Marking	Color	Purpose
Single Broken Line	Yellow	Passing permitted in both directions
Single Broken Line with Single Solid Line	Yellow (both)	Passing prohibited from side with solid line
Double Solid Lines	Yellow (both)	Passing prohibited in both directions

Two questions were asked in the 1981 TTI study (2) about a broken yellow centerline separating two lanes. The first question asked if the road was one-way or two-way, and the second question asked if passing was permitted. Both questions had a correct response rate of 87 percent in the multiple choice survey. When shown a film of a broken yellow center line, only 53 percent gave the correct open-ended response for both issues. Another 20 percent had one or the other issue correct, but not both. A total of 28 percent did not understand the meaning of the marking at all.

Lane Lines

3B-2

Lane lines are used to separate lanes of traffic moving in the same direction. They are normally broken white lines, but a solid white line may be used in areas where it is advisable to discourage lane changing. A double solid white line is used where traffic lanes are moving in the same direction, but lane changing is prohibited.

Two questions were asked in the 1981 TTI study (2) about a broken white lane line separating two lanes. The first question asked if the road was one-way or two-way, and the second question asked if passing was permitted. Only 47 percent selected the correct response of a one-way road. However, 92 percent stated that passing was permitted. When shown a film

of a broken white lane line, only 45 percent gave the correct open-ended response to a one-way street.

No-Passing Zone

3B-3

A no-passing zone in one direction is indicated by a single solid yellow line next to a broken yellow center line. A no-passing zone in both directions is indicated by a double solid yellow center line. The solid yellow line indicating a passing prohibition is often referred to as a barrier line. The no-passing zone markings have changed several times over the years. It was not until the 1948 MUTCD (25) that the use of the barrier line was formalized, although it could be either yellow or white. The 1961 MUTCD (22) specified that the barrier line had to be yellow, but it was often adjacent to a white center line. In fact, the triple line design of no-passing markings in the 1961 MUTCD (22) sandwiched a broken white center line between two solid yellow barrier lines.

The 1981 TTI study (2) asked two questions about a no-passing zone in one direction (solid yellow line adjacent to broken yellow line). The first question asked if the two-lane road was a one- or two-way road, and the second question asked if passing was permitted, and if so, from which lane. Most respondents (93 percent) recognized that it was a two-way road. However, understanding of the no-passing message was less well understood. Sixty-nine percent selected the proper lane from which passing was prohibited. Virtually all of those that viewed the film of the no-passing zone (99 percent) correctly recognized the passing restriction of the markings.

The 1981 TTI study (2) also asked two questions about a double solid yellow center line in which passing is prohibited in both directions. When shown a two-lane road with a double solid yellow center line, 92 percent stated it was a two-way road and 94 percent stated that passing was prohibited. In the film survey, 97 percent recognized the no-passing message of the pavement marking.

Two-Way Left-Turn Lane Markings

3B-12

Markings for a two-way left-turn lane were added to the MUTCD in the 1971 edition (23). They were not commonly used prior to this time. The markings consist of one-way no-passing zone markings on both sides of the turn lane.

Although they were relatively new at the time, the 1979 AAA study (3) included questions on two-way left-turn markings. In one question, drivers were placed in the lane adjacent to the left-turn lane and asked "is it legal to cross the yellow stripes" to get into the left-turn lane. Only 24 percent correctly responded that it was legal. In another question, drivers were placed in the two-way left-turn lane and asked what maneuvers were legal. Responses included "left-turn" (69 percent), "passing" (21 percent), and "right turn" (nine percent). The 1980 AAA study (4) repeated the same two questions. Responses to the question on the legality of crossing the yellow stripes were almost identical, with only 26 percent recognizing that it was legal to cross the lines. The correct response to the question about the maneuvers which could be made from a two-way left-turn lane increased to 79 percent.

The 1981 TTI study (2) included questions on two-way left-turn lane markings in both the multiple choice survey and open-ended responses to a film. In the multiple choice survey, 59 percent selected the correct response to the left-turn lane question. In open-ended response to a film, 51 percent gave a correct meaning of the markings.

TRAFFIC SIGNALS

Signals, which are addressed in Part IV of the MUTCD, include any power-operated traffic control device (other than a barricade warning light or steady burning lamp) by which traffic is warned or directed to take some specific action. The most common types of signals include traffic control, pedestrian, intersection beacons, and lane-use control, although there are also less common uses of signals.

Traffic Control Signal Indications

4B-5

Traffic signals used to control traffic at intersections are the most common form of signal. A traffic control signal has from three to five indications that display a circular or arrow indication. The arrangement of the indications within the signal is specified in section 4B-9 of the MUTCD.

The 1978 TTI study (1) contained three questions on traffic signal indications. In one question, the driver was shown a signal with a left green arrow in one signal head and a circular green indication in the two other signal heads for the approach, and the driver was asked what

should be done. The correct response (turn left, opposing traffic is stopped) was selected by 76 percent of the drivers. The second question showed a left green arrow in one signal head with circular red indications in the two other signal heads for that approach. Once again, the question asked what should be done. However, the correct response rate decreased from that of the first question to 68 percent. The picture for the third question showed a left-turn signal with a yellow arrow and asked what the yellow arrow meant. Although 45 percent selected the correct response, another 22 percent thought they could turn left quickly, and 28 percent would wait because a green light would be next which would allow them to turn.

Both of the AAA studies included questions on signal indications. The one question in the 1979 study (3) asked drivers what a left yellow arrow meant and 89 percent were able to select the correct answer "exclusive left-turn is ending." In one question in the 1980 study (4), drivers were shown a film where they were approaching a signal that was changing from green to yellow to red, and they were asked what they were supposed to do. While 71 percent knew the correct meaning of this sequence of indications, there were 22 percent who thought they could keep going and seven percent who thought they could go through the intersection after stopping and looking for a gap.

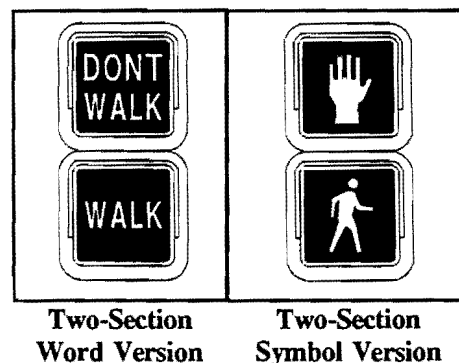
The 1981 TTI study (2) tested several signal indications. Drivers were shown a picture of a circular green and green arrow displayed simultaneously and asked what the green arrow meant. A total of 98 percent correctly recognized that the left-turn was protected. When shown a circular red displayed simultaneously with a green arrow in the multiple choice survey, 55 percent selected the correct response that the left-turn was protected. The remaining 45 percent thought that some form of wait or yield was necessary. The multiple choice survey also contained a question on a circular red with a yellow arrow. Drivers were asked what they should do when faced with these indications. Responses selected by the drivers included: "stop and wait for a green arrow" (46 percent), "stop, then proceed with caution" (21 percent), "make the turn quickly with caution" (18 percent), and "stop, then turn when no cars are coming" (13 percent).

As best can be determined from the reports, the traffic signals shown to survey participants in the studies described above did not have any signs addressing the left-turn aspects of the signal indications.

Pedestrian signals are intended for the specific purpose of controlling pedestrian traffic. Pedestrian signals are rectangular in shape and can be a one-section or two-section type. The messages **DON'T WALK** and **WALK** are the standard indications, although symbolized versions of these messages are an alternative. The **DON'T WALK** message is orange and the **WALK** message is white. These two messages are used to convey three meanings as shown in Table 2-13. The MUTCD permits a flashing **WALK** indication, but it is rarely used. The flashing **DON'T WALK** indication serves as the clearance interval for a pedestrian signal. However, its meaning is not well understood.

Table 2-13. Pedestrian Signal Indications

Indication	Display	Meaning
DON'T WALK	steady	Do not enter street.
DON'T WALK	flashing	Do not start to cross street, but if already started, complete crossing.
WALK	steady	Proceed with crossing street.



The 1978 TTI study (1) asked survey participants to select the correct meaning of the flashing **DON'T WALK** indication. While 42 percent stated that you could continue crossing if you had started, another 40 percent stated that you should return to the curb and wait for a **WALK** indication. The 1981 TTI study (2) evaluated the flashing **DON'T WALK** indication in the multiple choice survey. When given several responses from which to choose, 65 percent of the participants selected the correct answer. The study concluded that pedestrians tend to interpret the flashing **DON'T WALK** indication too cautiously.

Intersection control beacons use flashing red or flashing yellow indications to control traffic at an intersection. The flashing red indication requires a stop and the flashing yellow indicates that a driver may proceed through the intersection with caution. They are intended for use at intersections which do not justify traffic signals, but where accident rates indicate a special

hazard. There are two combinations of the colors: flashing yellow on one route and flashing red on the other, or flashing red on all approaches. Flashing yellow indications cannot be displayed to conflicting traffic. A **STOP** sign is used on every approach to which a flashing red beacon is displayed.

The 1978 TTI study (1) included one question on intersection beacons. A picture showed an intersection with a flashing yellow beacon and asked what color beacon the cross street would have. While a majority (54 percent) correctly thought that the cross street would have a red indication, sizable percentages selected incorrect responses. The possibility of a red or yellow flashing indication was selected by 26 percent and 17 percent thought the cross street would also have a flashing yellow indication.

The 1981 TTI study (2) tested both the flashing yellow and flashing red intersection control beacons in the multiple choice survey. The question on the red beacon asked for the proper response to the beacon, with 87 percent selecting the correct answer. The question on the yellow beacon asked what color the intersecting traffic would see, with 54 percent selecting the correct response. The yellow beacon was also shown in both surveys with open-ended responses. When shown a film of the signal, 98 percent of the drivers were able to give the correct driving response to the signal. When asked about the color of the beacon for intersecting traffic, 84 percent knew that it would be red.

Lane-Use Control Signals

4E-8

Lane-use control signals (LCS) are used to indicate how a specific lane should be used by traffic. They are most commonly used with reversible lanes. They are also used on freeways and high-occupancy vehicle lanes. These signals are rectangular in shape and the indications include a downward green arrow, red X, and yellow X. The indications may be in separate units or superimposed in the same unit. The forms and meanings of the indications are shown in Table 2-14.

One of the questions in the 1979 AAA study (3) showed a red X over a lane and asked if it was legal to drive in that lane. The "yes" and "no" response rates were 20 percent and 80 percent, respectively, indicating that a majority of the drivers understood the meaning of this indication.

Table 2-14. Lane-Use Control Signal Indications

Indication	Display	Meaning
Green Arrow	Steady	Driving permitted in the lane under signal.
Yellow X	Flashing	Lane under signal can be used for a left-turn and there may be oncoming traffic in the lane.
Yellow X	Steady	Driver should prepare to vacate the lane.
Red X	Steady	Driving is not permitted in the lane under the signal.

The 1981 TTI study (2) showed a film of the red X and green arrow indications, and asked drivers to give the meaning of the indications in their own words. Respondents were from areas where LCS' were not used. The correct responses were given by 51 and 55 percent for the red X and green arrow, respectively.

SCHOOL AREAS

Part VII of the MUTCD covers traffic control for school areas and addresses signs, markings, school area traffic signals, crossing supervision, and grade separated crossings. School area signs includes the signs shown in Table 2-15. The **School Advance** and **School Crossing** signs are the only warning signs to use the pentagon shape with the point up.

Table 2-15. School Area Signs

Sign Name	MUTCD Designation	Sign Shape	Sign Legend	Sign Colors
School Advance	S1-1	pentagon	symbol	black on yellow
School Crossing	S2-1	pentagon	symbol	black on yellow
School Bus Stop Ahead	S3-1	diamond	words	black on yellow
School Speed Limit	S4-1 to S4-4	rectangle	words	black on white

School Advance

S1-1

7B-9

The **School Advance** sign (S1-1) is intended for use in advance of locations where schools are adjacent to the highway or in advance of school crossings to warn drivers of the presence of school children. This sign is often confused with the **Pedestrian Advance Crossing** sign (W11-2). The sign was first introduced in the 1971 MUTCD (23). The 1948 and 1961 MUTCDs (25, 22) used a diamond shaped warning sign with the legend **SCHOOL**. The 1935 MUTCD (17) used a square sign with the sides vertical and the legend **SCHOOL**.



S1-1

One study (50) determined that, in general, drivers are not observant of this sign. Another study (38) found that there are some minor interpretation problems for this sign. Many people associate this sign with "pedestrians" and "crossings." Such misinterpretations were considered insignificant and were not thought to decrease safety.

In the 1978 TTI study (1), both the **School Advance** and **School Crossing** signs were shown together and respondents were asked about the meanings and differences of the two signs. Only 39 percent recognized that one sign is an advance warning and the other is a crossing warning. The most common misconception was evidenced in the identification of both signs as advance warning symbols.

The 1979 AAA study (3) found that only 18 percent selected the correct response ("school zone") for this sign. Two of the alternative choices were selected more often than the correct answer. "School crossing located here" was chosen by 31 percent and "pedestrian crossing" was chosen by 28 percent. A fourth choice, "school children in area" was chosen by 23 percent of the drivers. Although the AAA study classified this as an incorrect choice, it can be considered a proper interpretation of this sign. If this is done, the correct response rate to this sign increases to 41 percent.

Only 21 percent of the drivers in the 1981 TTI study (2) selected the correct response ("school advance") to this sign when the other two possible responses were "school crossing" and "pedestrian crossing." Open-ended responses were similar, with 24 percent giving a correct description of the sign when shown a picture of it, and 31 percent responding correctly when shown a film of the sign. The responses to this sign show that study participants most often confused the **School Advance** sign with the **School Crossing (S2-1)** and **Pedestrian Crossing (W11A-2)** signs.

The results of the Biotechnology study (5) indicated that respondents could not correctly identify the **School Advance** sign. In open-ended testing of the sign displayed in an in-context picture, 23 percent could correctly identify the sign.

Paniati (6) found that the **Advance School Crossing** sign had 66 percent of the responses classified as substantially correct. Of the substantially correct responses, 90 percent were "...pedestrian crossing." It is evident that many drivers do not perceive the difference between

the **Advance School Crossing** sign (S1-1) and the **Advance Pedestrian Crossing** sign (W11-2). While this in itself is not dangerous, it indicates that the sign is not getting the intended message across to the driver. The association between the pentagon shape and the school was not made. This study suggested that further educational efforts are warranted. In the Rice University study (7), 100 percent of the survey participants selected the correct response for the **School Advance** sign shown with a plaque containing the legend **SCHOOL**.

School Crossing

S2-1

7B-10

The **School Crossing** sign (S2-1) is intended for use at established crossings used by pupils going to and from school. This sign is often confused with the **Pedestrian Crossing** sign (W11A-2). When the **School Crossing** sign (S1-1) is used, a **School Advance** sign (S1-1) is erected in advance of the crossing. The only difference between the **School Advance** and **School Crossing** signs in the two lines added to the **School Crossing** sign to represent a crosswalk. This sign was first introduced in the 1971 MUTCD (23). The 1948 and 1961 MUTCDs (25, 22) used a diamond shaped warning sign with the legend **SCHOOL CROSSING**.



S2-1

In the 1978 TTI study (1), both the **School Advance** and **School Crossing** signs were shown together and respondents were asked about the meanings and differences of the two signs. Only 39 percent recognized that one sign is an advance warning and the other is a crossing warning. The most common misconception was the identification of both as advance warning signs.

The 1979 AAA study (3) found that 45 percent selected the correct meaning of this sign ("school crossing located here"), as opposed to the incorrect answers "pedestrian crossing located here" (28 percent), "school zone" (17 percent), and "school children in area" (11 percent). The Biotechnology study (5) found that 35 percent of the study participants could correctly identify this sign.

The 1981 TTI study (2) tested this sign for comprehension of the message and recognition of the sign shape. When asked to draw the shape of the sign, only 5 percent drew the correct pentagon shape. The correct response in the multiple choice survey was 50 percent. Correct response rates in the open-ended surveys were 46 percent for the picture of the sign, and 44 percent for the film. The sign was most frequently misinterpreted as a pedestrian crossing sign.

RAILROAD-HIGHWAY GRADE CROSSINGS

Part VIII of the MUTCD covers traffic control systems for railroad-highway grade crossings and includes information on signs, markings, signals, gates, and systems and devices. Railroad-highway grade crossing signs are listed in Table 2-16. There are two signs shapes among these signs which are unique to grade crossings. These shapes are the crossbuck and the circle.

Table 2-16. Railroad-Highway Grade Crossing Signs

Sign Name	Designation	Sign Shape	Sign Legend	Sign Colors	Section
Railroad Crossing	R15-1	crossbuck	words	black on white	8B-2
Number of Tracks	R15-2	plaque	words	black on white	8B-2
Exempt	R15-3	plaque	words	black on white	8B-6
Railroad Signal Malfunction	R15-4	rectangle	words	black on white	8B-4.1
Railroad Advance Warning	W10-1	circle	symbol	black on yellow	8B-3
Exempt	W10-1a	plaque	words	black on yellow	8B-6
Parallel Advance Warning	W10-2 to W10-4	diamond	symbol	black on yellow	8B-3
Uneven Tracks	W10-5	diamond	words	black on yellow	8B-3.1

Railroad Crossing (Crossbuck)

R15-1

8B-2

The **Railroad Crossing** sign (R15-1), commonly known as the **Crossbuck** sign, is used at locations where a railroad track or tracks cross a roadway. The R15-2 sign indicating the number of tracks shall be used when there are two or more tracks between the **Crossbuck** signs. The **Crossbuck** sign has been in the MUTCD since the 1935 edition (17). Until 1971, the angle in the outside quadrants of the **Crossbuck** in the national MUTCD was 50 degrees. However, the standard **Crossbuck** in Texas has always had an angle of 90 degrees between the arms.

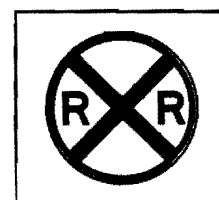


R15-1

In a study (51) of rail-highway grade crossing control devices, 76 percent correctly identified the **Crossbuck** as the device placed at the actual location of the crossing. This study indicated there is some confusion among drivers between the meanings of the **Crossbuck** and **Railroad Advance Warning** signs. Additionally, the study indicated that drivers do not associate the **Crossbuck** sign with the actual point of hazard. Similar results were found in another study of grade crossing traffic control (52), with 71 percent correctly identifying this correct location of the **Crossbuck** sign.

The 1978 TTI study (1) examined both the **Crossbuck (R15-1)** and **Railroad Advance Warning (W10-1)** signs in the same question which evaluated the relative placement of the two signs. A total of 50 percent were aware that the **Railroad Advance Warning** sign came first, and 26 percent chose the correct response that the **Crossbuck** is located at the crossing.

The circular **Railroad Advance Warning** sign (W10-1) is intended to provide drivers with advance notice of the presence of a railroad-highway grade crossing. The W10-1 sign is one of only two signs which use the circular shape, the other being the civil defense **Evacuation Route Marker (CD-1)**. The origin of this sign precedes the 1935 MUTCD (17). It has maintained its appearance since 1935.



W10-1

In one study (51), 19 percent of the drivers incorrectly identified the **Railroad Advance Warning** sign as the one placed at the crossing. This study indicated there is confusion among drivers between the meanings of the **Crossbuck** and **Railroad Advance Warning** signs. Another study (52) asked drivers to select the sign which is usually located several hundred feet in advance of a railroad crossing. While 62 percent selected the correct response, 15 percent selected the **Crossbuck**, and 19 percent selected a diamond sign with the legend **RAILROAD CROSSING**. These two studies both indicate that drivers have difficulty relating the placement of these devices to the crossing itself.

As mentioned previously, the 1978 TTI study (1) examined both the **Crossbuck (R15-1)** and **Railroad Advance Warning (W10-1)** signs in a question which evaluated the relative placement of the two signs. A total of 50 percent were aware that the **Railroad Advance Warning** sign came first, and 26 percent chose the correct response that the **Crossbuck** is located at the crossing.

The 1980 AAA study (4) found that 97 percent of drivers knew the correct response to this sign when the alternative choices did not involve another railroad choice. Therefore, this question did not test whether drivers understand the advance warning message of this sign.

As part of the 1981 TTI study (2), the research team evaluated a random sample of Department of Public Safety written driver knowledge tests and discovered that only 45 percent correctly answered the question on the **Railroad Advance Warning** sign. Of those that missed the question, 76 percent checked the response that said, "Always stop, look, and listen." As a result of this high level of misunderstanding, the sign was included in all of the surveys given in this study. The correct shape of the sign was known by 58 percent of those who were asked to draw the shape. In the multiple choice survey, only 17 percent selected the correct response, with three-fourths selecting the response that indicated a railroad crossing. In open-ended responses to a picture and film of the sign, correct responses were given by two and 33 percent, respectively.

DISCUSSION

A review of previous evaluations of driver comprehension of traffic control devices reveals that it can be very difficult to measure how well drivers understand certain traffic control devices. Some of the more significant factors which can influence the results of comprehension evaluations include the research method, the format on which the evaluation is based, the specific wording of the questions, interpretation of correct responses, the response format, the sample size, and the sample demographics. The emphasis of the evaluation or individual questions can also affect the results of the research. Results from different studies are not directly comparable to one another. In some cases, it is not even possible to compare the results of different questions in the same study.

In light of these factors, it is not surprising to find that some of the study findings described in this chapter show widely varying comprehension levels of a given traffic control device. The results of these studies must be interpreted carefully, giving consideration to the various factors which can influence the results. Even if a study finds that a particular traffic control device has a low comprehension level, this may not be sufficient justification for changing the use or appearance of the device. Corroborating findings from several studies may be needed before there is sufficient grounds for modifying the design or use of the device.

Driver comprehension of a traffic control device is only one of the factors that should be considered in an overall evaluation of the effectiveness of the device. Driver response to traffic

control devices is also an important consideration in the overall effectiveness of a device. Although a device should be understood before a driver can respond properly to it, the inverse is not always true. Drivers do not always perform the appropriate response to a device, even when they know the proper meaning of the device. A few of the other factors which should also be included in an evaluation of traffic control device effectiveness are conspicuity, recognizability, placement, cost, and maintenance.

The findings of this chapter have been used to identify those traffic control devices which may possess some degree of comprehension difficulties and specific aspects of particular devices which may not be fully understood by the driving public. This information was used in the selection of devices to be included in the survey and to identify the specific comprehension elements to address in the survey questions. The manner in which this information is used is described in the first year study report (9). The findings of this chapter also provide a useful comparison for the findings of the survey conducted for this project.

Previous research has not provided conclusive evidence that correlates driver performance or accident potential to the driver's understanding of the intended meaning of a traffic control device. During the planning stage of this project, discussions between the researchers and the Technical Panel Chairman recognized the value of being able to determine a threshold value of understanding of a traffic control device as it relates to traffic safety. However, during the course of this research, it became clear that a threshold value would have little practical use due to the complexity of the driving task, various degrees of driver experience levels, and the variability of the roadway environment. For a sign to be effective, many variables need to be considered, one of which is the actual design of the sign message. Only an experienced professional is in a position to understand the complexity of designing sign messages and it is a task that requires continuing education to state-of-the-art methods and materials.

CHAPTER 3

SURVEY METHODOLOGY AND ADMINISTRATION

The survey of motorist understanding of TCDs was conducted in 12 driver licensing stations located in six geographic regions of the State. Licensing offices were chosen as logical places to recruit drivers that represent a good cross section of demographic and socioeconomic subgroups.

The survey sample was selected such that it was representative of the driving population of the State of Texas with respect to three demographic characteristics--gender, age, and ethnicity. A representative quota sample of 2000 was targeted. The quotas were drawn from within the six geographic regions that correspond to Texas Department of Public Safety (DPS) regional boundaries. In each region the survey was conducted in a large city (over 50,000 population) and a small city (under 50,000 population). A more detailed discussion of the sampling plan is included in the Research Report No. 1261-1, "Assessment and Improvement of Motorist Understanding of Traffic Control Devices" (9).

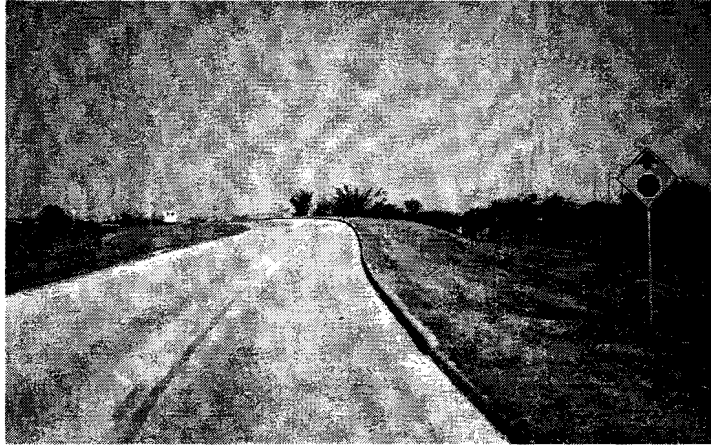
The survey instrument was a videotape presentation of 46 TCDs that was 17 minutes in length. Sixteen demographic and driving related questions were asked at the end of the videotape presentation. The questions were ordered to provide variations in the stimulus material. That is, questions about signals and pavement markings were interspersed among regulatory and warning signs.

In the presentation, each traffic control device was shown first in a photograph that was "in-context" and intended to give contextual cues that would ordinarily be present in the driving environment. A second slide followed that presented a close-up representation of the TCD along with four response choices. The questions were designed with one desirable response, two responses within the realm of possible misunderstanding, and a "not sure" response. In some cases, the "incorrect" responses contained some degrees of truthfulness. These choices were derived from previous studies, expert opinion, and confusing or conflicting information that is currently provided to motorists. Figure 3-1 illustrates the in-context and close-up photographs used in the survey question format.

Stop Ahead (W3-1a)

Two-Way Left Turn Lane Sign (R3-9b)

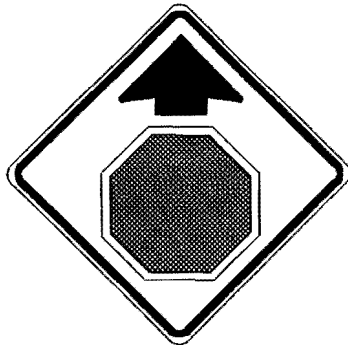
In-Context Photo



In-Context Photo

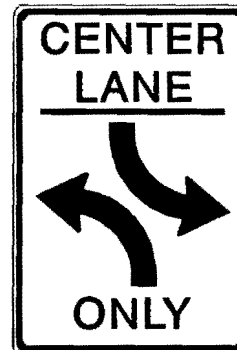


Close-Up View with Responses



1. Stop when you see this sign.
2. Be prepared for a STOP sign ahead.
3. At the next STOP sign you should go straight after you stop.
4. Not Sure

Close-Up View with Responses



1. The center lane is to be used only for making left turns.
2. You will be able to make only left turns at the next intersection.
3. The center lane is to be used only for making left and right turns.
4. Not Sure

Figure 3-1. In-context and Close-up Survey Example

Surveyors were instructed to approach potential respondents without regard to individual characteristics, in order to avoid introducing bias into the sample. The clientele of the licensing station was presumed to match regional demographics. The only screening question was to ascertain that the potential respondent was a driver.

SURVEY SAMPLE CHARACTERISTICS

The target sample size was 2,000. This sample size was determined in order to provide enough data for meaningful analysis for the various population subgroups, i.e., males, females, different age and ethnic groups, with varying levels of driving experience. The sample size achieved was 1,745. This sample size was sufficient to analyze each of the variables of interest with an acceptable level of precision.

Table 3-1 describes the sociodemographic characteristics of the survey sample. The sample was fairly evenly divided between males and females, although females were slightly under-represented in the sample (as in the driving population). The age distribution of the sample was somewhat younger than the distribution of the general population. However, the ethnic composition of the sample closely resembled the ethnic composition of the State as a whole. The sample was somewhat better educated in general. Approximately 88 percent reported English as the primary language spoken in their home. Of those whose primary language was not English, 69.2 percent spoke Spanish, 5.7 percent spoke Chinese, 4.3 percent spoke Vietnamese, 3.3 percent spoke Filipino, and 17.5 percent spoke a total of 20 other languages.

Table 3-2 describes the characteristics of the survey sample in terms of driving related variables. Respondents were asked to estimate the number of miles they drove during an average year; whether they drove primarily within city, outside city, or a combination of city and rural driving; the number of long distance trips they made per year; number of years licensed; type of driver license; if they drove on the job; type of vehicle they drove; and if and when they had taken a driver education course. The sample size generated frequencies for each of these variables that permitted analysis of the effect of these experience/exposure characteristics.

Table 3-1. Sociodemographic Characteristics of Survey Sample

Characteristic		Number	Percent	Characteristic		Number	Percent
Gender	Male	894	51.2	Age	16 - 24	455	26.1
	Female	851	48.8		25 - 64	1,202	68.9
Family Background	Anglo	1,057	60.6		65 +	88	5.0
	Black	207	11.9	Years of Education	Less than High School	282	16.2
	Hispanic	391	22.4		High School Graduate	480	27.5
	Other	90	5.2		Tech/Business School	96	5.5
English Language	Primary	1,529	87.6		Some College	433	24.8
	Secondary	216	12.4		College Graduate	303	17.4
				Total	Graduate School	151	8.7
					---	1,745	100.0

Table 3-2. Driver Characteristics of Survey Sample

Characteristic		Number	Percent	Characteristic		Number	Percent
Drive for Job	Yes	435	24.9	Driver Education	Yes	1,002	57.4
	No	1,310	75.1		No	743	42.6
Type of License	Operator	1,541	88.3	Type of Driving	Within City	930	53.3
	Commercial	204	11.7		Outside City	188	10.8
	Motorcycle	74	4.2		Both	627	35.9
Trips/Year > 300 mi	None	300	17.2	Miles Driven per Year	< 10,000	554	31.7
	1-10	1,262	72.3		10,000 - 30,000	1,074	61.6
	> 10	183	10.5		> 30,000	117	6.7
Years Licensed	No License	99	5.7	Years Since Driver Education	None	738	42.3
	< 1	88	5.0		< 1	116	6.6
	1-10	475	27.2	1-10	386	22.1	
	> 10	1,083	62.1	> 10	505	28.9	
Type of Vehicle Driven	Passenger Car	1,508	86.4	Total	---	1,745	100.0
	Pickup	205	11.7				
	Diesel	18	1.0				
	Other	14	0.8				

LIMITATIONS OF THE STUDY

Use of the survey method for assessing the communicative effectiveness of traffic control devices has several limitations. The presentation of the survey results should be read with these limitations in mind.

One limitation of the survey is related to respondent recruitment. While driver licensing (DL) offices are ideal venues for finding and questioning drivers, at least some of these drivers

may have been more prepared for driving related questions, depending on their purpose for being in the DL office on the day of the survey. The majority of the respondents were not newly licensed or recently tested. They were more often accompanying someone else doing business at the DL office or were renewing their existing license.

The survey stimulus material was auditory and the responses were verbal. This technique was employed to compensate for variations in reading ability. However, the videotape was timed such that most responses were required within three or four seconds of hearing the question. It is acknowledged that processing time varies within the population as well. A survey with unlimited response time would probably show higher comprehension levels than a survey with time limitations, as was used in this study.

The use of a multiple choice format places some restrictions on the interpretation of the survey results. Because multiple choice questions eliminate a respondent's freedom to develop their own explanation or interpretation for a device, their response is limited by the possible choices. The use of multiple choice questions may also eliminate potential areas of confusion.

Although each traffic control devices was presented in two formats (in and out of context), neither truly represented the driving environment in which the TCDs would be encountered and interpreted. The survey format is always limited to the extent that true simulation is not possible. Therefore, we cannot assume that verbal responses to simulated stimuli are necessarily equivalent to the corresponding driving response in a real-world setting.

As mentioned previously, the response choices were designed with one desirable response, two responses within the realm of possible misunderstanding, and a "not sure" response. However, the 46 TCD questions that comprised the survey were not each designed solely to determine if drivers understood the TCD message. In some cases a particular aspect of the TCD message was questioned. In some cases the question was designed to determine degrees of misinformation. In these cases, no response was absolutely correct, but a commonly held idea constituted the desired response. Some questions asked for an appropriate driving response. Some questions asked for a definition. In a few cases the intended purpose of the sign was under investigation, and was not expected to be common knowledge. Therefore, in summary, the results of this survey should not be construed as a straightforward measurement of motorist comprehension of traffic control devices.

CHAPTER 4

COMPREHENSIVE SURVEY RESULTS

For this report, the survey results are divided into two chapters. Chapter 4 is a presentation of the results for the survey in its entirety. In other words, the results of the 46 questions as a **group**, and the analysis of the sociodemographic and driving related variables in relation to the 46 questions combined are provided. Chapter 5 is a presentation of the results for each of the 46 questions.

OVERALL RESULTS

On average, the 1,745 respondents surveyed gave correct responses to 29 of the 46 questions. If the 46 questions are examined as a group (viewing the questionnaire instrument in the same manner as a "test" of knowledge), the mean score was 64.0 percent. Figure 4-1 shows the distribution of correct responses to the survey. Table 4-1 gives correct response percentages for the various types of TCDs studied.

Table 4-1. Correct Response Rates for TCD Types

Type of Traffic Control Device	No. of Devices	Percent Correct	Percent Incorrect	Percent Not Sure
Regulatory	13	63.0	31.0	6.1
Warning	16	59.7	33.2	7.1
Other Signs	4	75.3	17.6	7.1
Markings	8	67.1	23.0	9.9
Signals	5	66.2	26.6	7.2
Total	46	64.0	28.7	7.3

The single question that elicited the most correct responses pertained to the word message **REDUCED SPEED AHEAD** sign (R2-5a), with 93.2 percent selecting the correct answer. The TCD that elicited the least number of correct responses was also a word message sign, the **PROTECTED LEFT ON GREEN** signal sign (R10-9a). Only 15.5 percent of the survey respondents selected the correct answer to this sign.

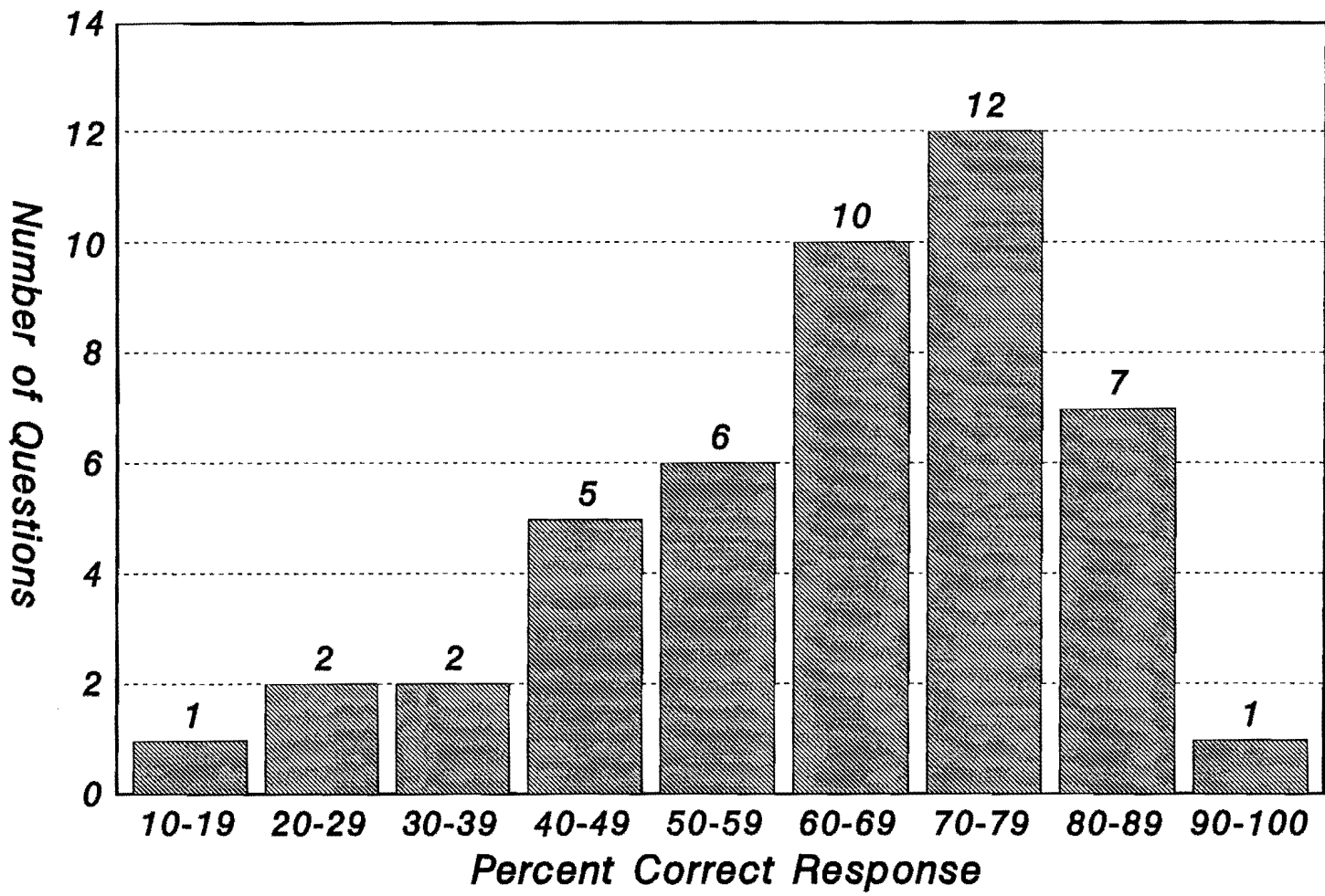


Figure 4-1. Distribution of Survey Responses

The regulatory and warning signs in the survey can be further categorized as a word or symbol legend, and some of the signs can also be classified as a particular type, such as signal regulatory signs. Table 4-2 gives the correct response percentages for each of the categories. The lowest percentage of correct responses (47.7 percent) was given for traffic signal signs that are intended to instruct motorists making turning movements at signalized intersections. These signs were each word message signs. The word message warning sign questions were answered correctly 59.4 percent of the time, while symbol message warning sign questions were answered correctly 59.8 percent of the time.

Table 4-2. Correct Response Rates for Word and Symbol Legends

TCD Category	Number of Devices	Percent Correct	Percent Incorrect	Percent Not Sure
Regulatory Signs	13	63.0	31.0	6.1
Word Message	6	69.5	22.0	8.5
Symbol Message	4	64.7	31.7	3.6
Signal Signs ¹	3	47.7	47.9	4.4
Warning Sign	16	59.7	33.2	7.1
Word Message	6	59.4	29.3	11.3
Symbol Message	10	59.8	35.5	4.6

Note: ¹ Signal signs are not included in word or symbol categories

RESULTS BY SOCIODEMOGRAPHIC VARIABLES

Figure 4-2 shows the average number of correct responses for the combined 46 questions by each of the sociodemographic variables. The figure indicates that males "scored" significantly higher than females (66 percent compared to 60 percent). Figure 4-2 shows the highest scoring age group to be 25-34 years and the lowest scoring age group to be over 75 years. Respondents over 75 years old as a group scored significantly lower than other age groups for the 46 questions as a group.

With regard to ethnicity, Anglos scored significantly better than the other three ethnic groups. And, as seen in Figure 4-2, English-speaking respondents scored significantly better than non-English speaking respondents.

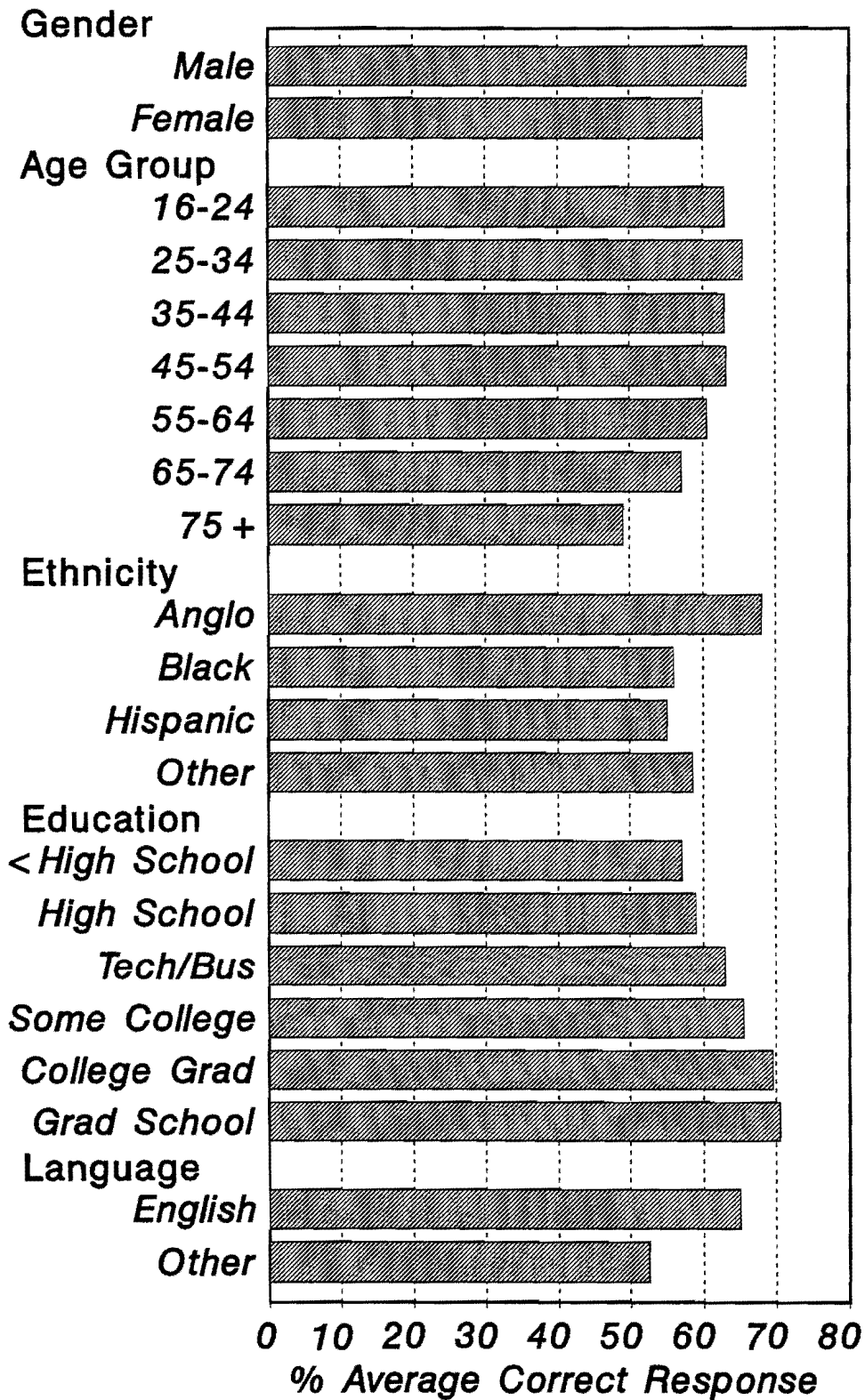


Figure 4-2. Correct Response Rates by Sociodemographic Variable

Figure 4-2 also illustrates the positive association between education and correct responses. A graduate degree was associated with a higher score than any other demographic, exposure, or experience variable.

Table 4-3 gives correct response percentages for each of the categories of TCDs studied by gender and age. Females gave a greater number of incorrect answers than males for symbol message warning signs. As noted previously, increasing age was associated with decreasing comprehension levels. However, respondents over 75 had significantly smaller correct response rates for traffic signal questions. Whereas the average percent for signals was 66.2, drivers over 75 knew only 39.0 percent of the correct answers for signals.

Table 4-3. Correct Response Rates by Gender, Age and TCD Type

Type of Traffic Control Device	Percent Correct								
	Sex		Age						
	Male	Female	16-24	25-34	35-44	45-54	55-64	65-74	75+
Regulatory Signs	65.9	59.9	61.7	65.0	64.0	62.8	61.5	57.4	52.3
Warning Signs	62.7	56.5	59.0	61.5	59.3	61.2	58.1	54.9	50.0
Word Message	62.5	55.3	59.1	60.4	59.4	60.9	52.9	57.8	50.0
Symbol Message	66.7	56.8	62.0	65.1	62.0	63.3	61.5	55.3	49.1
Other Signs	78.1	72.4	77.4	78.8	74.4	75.0	69.5	61.8	51.3
Markings	70.0	64.0	67.5	69.7	66.6	67.8	62.5	60.1	50.6
Signals	68.8	63.6	67.8	69.9	66.2	62.8	61.2	57.9	39.0
Totals	66.9	60.9	63.8	66.3	63.9	64.2	61.1	57.4	49.7

It is important to note that the sociodemographic variables illustrated in Figure 4-2 were co-variant. Specifically, there were significantly more college educated respondents in the 25 to 64 year old group than other age groups. Additionally, minority ethnic groups were over-represented in the youngest category. Anglos and the ethnic groups classified as Other were significantly more likely to be college educated than Hispanics and Blacks. As expected, ethnicity and language were highly correlated. And, education was associated with language, with a higher percentage of non-English speaking respondents who had less than high school education than English speaking respondents.

RESULTS BY EXPERIENTIAL VARIABLES

Figure 4-3 shows the average number of correct responses for the combined 46 questions by each of the driving experience/exposure variables. Respondents were asked, "Other than to and from work, is driving a vehicle a major part of your job?" Figure 4-4 shows that on-the-job driving had little effect on percentage of correct responses. However, professional drivers scored significantly higher than non-professionals, as measured by type of license and type of vehicles driven.

Figure 4-4 shows a linear relationship between estimated miles driven per year and correct response percentages. Respondents who reported they drove over 30,000 miles per year had higher scores than any other category of driving exposure or experience. This linear relationship was also evidenced between number of trips made per year (over 300 miles) and correct response percentages. Furthermore, the type of driving respondents reported had an influence on correct interpretation of the TCDs. Those who reported they drove more outside the city or combined city driving with intercity driving had a greater number of correct responses than those who reported a tendency toward limited city driving. The relationship between years of driving experience, as measured by the number of years licensed, and correct responses is also shown in Figure 4-3. Unlicensed respondents scored significantly worse than licensed respondents. In general, knowledge increased as driving experience increased.

A large difference in the percentage of correct responses was observed between those who had taken a driver education course and those who had not. As shown in Figure 4-3, driver educated respondents were correct 67.6 percent of the time, while non-driver educated respondents were correct 57.4 percent of the time. While the course itself proved beneficial, the elapsed time since taking the course did not have a diminishing effect on survey performance. In fact, those who had taken the course more than five years ago did better than those who had taken the course within the previous year.

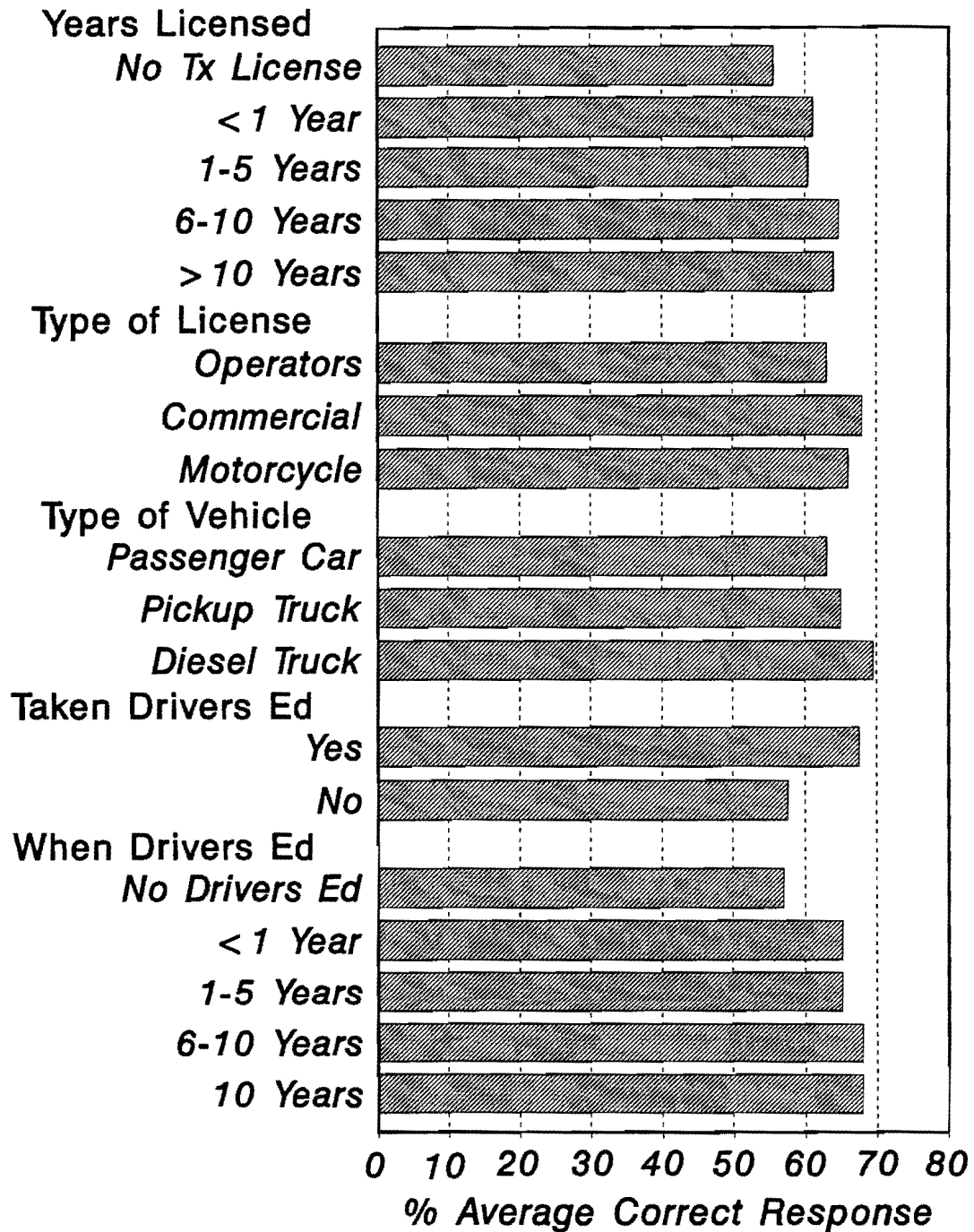


Figure 4-3. Correct Response Rates for Experiential Variables (Driving Experience)

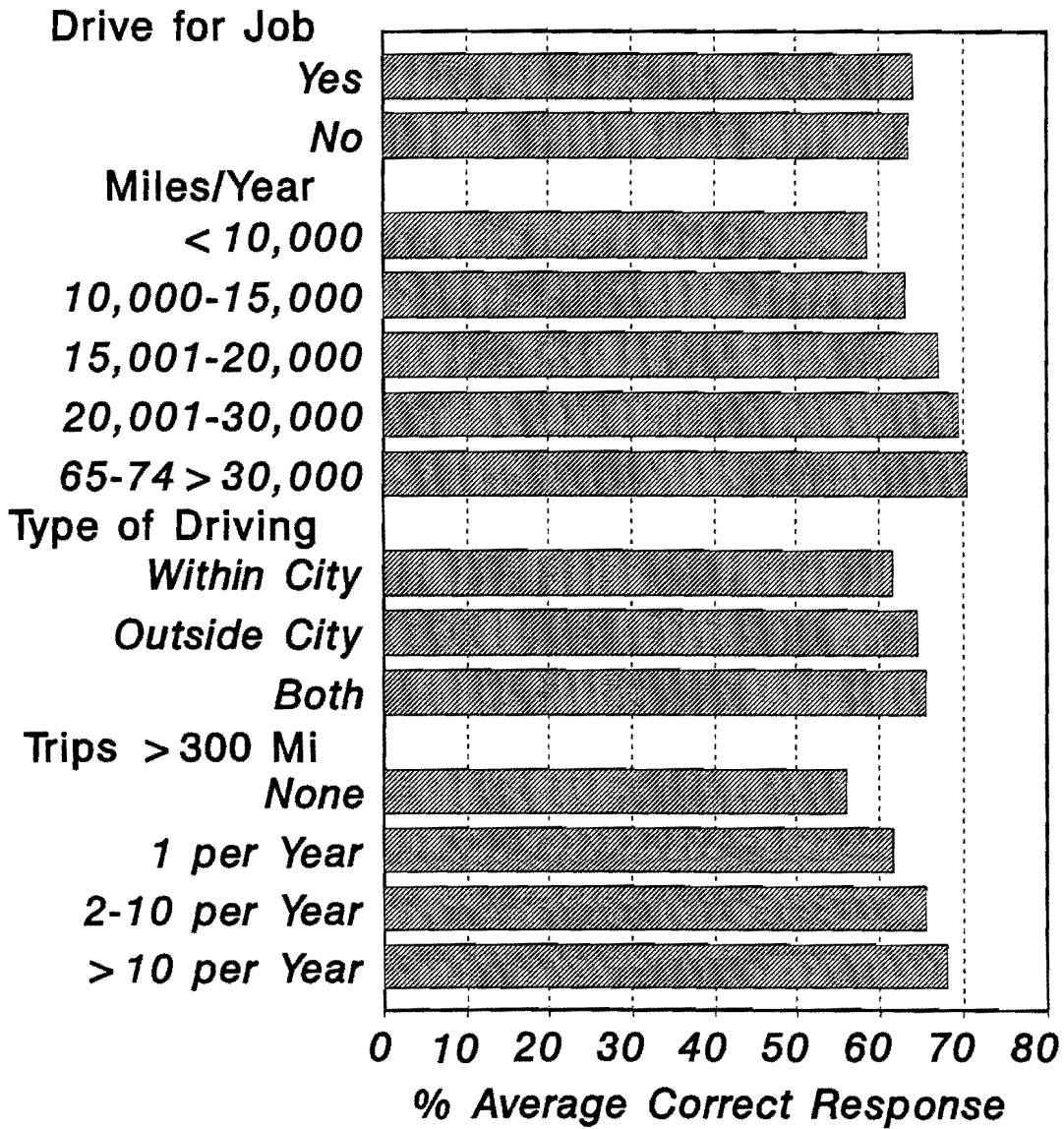


Figure 4-4. Correct Response Rates for Experiential Variables (Type of Driving)

Table 4-4 gives correct response percentages for each of the categories of TCDs studied comparing those who had taken driver education with those who had not taken driver education. While those who had taken driver education showed higher scores for each of the categories, the largest difference (14 percentage points) was observed in responses to questions regarding supplemental signal plates.

Table 4-4. Correct Response Rates by Driver Education and TCD Type

Type of Traffic Control Device	Percent Correct for Years Since Driver Education Taken				
	No Driver Educ.	< 1 Year	1 - 5 Years	6 - 10 Years	> 10 Years
Regulatory Signs	56.1	61.9	66.6	68.5	69.9
Warning Signs	54.5	63.0	60.4	63.1	65.1
Other Signs	68.1	83.8	77.7	82.3	80.7
Markings	61.0	70.5	69.0	73.8	72.3
Signals	60.5	65.0	69.6	75.4	70.7
Total	57.9	66.0	66.2	69.5	69.7

As with the sociodemographic variables, many of the driving related variables illustrated in Figures 4-3 and 4-4 were co-variant. Specifically, males were more likely than females to drive on the job, be professional drivers, drive a different type of vehicle than a passenger car, drive more miles, and make more long distance trips.

Several obvious relationships were noted with regard to age and driving experience. For example, years of driving experience was positively associated with age. As in the general driving population, the sample reported fewer miles driven and long distance trips per year among both the younger and older respondents. Commercial driver licenses were primarily held by middle aged drivers.

There were significant differences between those who did and those who did not take driver education based on age, ethnicity, education, language, miles driven, type of miles driven, number of trips per year, and how long they had been licensed. Respondents who had taken driver education were more likely to be younger, Anglo, highly educated, English speaking, drive more miles on average, take more trips on average, and be newly licensed or licensed within the past ten years. There were no significant differences between those who had and those who had not taken driver education based on gender or license type.

CHAPTER 5

DETAILED SURVEY RESULTS

In the paragraphs that follow, the results for each traffic control device studied in the survey will be presented. The results are summarized by type of TCD. For each question, the correct response is indicated by an asterisk (*). The precision of the answers to the various questions ranges between ± 1.0 percent and ± 2.0 percent, based upon a 90 percent confidence interval. Traffic control devices are listed in the order that they appear in the Texas MUTCD (10). The centered part of the heading is the sign designation, if applicable. The part of the heading to the right is the Texas MUTCD section number.

REGULATORY SIGNS

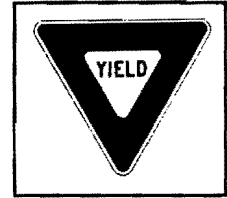
Ten of the 46 survey questions addressed regulatory signs. The TMUTCD (10) states that "regulatory signs shall clearly indicate the requirements imposed by the regulation" [emphasis added]. Table 5-1 gives the response percentages for the group of regulatory sign questions, and is followed by a description of responses for each question.

Table 5-1. Survey Results for Regulatory Signs

Sign	MUTCD Designation	Percent Correct	Percent Incorrect	Percent Not Sure
YIELD	R1-2	79.4	19.8	0.8
REDUCED SPEED AHEAD	R2-5a	93.2	5.6	1.1
SPEED ZONE AHEAD	R2-5c	55.0	37.3	7.7
Mandatory Movement	R3-7	79.5	18.9	1.6
Double Turn	R3-8	65.0	31.3	3.7
Two-Way Left Turn Lane	R3-9b	58.6	50.4	5.0
HOV Restriction	R3-14	45.7	21.1	33.2
SLOWER TRAFFIC KEEP RIGHT	R4-3	70.8	27.7	1.5
DO NOT CROSS DOUBLE WHITE LINE	R4-3B	72.6	21.3	6.1
Keep Right	R4-7	69.9	25.1	5.0
PROTECTED LEFT ON GREEN ARROW	R10-9	53.0	43.7	3.3
PROTECTED LEFT ON GREEN	R10-9a	15.5	82.2	2.3
LEFT TURN YIELD ON GREEN Ball	R10-12	74.5	17.9	7.6

What does the YIELD sign tell you?

- 15.1 You must slow down before entering the intersection.
 - *79.4 You may enter the intersection if it is safe to do so, otherwise you must stop or slow down until it is safe.
 - 4.6 You must stop at the intersection before you enter it.
 - 0.8 Not Sure
- * Correct Response



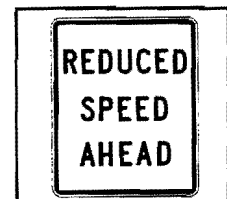
R1-2

While a majority of drivers would know this sign means to yield, it is of greater importance to determine if they know how the term "yield" applies to them as they approach it. There is some concern that, although the legal definition of yielding has not changed, the actual practice of yielding in daily driving has become more "permissive", i.e., that slowing is all that is required. For 15.1 percent of drivers, this may well be the case. However, 79.4 percent are knowledgeable about the correct response to a **YIELD** sign.

Previous research (53) has shown an over-involvement of older drivers (over 65 years) in accidents due to failure to yield right-of-way at intersections. However, the survey results did not show a significant relationship between age and misunderstanding the **YIELD** sign. Hispanics and those who reported they did not take any long distance trips were most apt to indicate that to slow down is the appropriate response to the **YIELD** sign.

What does this sign mean?

- 1.9 The speed limit will be higher ahead.
- 3.7 The speed limit ahead will be strictly enforced by the police.
- *93.2 The speed limit will be lower ahead.
- 1.1 Not Sure



R2-5a

Signs indicating a reduced speed are used when advance notice is needed to enable the motorist to comply with a posted speed a short distance ahead. Two of the three versions of the signs for reduced speed ahead were tested in this survey. The **REDUCED SPEED AHEAD** sign

had the highest correct response rate (93.2 percent) of all the 46 TCDs studied. The dramatically higher percentage of correct responses for the **REDUCED SPEED AHEAD** sign than the **SPEED ZONE AHEAD** sign suggests that the **REDUCED SPEED AHEAD** signs conveys a clearer meaning of the situation.

SPEED ZONE AHEAD**R2-5c****2B-14**

What is the meaning of this sign?

- 6.2 The speed limit will be higher ahead.
- 31.1 The speed limit ahead will be strictly enforced by the police.
- *55.0 The speed limit will be lower ahead.
- 7.7 Not Sure

**R2-5c**

Signs indicating a reduced speed zone are typically used in rural areas when advanced notice is needed to enable the motorist to comply with a posted speed a short distance ahead. The **SPEED ZONE AHEAD** sign proved inferior to the **REDUCED SPEED AHEAD** sign in conveying its intended message. A common association with the message of **SPEED ZONE AHEAD** was there is enforcement ahead (selected by 31.1 percent of the respondents). This misunderstanding was held by a significantly larger proportion of non-Anglo drivers, drivers with less than high school education, drivers who do not make long distance trips, and drivers with few years of driving experience. As respondents increased in age, so did understanding of this sign. The **SPEED ZONE AHEAD** sign had a higher percentage of "Not Sure" responses than any other regulatory sign, with the exception of the HOV Lane sign.

Mandatory Movement**R3-7****2B-17**

What does this sign mean?

- 14.0 Turn right at the next driveway if you are in this lane.
- *79.5 Turn right at the next intersection if you are in this lane.
- 4.9 You are not allowed to change lanes after you see this sign.
- 1.6 Not Sure

**R3-7**

The response choices provided for this question were designed to determine how literal this sign is interpreted. Do drivers think they must turn immediately or they have no other

immediate option but to turn? Approximately 19 percent did. By and large, these were drivers whose primary language was something other than English.

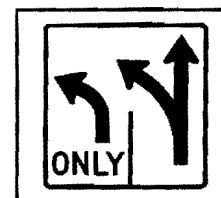
Double Turn

R3-8

2B-17

Which is the most correct statement about this sign?

- *65.0 To go straight, you must be in the lane on the right.
- 18.4 You may go straight or turn left in the left lane.
- 13.0 You must go straight if you are in the lane on the right.
- 3.7 Not Sure



R3-8

The **Double Turn** sign was not clearly understood by 35 percent of those surveyed. This sign is complicated by the several options presented with the arrows. Likewise, the responses choices required more thought than most of the other questions because options were presented contingent upon lane position. Incorrect responses were given by significantly more Hispanic drivers, drivers with less than high school education, respondents whose primary language was not English, who had not taken driver education, and drivers with little driving experience.

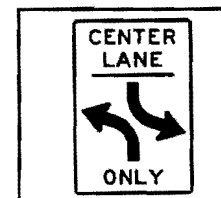
Two-Way Left Turn Lane

R3-9b

2B-19

Which one of the following statements is true when you see this sign?

- *44.6 The center lane is to be used only for making left turns.
- 6.7 You will be able to make only left turns at the next intersection.
- 43.7 The center lane is to be used only for making left and right turns.
- 5.0 Not Sure

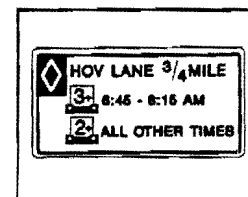


R3-9b

The correct response for the **Two-Way Left-Turn Only** sign was given by only 45 percent of the survey respondents. This sign has three components--the words "center lane," two arrows pointing in opposite directions, and the word "only." The survey attempted to determine how well drivers assemble these components into meaning an exclusive lane for left-turning vehicles. The presentation of the two arrows prompted 44 percent of the respondents to say the center lane is usable for making left and right turns. These respondents were more likely to be non-Anglo drivers with little driving experience. In post-survey interviews, several respondents immediately recognized the error in their thinking. It is not known what the effect of this misinterpretation is in the driving environment.

It is 7:30 AM, what vehicles are allowed to enter the HOV lane?

- 9.9 Carpools with 2 or more people.
- *45.7 Carpools with 3 or more people.
- 11.2 Carpools with more than 3 people.
- 33.2 Not Sure



R3-14

The **HOV Restriction** sign pictured above was presented to the survey respondents along with this question: "It is 7:30 a.m., what vehicles are allowed to enter the HOV lane?" The number of people in an allowed carpool was the source of confusion for 21 percent of the respondents. That is, 10 percent said vehicles with carpools of two or more people were allowed, and 11 percent said vehicles with carpools of more than three people were allowed. One-third of the drivers surveyed were not sure which vehicles would be allowed in the HOV lane. The drivers that were knowledgeable about this sign tended to be younger, Anglo, higher educated, English speaking respondents who had also taken driver education.

What is the meaning of this sign?

- 26.6 If you are driving slower than the speed limit, you should be in the lane on the right.
- *70.8 If you are driving slower than the other traffic, you should be in the lane on the right.
- 1.1 If you have car trouble you should pull off on the right side of the road.
- 1.5 Not Sure

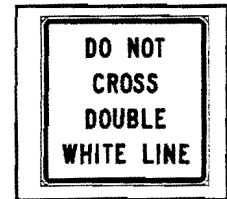


R4-3

The Texas Drivers Handbook says if you are driving slower than the normal stream of traffic, keep in the right-hand lane. The study hypothesis was that some drivers think if they are going the speed limit, they should not be considered "slower traffic." Thus, the weaving that this sign is supposed to eliminate would not be eliminated. This proved to be the case for over a quarter of the drivers surveyed. Incorrect responses were given significantly more often by those who did not speak English as their primary language. Contrary to expectation, the notion that the right-hand lane is for vehicles traveling slower than the speed limit was not associated with age.

What does the sign on the right mean?

- *72.6 Do not change lanes or turn across the double white lines.
- 9.6 Do not pass. Two-way traffic.
- 11.7 Do not change lanes.
- 6.1 Not Sure



R4-3b

The **DO NOT CROSS DOUBLE WHITE LINE** message sign is designed to inform motorists of the regulation against changing lanes or turning across double white lines. This prohibition was understood by 73 percent of the motorists surveyed. Twelve percent interpreted the sign simply as a prohibition against changing lanes, and 10 percent interpreted this sign as a prohibition against passing. Drivers over 75 years of age and Spanish-speaking Hispanics were more likely to misinterpret this sign.

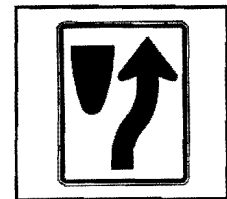
Keep Right

R4-7

2B-25

What is the appropriate response to this sign?

- 1.2 Turn right.
- *69.9 Go to the right side of this sign.
- 23.9 Stay in the far right lane.
- 5.0 Not Sure



R4-7

The **Keep Right** symbol sign is intended for use at the ends of medians, traffic islands, parkways, etc., and is not intended as a lane assignment regulation. However, 24 percent of those surveyed interpreted this sign as a directive to "stay in the far right lane." Seventy percent gave the appropriate response choice. This sign was more clearly understood by those who reported they traveled over 30,000 miles per year and by drivers with commercial licenses.

Traffic Signal Regulatory Signs

Right-of-way movements and the resultant effect on traffic flow is profoundly affected by comprehension, not only of traffic signals but also of regulatory signs that accompany traffic signals. Three of these traffic signal signs were included in the survey. Table 5-1 gives the response percentages for each.

Which one of the following statements is true with regard to a left turn at this intersection?

- 27.0 You are allowed to turn **only** when the green arrow is on.
- *53.0 You are allowed to turn when the green ball is on **if** it is safe to do so.
- 16.6 You are protected from oncoming traffic if you turn from the turn lane when either the green arrow or the green ball is on.
- 3.3 Not Sure



R10-9

The **PROTECTED LEFT ON GREEN ARROW** sign is in the Texas MUTCD but is not in the national MUTCD. Fifty-three percent recognized the ability to make a left turn when facing a green ball as well as the ability to make a protected left turn when facing a green arrow. However, 27 percent believed turns are permitted only when facing a green arrow if this supplemental plate accompanies the signal. A more serious error was committed by the 16.6 percent who believed turns are protected when facing either the green arrow or the green ball if this supplemental plate accompanies the signal. Language was the most significant variable associated with correctly identifying the meaning of this message sign.

If you want to turn left at this intersection and the green light is on, what should you do?

- 34.7 Yield to oncoming traffic. They will have a green light also.
- 47.5 Wait for a green arrow. Then turn left.
- * 15.5 Turn left. Oncoming traffic will have a red light.
- 2.3 Not Sure



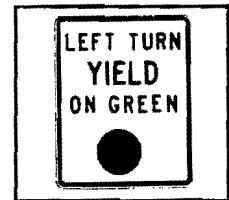
R10-9a

Like the **PROTECTED LEFT ON GREEN ARROW** sign, the **PROTECTED LEFT ON GREEN** sign is in the Texas MUTCD but is not in the national MUTCD. The survey results indicate that this sign does not effectively communicate right-of-way assignment to a large majority of drivers. Only 15.5 percent recognized that a left turn would be protected, while 47.5 percent would wait for a green arrow to provide a protected left turn. Thirty-five percent thought oncoming traffic would have a green light also. These incorrect responses were fairly

uniformly distributed across the survey population. However, respondents who had taken driver education within the past year performed significantly better on this question.

If you have a green signal, what should you do to turn left?

- *74.5 Stop and wait for a gap in traffic. Then turn left.
- 13.6 Wait for green arrow. Then turn left.
- 4.3 Turn left. Oncoming traffic will have a red light.
- 7.6 Not Sure



R10-12

The **LEFT TURN YIELD ON GREEN Ball** sign does the best job of those signs in this survey of informing the driver of a permissive left turn condition, with 74.5 percent choosing the correct response for this question. A certain percentage of respondents (13.6) would wait for a green arrow. The more dangerous interpretation was made by only 4.3 percent of the respondents (interpreting a protected left turn). Those least apt to provide the correct interpretation were over 65 years old, respondents with less than high school education, non-English speaking respondents, unlicensed drivers, and drivers who had not taken driver education.

WARNING SIGNS

Approximately one-third of the survey (16 questions) dealt with warning signs. Of these, one question specifically addressed knowledge of the shape and color of warning signs. In the next to last question in the survey, the yellow diamond shape was presented out of context and the respondent was asked, "What does a sign this shape and color mean?" Among the incorrect responses, 9.4 percent said they did not know, 12.9 percent thought the cues were for construction signing, and 19.7 percent thought they were for directions or guidance. The correct response was given by 58.1 percent of the respondents. Table 5-2 gives the response percentages for the group of warning sign questions, and is followed by a description of responses for each question.

Table 5-2. Survey Results for Warning Signs

Warning Sign	MUTCD Designation	Percent Correct	Percent Incorrect	Percent Not Sure
Warning Sign Shape & Color	—	58.1	32.6	9.4
Turn	W1-1	31.9	55.9	12.2
Curve	W1-2	32.4	66.7	0.9
Reverse Turn	W1-3	66.5	30.8	2.7
Stop Ahead	W3-1a	87.4	9.7	2.9
Lane Reduction Transition	W4-2	61.2	34.2	4.6
LANE ENDS MERGE LEFT	W9-2	64.0	28.4	7.6
Narrow Bridge	W5-2a	81.7	14.6	3.7
Divided Highway Ends	W6-2	50.7	43.7	5.6
Slow Down on Wet Road	W8-5	62.3	36.5	1.1
ROUGH ROAD	W8-8	88.7	9.7	1.7
GROOVED PAVEMENT AHEAD	W8-12	29.2	56.0	14.7
Truck Crossing	W11-10	66.1	30.7	3.2
LIMITED SIGHT DISTANCE	W14-4	44.9	40.3	14.8
WATCH FOR ICE ON BRIDGE	W19-2	84.0	13.9	2.1
RAMP METERED WHEN FLASHING	W19-3	45.7	27.5	26.8

Turn

W1-1R

2C-4

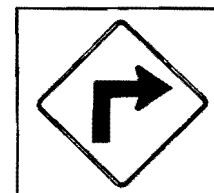
What does this sign mean?

10.7 There is an intersecting road to the right ahead.

*31.9 You should drive 30 miles per hour or less to make the next turn.

45.2 You should turn right at the next intersection.

12.2 Not Sure



W1-1R

The **Turn** sign is used where the recommended speed on the turn is 30 m.p.h. or less. This was the point emphasized in the question posed for this survey. Respondents were more likely to focus on the directional aspect of the sign than the severity aspect. This question was a confusing one to many of the respondents, as indicated by the large percentage of "Not Sure"

responses and by a number of comments made during the survey to the effect that "there is more than one correct answer" or "there is no correct answer."

Those who did have a thorough understanding of the Turn sign were more often male and more often professional drivers. Misunderstanding was not significantly related to age, ethnicity, language, education, or driver education.

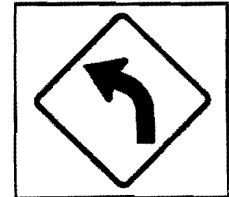
Curve

W1-2L

2C-5

How should you respond to this sign?

- 65.0 The road will curve to the left a short distance ahead and you should slow down before reaching the curve.
- *32.4 The road will curve to the left a short distance ahead, but you may drive the curve at the speed limit.
- 1.7 The next mile of highway has several curves and you should slow down.
- 0.9 Not Sure



W1-2L

This question presented the Curve sign without an Advisory Speed Plate to see if drivers recognized the speed message of the sign. The Curve sign is used where the recommended speed is greater than 30 m.p.h., a fact that is not very well known to the driving public. Those who did know it (32 percent) tended to be Anglos who had taken driver education.

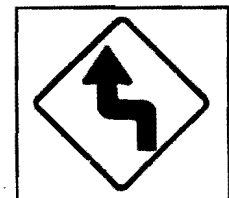
Reverse Turn

W1-3L

2C-6

What does this sign mean?

- 25.6 Winding road ahead.
- 5.3 You will make a turn to the right, then turn to the left ahead.
- *66.5 You will make a turn to the left, then turn to the right ahead.
- 2.7 Not Sure

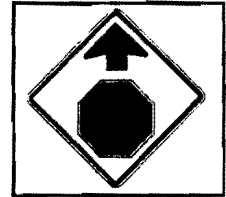


W1-3L

The directional aspect of the Reverse Turn Sign was the focus of this survey question. Two-thirds of the drivers surveyed gave correct responses. While only 5 percent selected the response that gave wrong directions, 26 percent selected the response that made no reference to directions. This was a problem in particular for female and Black respondents.

What is this sign telling you to do?

- 2.1 Stop when you see this sign.
- *87.4 Be prepared for a STOP sign ahead.
- 7.6 At the next STOP sign you should go straight after you stop.
- 2.9 Not Sure

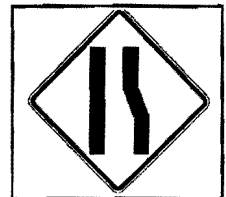


W3-1a

A vast improvement was revealed in Texas drivers' understanding of the **Stop Ahead** sign from the TTI survey (2) conducted 10 years ago. In the previous survey, 45 percent selected the third choice indicating the requirement to go straight after stopping, and 42 percent selected the correct response. Only 9.7 percent of the respondents in the current survey had a misinterpretation of the **Stop Ahead** sign.

What does this sign mean?

- *61.2 There are fewer lanes ahead and traffic on your right will move into your lane.
- 22.8 There is a one-lane road ahead.
- 11.3 There are narrow lanes ahead.
- 4.6 Not Sure

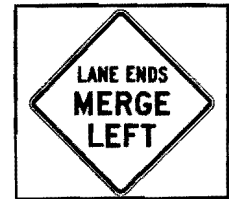


W4-2

The response choices for this question require the driver to be knowledgeable of this warning sign because the symbol could conceivably describe any of the three choices. The difference between fewer lanes, one-lane, and narrow lanes ahead was not apparent to 39 percent of the respondents. Language was a major factor in choosing the incorrect answer. Driver education was a major factor in choosing the correct answer.

What should you do in response to this sign?

- *64.0 Be aware that traffic will be coming into your lane from the right.
- 11.6 Move to the right lane.
- 16.8 Prepare to exit on the left.
- 7.6 Not Sure

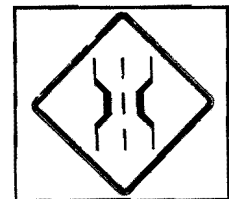


W9-2L

The correct meaning of the **LANE ENDS MERGE LEFT** was given by 64 percent of the survey respondents. Respondents were presented this sign from the perspective of the left lane. Over 11 percent thought the appropriate response for the left lane traffic would be to move to the right lane, and an additional 16.8 percent thought this lane of traffic should prepare to exit to the left. Drivers over 75 years of age and non-English speaking drivers were particularly prone to select incorrect responses for this TCD.

What does this sign mean?

- 4.2 Passing is not allowed on the bridge ahead.
- 10.4 A one-lane bridge is ahead.
- *81.7 A narrow bridge is ahead.
- 3.7 Not Sure



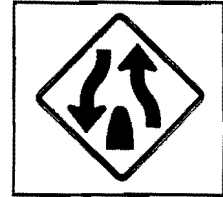
W5-2a

The **Narrow Bridge** sign has been a subject of interest in several recent motorist comprehension studies (5, 54, 55). An FHWA study (5) tested alternative designs for the **Narrow Bridge** sign, after determining that motorist understanding was deficient. A criticism of the **Narrow Bridge** sign has been that it presents a plan view that is not easy to interpret.

Given the options listed above, respondents had little difficulty determining the intended message. However, since the word "bridge" was included in each response, the level of correct interpretation of the plan drawing was not directly measured.

What is this sign telling you?

- *50.7 There is two-way traffic ahead.
- 6.0 There is one-way traffic ahead.
- 37.8 There is a divided highway ahead.
- 5.6 Not Sure



W6-2

Divided Highway Ends (W6-2) and **Divided Highway (W6-2)** signs are both commonly used, but the problem hypothesized was the interchangeability of these two signs in the minds of motorists. Earlier studies (2, 54, 56) proposed a concern that these signs may be read from top to bottom instead of from bottom to top as intended. The 37.8 percent who thought this sign meant there is a divided highway ahead may have been responding to the divided highway phrase itself, and overlooking the implication for traffic directions.

Males correctly answered this question significantly more often than females. Furthermore, the largest difference in correct responses between males and females was evidenced for this question.

What does this sign mean?

- 33.9 Be prepared for a winding road.
- *62.3 Slow down when the pavement is wet.
- 2.6 Watch for out of control vehicles.
- 1.1 Not Sure



W8-5

The **Slow Down on Wet Road** symbol sign has been included in two previous TTI studies on traffic control devices (1, 2). In the former study, 75 percent accurately interpreted the sign, and 21 percent misconstrued the sign to mean the roadway winds or curves several times. In the latter study, 81 percent correctly identified the **Slow Down on Wet Road** symbol sign, and only 16 percent misconstrued the sign to mean the road winds or curves. Using a comparable question, the current study shows a definite decline in comprehension for this sign during the 10 year interim.

As in the 1981 TTI study (2), ethnic minorities were most inclined to give incorrect and "Not Sure" responses. However, correct answers were not associated with the language variable. Commercial drivers were significantly more knowledgeable of the meaning of this sign. Driver education was not significant for comprehension of the **Slow Down On Wet Road** sign.

ROUGH ROAD

W8-8

2C-30.2

What is the purpose of this sign?

- 7.2 To let motorcyclists know they should use caution.
- 2.5 To let motorists know the road will be noisier ahead.
- *88.7 To let motorists know the pavement is in poor condition.
- 1.7 Not Sure



W8-8

The **ROUGH ROAD** sign had the highest correct response rate of all the warning signs in the survey. It is worth noting that the first two "incorrect" responses have some degree of truthfulness in them. The **ROUGH ROAD** sign was fairly well understood by everyone except respondents who classified themselves in the "Other" ethnic group and who did not speak English as their primary language.

GROOVED PAVEMENT AHEAD

W8-12

2C-30.5

What is the purpose of this sign?

- 16.5 To let motorists know the road will be slippery when wet.
- 39.5 To let motorists know the road will be noisier ahead.
- *29.2 To let motorcyclists know they should use caution.
- 14.7 Not Sure

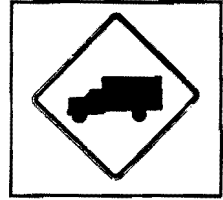


W8-12

Drivers were asked to choose the response that describes the purpose of this sign. While the first and second options may be true conditions, they do not accurately define the purpose of the **GROOVED PAVEMENT AHEAD** sign. Drivers most frequently associated increased noise with grooved pavement. The 29 percent who did know the purpose of the grooved pavement sign were more often under 25 years old, in the ethnic group classified as "Other," spoke a language other than English as their primary language, had no operator license, but had a motorcycle license.

What does this sign mean?

- 2.0 Be prepared for fire trucks entering or crossing the roadway in this area.
- 28.7 This is a warning that this road is heavily used by large trucks.
- *66.1 Be prepared for trucks entering or crossing the roadway in this area.
- 3.2 Not Sure

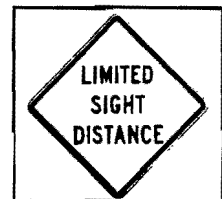


W11-10

The warning that is important to communicate with this sign is that trucks may enter or cross the roadway on which the motorist is driving. This warning was correctly understood by 66 percent of the survey respondents. Not surprisingly, a driver characteristic that was significantly associated with knowledge of this TCD was having a commercial driver license.

What is the purpose of this sign?

- 31.7 To warn drivers that shadows make it difficult to see cars coming from the other direction.
- *44.9 To let drivers know they should be prepared to stop with little warning.
- 8.6 To let drivers with eyesight problems know they should use caution in this area.
- 14.8 Not Sure

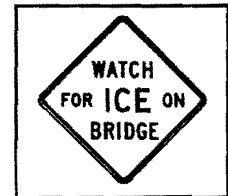


W14-4

Drivers were asked to identify the purpose of the **LIMITED SIGHT DISTANCE** sign. Less than half (45 percent) correctly interpreted this warning. Almost one-third perceived the message as one of a temporary condition (i.e., the presence of shadows). And a relatively large percentage of the respondents (15 percent) were not sure of the meaning of this sign. Drivers with significantly greater percentages of correct responses were 45 to 54 years old, college educated, Anglos who drive over 30,000 miles per year, take more than 10 long distance trips per year, have been driving more than 10 years, and have a commercial driver license.

When you see this sign, what should you do?

- 2.5 Don't drive on the bridge if there is ice on it.
- 11.5 Slow down and gently apply the brakes while you are on the bridge.
- *84.0 Slow down, don't brake or make sudden turning movements on the bridge.
- 2.1 Not Sure

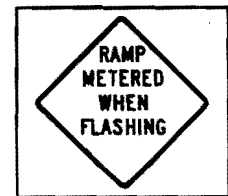


W19-2

The message conveyed by the words on this sign seem obvious. However, other than watch for ice, what would motorists think is an appropriate driving response? The majority (84 percent) did know the appropriate response, but 11.5 percent thought that brakes should be applied. The most significant effect on understanding this sign was language. Those that did not speak English as their primary language were most apt to misinterpret the sign.

What does this sign mean?

- *45.7 When the yellow lights are flashing, a traffic signal at the entrance to the freeway is in use.
- 19.9 Only a certain number of cars are allowed on the ramp when the yellow lights are flashing.
- 7.6 You must pay a toll to use the freeway entrance ramp.
- 26.8 Not Sure



W19-3

A metered ramp is a relatively rare encounter for most drivers throughout the State. Therefore, for many of the respondents the survey measured interpretation based solely on comprehensibility rather than previous experience. The novelty of this sign as a TCD no doubt accounts for a portion of the 26.8 percent "Not Sure" responses. Fewer than half of the respondents knew the meaning of this warning sign. Drivers that knew the meaning of the sign tended to be from urban areas and had commercial or motorcycle driver licenses.

OTHER SIGNS

Four survey questions addressed other types of signs. There was one question on guide sign color, one question on a school speed limit sign, and two questions on railroad advance warning signs. Table 5-3 gives the response percentages for these sign questions, and is followed by a description of responses for each question.

Table 5-3. Survey Results for Other Signs

Other Sign	MUTCD Designation	Percent Correct	Percent Incorrect	Percent Not Sure
Guide Sign Color	2A-11	75.1	10.5	14.3
School Speed Limit	S5-1	79.0	16.2	4.8
Railroad Advance Warning	W10-1	77.8	20.9	1.3
Parallel Railroad Advance Warning	W10-3	69.3	22.6	8.1

Guide Sign Color

2A-11

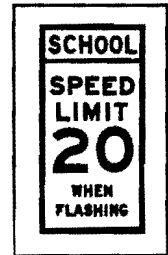
What is a sign with a green background used for?

- *75.1 To provide directions or guidance.
- 7.6 To provide general warnings to drivers.
- 2.9 To provide warning for construction areas.
- 14.3 Not Sure

A green rectangle was presented out of context and respondents were asked, "What does a sign this shape and color mean?" Fourteen percent were not sure, 3 percent thought the green rectangle was used to provide warning for construction areas, and 7.6 percent thought they were used to provide general warnings to drivers. Seventy-five percent of the respondents gave the correct response. Drivers over 65 were particularly apt to miss this question, as were those whose primary language was not English, and respondents who had not taken driver education.

At what point can you speed up again after passing this sign?

- 5.7 After you cross the school crosswalk.
- 10.5 After you go past the block of the school building.
- *79.0 When you see a Speed Limit sign.
- 4.8 Not Sure

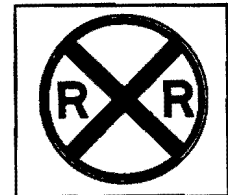


S5-1

While the regulatory speed limit message of this sign would seem obvious, a less obvious factor associated with this sign is its effectiveness for the intended range of the school speed limit. Respondents were asked at what point they would resume their prior speed. Seventy-nine percent correctly answered "when you see a **Speed Limit** sign." Ten percent said they would resume prior speed after the block of the school building, and six percent said after the crosswalk.

What is the purpose of the sign on the right of the roadway?

- 17.4 To let you know you are at a railroad crossing.
- *77.8 To let you know you will cross railroad tracks ahead.
- 3.5 To let you know there are two railroad tracks ahead.
- 1.3 Not Sure

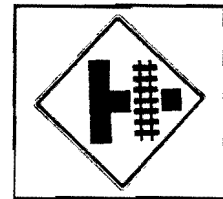


W10-1

A common problem associated with the **Railroad Advance** warning sign is the failure to recognize the advance nature of the circular sign (as compared to the on-site characteristic of the **Crossbuck**). This problem was measured in the 1981 TTI study (2) using a similar question to the current study. In the previous study, 17 percent of the respondents correctly identified the **Railroad Advance** sign, while 82 percent gave a response that indicated an on-site sign. The findings in this study show a reversal in the interpretations. Seventeen percent believed this sign would be located at the railroad crossing, and 78 percent correctly recognized that the sign indicates railroad tracks ahead. Understanding of this sign was positively associated with driver education and negatively associated with age. Driver education resulted in a 12.5 percentage point improvement in performance. Respondents in the 16 to 24 year age group selected the correct response 83 percent of the time, while those in the over 75 year age group selected the correct response only 45 percent of the time.

What does this sign mean?

- 0.9 If you turn onto the side road, you will cross a gravel road.
- 21.7 You will cross a railroad track, then come to an intersection ahead.
- *69.3 If you turn onto the side road, you will cross a railroad track.
- 8.1 Not Sure



W10-3

The confusing aspect of the **Parallel Railroad Advance** warning sign for 21.7 percent of the survey respondents was driver orientation. Those who selected the second response would assume the driver facing this sign would be on the secondary, intersecting roadway. A relatively large number of drivers were not sure of the correct response. Language and Driver Education were key variables associated with interpreting this symbol sign.

MARKINGS

Eight of the 46 questions dealt with markings, of which seven dealt with pavement markings. The average percent of correct responses to the seven pavement marking questions was 67.8. Table 5-4 gives the response percentages for each of the marking questions, and is followed by a description of responses for each question.

Table 5-4. Survey Results for Pavement Markings

Pavement Marking	Percent Correct	Percent Incorrect	Percent Not Sure
Single Broken Yellow Center Line	76.8	20.4	2.8
Two-Way Left Turn Lane Markings	58.6	33.8	7.6
Single Broken White Lane Line	50.3	46.4	3.3
Double Solid White Lane Line	61.0	29.0	10.0
No-Passing Zone	88.0	9.0	3.0
Solid White Edge Line	74.7	20.0	5.3
Preferential Lane Marking	65.3	6.8	27.9
Type 3 Object Marker	61.9	18.7	19.4

Which one of the following statements is true about the dashed yellow center line?

- *76.8 This is a two-way road where you are allowed to pass.
- 12.2 This is a two-way road where you are not allowed to pass.
- 8.2 This is a one-way road where you are allowed to change lanes.
- 2.8 Not Sure

While almost 77 percent of the respondents correctly identified the broken yellow center line as a two-way road where passing is allowed, over 12 percent thought that passing was not allowed. Although the passing distinction was not made by this group, a total of 89 percent of the respondents recognized the two-way characteristic of the broken yellow line. A relatively small percent was not sure of the correct response, and the most erroneous response choice was selected by over eight percent of the drivers surveyed. Respondents who had taken a driver education course were far more likely to answer this question correctly than respondents who had not taken a driver education course.

Two-Way Left Turn Markings

How do you use this center lane?

- 26.2 Get into this lane at the point where you are ready to turn left.
- *58.6 Get into this lane when you need to slow down in order to turn left.
- 7.6 Get into this lane when you need to speed up in order to move into the traffic lane.
- 7.6 Not Sure

The question that accompanied these response choices was, "How do you use this center lane?" Technically, it is not completely clear which answer is correct. The Texas MUTCD (10) states that this lane is "for exclusive use of left turn vehicles and **shall not be used for passing and overtaking or travel by a driver except to make a left turn**" [emphasis added]. The *Texas Driver Handbook* (57) specifies that the center lane should not be used as a travel or passing lane, but also says "the only time a vehicle should enter the center lane is at a point where the vehicle will have time to **slow down or stop** in order to make a safe left turn" [emphasis added]. For survey tabulation purposes, the second response was considered the preferred response, while the first response was considered second best. Since the question

asked was "how do you use the center lane," the respondents were told (if they asked) that there was no incorrect response, but that the second response was a desirable response.

Of interest was the percentage of drivers who use the center turn lane as an acceleration lane. This response is the least desirable driving response, and was given by 7.6 percent of the survey respondents. Another 7.6 percent were not sure how the lane should be used.

The ambiguity surrounding this question (and the fact that 59 percent of drivers would use this lane to decelerate) points to a need for clarification. According to DPS representatives on the study advisory panel, driving violations with respect to two-way left turn lane markings are apt to be enforced according to varying interpretations. Due to the great degree of confusion surrounding it, this pavement marking warrants further study.

Single Broken White Lane Line

3B-2

Which one of the following statements is true about the dashed white line?

- *50.3 This is a one-way road where you are allowed to change lanes.
- 4.2 This is a one-way road where you are not allowed to change lanes.
- 42.2 This is a two-way road where you are allowed to pass.
- 3.3 Not Sure

Just over half of the respondents recognized the one-way designation of the white lane line. However, a large percentage (42 percent) responded that the white lane line indicated a two-way road. In this case the broken lane line effectively communicates the ability to change lanes or pass, but does not effectively communicate directional information. An important variable associated with a correct response was driver education. Additionally, a linear relationship between age and correct responses was observed. Respondents under 25 answered this question correctly 65 percent of the time while respondents over 75 answered correctly 10 percent of the time. The lower levels of comprehension associated with older drivers may be attributed to the fact that a broken white line was used as a center line until the 1971 MUTCD (23) was published.

Which one of the following statements is true about the double white lines on the pavement?

- *61.0 It is illegal to change lanes across these lines.
- 22.1 You may change lanes across these lines with caution, if necessary.
- 6.9 You may change lanes across these lines from left to right, but not from right to left.
- 10.0 Not Sure

Thirty-nine percent of the drivers surveyed either considered it permissible to change lanes across double solid white lane lines (29 percent) or were not sure if changing lanes is permitted (10 percent). The fact that 61 percent of the respondents answered this question correctly is actually somewhat positive, given that the *Texas Drivers Handbook (57)* (the Handbook upon which driver certification tests are based in Texas) does not specifically address double solid white lines. The Handbook illustrates the solid white line and describes its purpose to include channelizing, transitions, and lane use control. The Handbook specifies that "crossing a solid white line should be avoided if possible." The in-context presentation used in the video survey portrayed a channelizing use of the double solid white lane lines. Therefore, some confusion may be explained by the similarity of use to the single solid white line and the lack of information available regarding double solid white lane lines. Respondents with college degrees were far more likely to choose the correct response. Driver education was not a significant variable for this pavement marking.

If you are traveling in the right lane, which of the following statements is true about the center line?

- 5.8 This is a two-way road where you are allowed to pass.
- *88.0 This is a two-way road where you are not allowed to pass.
- 3.2 This is a one-way road where you are allowed to change lanes.
- 3.0 Not Sure

No-passing zone markings were the most understood pavement markings surveyed. Very few respondents (3.2 percent) confused the roadway with a one-way road, and very few (3.0 percent) were not sure of the meaning of this marking.

What is the purpose of the solid white line on the right side of the roadway?

- 9.6 To let you know there is no curb on this road.
- 10.4 To let you know that you should not cross this line for any reason.
- *74.7 To let you know where the edge of your driving path is.
- 5.3 Not Sure

The purpose of the question concerning the solid white edge line was to determine the number of drivers who mistakenly believe that it represents something other than the edge of the driving path. This belief was held by 20 percent of those surveyed. It is important to know what expectations are held when the solid white edge line is not present. The survey indicates that approximately 10 percent may expect a curb to be present. Another 10 percent may think driving beyond the pavement edge is permitted in the absence of the solid white edge line. These are assumptions based on incorrect responses and would be better tested with directly related questions. Furthermore, a significantly correlated sociodemographic variable was language. To a driver whose primary language is not English, the responses provided may seem similar or at least in some ways redundant.

Why is the white diamond painted on the pavement?

- 4.3 This is a symbol used for aircraft speed control.
- *65.3 This lane is to be used only by certain vehicles.
- 2.5 This is a two-way road.
- 27.9 Not Sure

The diamond preferential lane marking was included in the survey to determine the familiarity and comprehension level of Texas motorists statewide with a marking used only on select freeways in the State. Indeed, a large percentage (28) of respondents were not sure of the meaning of this marker. Incorrect and "Not Sure" responses were more often given by respondents residing in the smaller cities of the sample. Many commented that they had never seen this marking. Correct responses were given more often by drivers in Houston, Dallas, and San Antonio. Other driver characteristics that were associated with knowledge of the diamond preferential lane marking were those with high levels of education, males, and those who had

taken driver education. Unfamiliarity with this traffic control device was more prevalent among those with lower levels of driving exposure, i.e., those who drove fewer miles per year, made fewer long distance trips per year, and had no license.

Type 3 Object Marker

OM-3R

3C-1

What does this marker tell you?

- 14.8 You should reduce your speed.
- *61.9 There is something at the edge of the roadway you should avoid hitting.
- 3.9 You should drive to the right edge of this post.
- 19.4 Not Sure



A right side Type 3 Object Marker sign was presented, and 62 percent of the drivers surveyed made a correct response choice. Four percent incorrectly thought drivers should drive to the right. Fifteen percent thought the intent of the marker was to instruct drivers to reduce their speed. Over 19 percent of the respondents were simply not sure of the purpose of this marker. Those least apt to know the purpose of the Type 3 Object Marker were ethnic minorities, unlicensed drivers, and persons who drive fewer miles per year and do not travel long distances.

SIGNALS

Table 5-5 gives the response percentages for the five survey questions which addressed signal indications. A detailed description of responses for each question follows.

Table 5-5. Survey Results for Signals

Signal	Percent Correct	Percent Incorrect	Percent Not Sure
Yellow Arrow - Traffic Signal	80.4	13.2	6.4
Flashing Yellow Ball - Traffic Signal	80.7	18.1	1.2
Flashing Red - Intersection Beacon	41.1	54.8	4.1
Flashing Yellow - Intersection Beacon	54.0	40.8	5.2
Steady Red X - Lane-Use Control Signal	74.9	6.1	19.0

What does it mean when the yellow arrow is on?

- 6.1 You should not enter the intersection.
- 7.1 Your time to turn is about to begin.
- *80.4 Your time to turn is about to end.
- 6.4 Not Sure

The transition from green to yellow to red is carried over conceptually in the treatment of arrows. This concept was recognized by a majority of the drivers surveyed (80 percent) who indicated the end of a turn phase as the meaning of a yellow arrow.

You are approaching a blinking yellow signal, how should you respond?

- 9.3 Treat the intersection as if it has a stop sign.
- 8.8 Stop. Wait for the light to turn green.
- *80.7 Go through the intersection with caution.
- 1.2 Not Sure

The concept of yellow as caution is relatively effectively communicated, even in the flashing mode for signals. Approximately 81 percent of the survey respondents knew the appropriate response to a Flashing Yellow Ball.

If your direction of travel faces the blinking red light, what color light would the intersecting traffic see?

- 13.8 Blinking red
- 41.0 Blinking yellow
- *41.1 Either red or yellow, depending on the intersection.
- 4.1 Not Sure

Intersection control beacons were surveyed in terms of the driver expectancy of right-of-way assignment. The survey did not address the question of whether or not the driver knew the correct response to a flashing red beacon. Rather, the question that was posed was "what color light would intersecting traffic see?" The responses given show a great degree of unfamiliarity with the color combinations on beacons. The 41 percent who thought intersecting traffic would see yellow were erring on the side of caution. However, the 14 percent who thought intersecting traffic at a flashing red beacon would also always see a flashing red beacon failed to know a critical right-of-way assignment. These mistakes were more often made by the youngest (under 25) and the oldest (over 75) drivers surveyed. Education was also a factor, i.e., those with less than high school education were incorrect more often. Additionally, respondents whose primary language was not English and those with fewer years of driving experience were less likely to give the correct response.

Flashing Yellow Intersection Beacon

4B-5

If your direction of travel faces the blinking yellow light, what color light would the intersecting traffic see?

- *54.0 Blinking red
- 14.1 Blinking yellow
- 26.7 Either red or yellow, depending on the intersection.
- 5.2 Not Sure

As with the Flashing Red Beacon, the question that was posed for the Flashing Yellow Beacon was "what color light would intersecting traffic see?" Again, a significant amount of ignorance is evident in the distribution of responses. The driving response that results from believing intersecting traffic may also face a yellow beacon would presumably be to come to a stop. While this constitutes an error on the side of caution in relation to intersecting traffic, the risk of rear-end collisions is increased for those who are familiar with color combinations on beacon signal faces. Familiarity with the opposing color for the Flashing Yellow Beacon was particularly low amongst drivers over 75 years of age and respondents who classified themselves in the "Other" ethnic category.

What does the red X signal mean?

2.2 Stop here.

*74.9 Do not drive in this lane.

3.9 This is a signal for buses.

19.0 Not Sure

Lane-use control signals are currently used in several urban areas in Texas, and their use is expected to increase. This survey question was an endeavor to determine the response to a lane use control by drivers throughout the State who have had varying amounts of exposure to them. The responses indicate that three quarters of Texas drivers would make an accurate interpretation of the signal. Incorrect and uncertain responses were more often given by drivers over age 75 and by Hispanics.

CHAPTER 6

SUMMARY AND CONCLUSIONS

A video survey of 1,745 Texas drivers assessed understanding of 46 traffic control devices. The findings for each category of traffic control device are summarized in the following paragraphs.

REGULATORY SIGNS

The survey revealed that the intended message of a lower speed limit was received by drivers more often when the **REDUCED SPEED AHEAD** sign was presented than when the **SPEED ZONE AHEAD** sign was presented. Almost 80 percent of the respondents selected appropriate driving responses to the **YIELD** and **RIGHT LANE MUST TURN RIGHT** word message signs. The **SLOWER TRAFFIC KEEP RIGHT, DO NOT CROSS DOUBLE WHITE LINE**, and **Keep Right** signs each received correct responses by a "passing" 70 percent of the drivers surveyed. Messages that involve a decision using left/right choices or choices of contingency appear to be more complicated to drivers. Correct responses fell to 65 percent for the **Double Turn** sign and 45 percent for the **Two-Way Left Turn Only** sign. These lower percentages may be a function of the measurement format, as evidenced by correlations between education, language, and correct responses. The **HOV Restriction** sign question was not answered correctly by the majority of the drivers surveyed.

Traffic Signal Signs

The survey results indicate the **LEFT TURN YIELD ON GREEN** Ball sign does the best job of informing the driver of a permissive left turn condition, with 74.5 percent choosing the correct response for this sign, compared to 53 and 15.5 percent for the **PROTECTED LEFT ON GREEN ARROW** and **PROTECTED LEFT ON GREEN** signs, respectively. The **PROTECTED LEFT ON GREEN** sign was especially confusing to drivers, as 35 percent indicated the sign meant yield the right-of-way to oncoming traffic when the signal is showing a green ball, and 47 percent indicated a green arrow for left turn would follow. No particular driving or demographic characteristic emerged as more important than others in their association with correct responses to this TCD, primarily because incorrect responses were somewhat universal. The other two signal signs were especially confusing for older respondents, drivers whose

primary language was not English, unlicensed drivers, and drivers with less than high school education.

WARNING SIGNS

The warning signs included on the survey represent a variety of conditions and hazards, some of which are very common and some of which would seldom be encountered by many Texas drivers. Thus, a wide range of correct response levels was obtained for the group of warning signs.

The results for several symbol signs suggest that supplemental message plaques may improve the effectiveness of these signs. The **Slow Down On Wet Road**, **Lane Reduction Transition**, **Divided Highway Ends**, and **Truck Crossing** signs were each correctly responded to by less than two-thirds of the drivers surveyed. On the other hand, the **LANE ENDS MERGE LEFT** sign may be improved by the development of a new sign to convey its meaning, as only 64 percent correctly interpreted the word message.

Lack of knowledge concerning the recommended speeds for **Curve** versus **Turn** signs indicate that advisory speed plates should accompany these signs. Although an advisory speed plate is currently mandatory for the **Curve** sign when the curve requires a speed lower than the posted speed, the survey points to the need to extend this requirement to **Turn** signs as well.

Many of the driver and background characteristics had a statistically significant relationship with the responses to the warning signs. In looking at all these relationships, two major themes emerged. Older drivers (primarily over 75) tend to have more problems than other drivers with the interpretation of symbol signs. And respondents whose primary language is not English tend to have more problems than other drivers with word message signs.

OTHER SIGNS

A greater proportion of survey respondents (75 percent) knew that green represented a guide sign than knew the yellow warning code (58 percent). However, 14 percent were not sure of the intent of green, rectangular signs. Drivers continue to equate the **Railroad Advanced**

Warning with an on-site warning. Orientation is also a problem for the **Parallel Railroad Advanced Warning** sign.

The survey indicated that 21 percent of drivers do not know the distance they are required to maintain a lowered speed beyond a **School Speed Limit** sign. Over 16 percent would use a landmark other than a posted speed from which to resume speed.

MARKINGS

Of the pavement markings examined in this survey, No Passing Zone markings received the highest percentage of correct responses. While 89 percent of the drivers surveyed associated yellow pavement markings with two-way traffic, white pavement markings were not viewed as an indication of one-way traffic by 42 percent of the survey respondents. Double solid white lines did not communicate prohibitory crossing to the majority of the survey respondents.

With regard to driver characteristics that were associated with knowledge of pavement markings, age appeared to be a variable of importance. Overall, older drivers had lower percentages of correct answers to each of the pavement marking questions, with one notable exception. More older drivers knew that the solid white edge line marked the edge of the driving lane. The driver education variable had an important effect on knowledge of the difference between yellow and white dashed center lines.

SIGNALS

The survey revealed that many motorists were often incorrect or not sure of the signal face indications on intersection beacons for intersecting traffic. Of special concern were the 14 percent who maintained that beacons always flash red to both directions. Yellow indications on traffic signals were reasonably well understood by the majority of drivers surveyed. Furthermore, the steady red X indication for a lane-use control signal was interpreted correctly by 75 percent of the respondents.

In general, flashing signal indications (red and yellow beacons and yellow ball) were more problematic for novice drivers. Those with no license or who had been licensed for less than

one year were well below average for correct responses. Hispanics and Other ethnic groups were well below average in response to flashing beacons. The yellow arrow and red X were particularly problematic for drivers over 75 years of age. The average percent correct for the yellow arrow question was 80, and the average for the red X question was 75. Drivers over age 75 averaged 35 and 25 percent correct, respectively.

FUTURE RESEARCH EFFORTS

A primary objective of the survey technique was problem identification. The survey results suggest that accurate driver interpretation of some traffic control devices could be improved. Further study plans include determining methods to improve message effectiveness. A variety of approaches can be considered to improve traffic control device effectiveness. These include changes in design and application of traffic control devices, enhancement of educational information provided to drivers, and perhaps changes in policy regarding funding at the State level for driver education in the public school system. These approaches will be studied in greater detail during the third phase of this research.

Additionally, the third phase will include further in-depth analysis of selected traffic control devices from this and other studies. This in-depth analysis will again utilize an interactive approach with Texas drivers, either through in-depth interviews, structured response questionnaires, or focus group techniques. A study plan will be developed during the early stages of the third research phase. The objective will shift from problem identification for a broad range of traffic control devices to investigative analysis of solutions.

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APPENDIX A
SURVEY SUMMARY

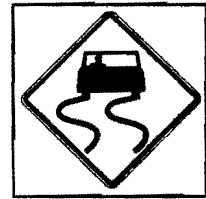
This appendix contains the survey questions in the order in which they were given in the survey along with the response percentages for each question. The traffic control device name, sign designation (if the device is a sign), and Texas MUTCD Section number are given for each question. However, this information was not a part of the survey. An asterisk is used to indicate the correct response for each question.

The paragraph below was read to survey participants at the beginning of the survey.

In the survey you are about to take you will be shown an assortment of signs, signals, and markings that are frequently on or near the streets and highways of Texas. For each one, two pictures will be given. The first picture will have the sign, signal, or marking as it is seen on the road. The narrator will tell you what you should be looking for in the picture. The next picture will be a close-up of the sign, signal, or marking, and four possible answers on it. One of the four answers is "not sure". If you are unsure of the correct response, or are undecided between two responses, then "not sure" is the correct response. This is not a test in which there is always just one right answer. Sometimes you will be asked what you would do in response to a sign and your answer would not be considered right or wrong. As each question is read, call out the answer you choose and I will enter it for you. Choose only one answer. If you have a question or comment about any question during the survey, let me know and I will make a note of it as we go along. We will go back to that question when the tape is over. You should not fast-forward or reverse the tape. At the end of the survey, I will ask you some specific questions about such things as your age, education, and driving experience, which will all be confidential.

1. **Slow Down on Wet Road** sign (W8-5), TMUTCD Section 2C-30
What does this sign mean?

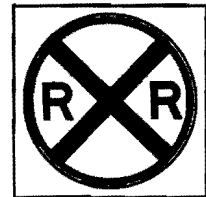
- 1) 33.9% Be prepared for a winding road.
- 2)* 62.3% Slow down when the pavement is wet.
- 3) 2.6% Watch for out of control vehicles.
- 4) 1.1% Not Sure



W8-5

2. **RR Advance Warning** sign (W10-1), TMUTCD Section 8B-3
What is the purpose of the sign on the right of the roadway?

- 1) 17.4% To let you know you are at a railroad crossing.
- 2)* 77.8% To let you know you will cross railroad tracks ahead.
- 3) 3.5% To let you know there are two railroad tracks ahead.
- 4) 1.3% Not Sure.



W10-1

3. **SPEED ZONE AHEAD** sign (R2-5c), TMUTCD Section 2B-14
What is the meaning of this sign?

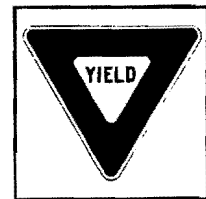
- 1) 6.2% The speed limit will be higher ahead.
- 2) 31.1% The speed limit ahead will be strictly enforced by the police.
- 3)* 55.0% The speed limit will be lower ahead.
- 4) 7.7% Not sure.



R2-5c

4. **YIELD** sign (R1-2), TMUTCD Section 2B-7
What does the yield sign tell you?

- 1) 15.1% You must slow down before entering the intersection.
- 2)* 79.4% You may enter the intersection if it is safe to do so, otherwise, you must stop or slow down until it is safe.
- 3) 4.6% You must stop at the intersection before you enter it.
- 4) 0.8% Not Sure.



R1-2

5. **Mandatory Movement** sign (R3-7R), TMUTCD Section 2B-17
What does this sign mean?

- 1) 14.0% Turn right at the next driveway if you are in this lane.
- 2)* 79.5% Turn right at the next intersection if you are in this lane.
- 3) 4.9% You are not allowed to change lanes after you see this sign.
- 4) 1.6% Not Sure.



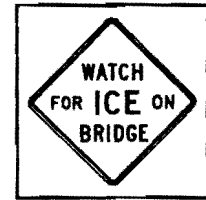
R3-7R

6. **Two-Way Left Turn** markings, TMUTCD Section 3B-1
How do you use this center lane?

- 1) 26.2% Get into this lane at the point where you are ready to turn left.
- 2)* 58.6% Get into this lane when you need to slow down in order to turn left.
- 3) 7.6% Get into this lane when you need to speed up in order to move into the traffic lane.
- 4) 7.6% Not Sure.

7. **WATCH FOR ICE ON BRIDGE** sign (W19-2), TMUTCD Section 2C-41
When you see this sign, what should you do?

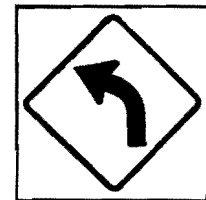
- 1) 2.5% Don't drive on the bridge if there is ice on it.
- 2) 11.5% Slow down and gently apply the brakes while you are on the bridge.
- 3)* 84.0% Slow down, don't brake or make sudden turning movements on the bridge.
- 4) 2.1% Not Sure.



W19-2

8. **Curve** sign (W1-2L), TMUTCD Section 2C-5
How should you respond to this sign?

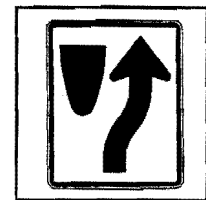
- 1) 65.0% The road will curve to the left a short distance ahead and you should slow down before reaching the curve.
- 2)* 32.4% The road will curve to the left a short distance ahead, but you may drive the curve at the speed limit.
- 3) 1.7% The next mile of highway has several curves and you should slow down.
- 4) 0.9% Not Sure.



W1-2L

9. **Keep Right** sign (R4-7), TMUTCD Section 2B-25
What is the appropriate response to this sign?

- 1) 1.2% Turn right.
- 2)* 69.9% Go to the right side of this sign.
- 3) 23.9% Stay in the far right lane.
- 4) 5.0% Not Sure.



R4-7

10. **SLOWER TRAFFIC KEEP RIGHT** sign (R4-3), TMUTCD Section 2B-23
What is the meaning of this sign?

- 1) 26.6% If you are driving slower than the speed limit, you should be in the lane on the right.
- 2)* 70.8% If you are driving slower than the other traffic, you should be in the lane on the right.
- 3) 1.1% If you have car trouble, you should pull off on the right side of the road.
- 4) 1.5% Not Sure



R4-3

11. **Flashing Yellow Beacon** signal, TMUTCD Section 4B-5

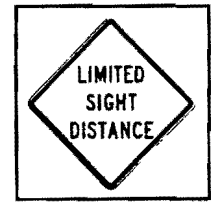
If your direction of travel faces the blinking yellow light, what color light would the intersecting traffic see?

- 1)* 54.0% Blinking red.
- 2) 14.1% Blinking yellow.
- 3) 26.7% Either red or yellow, depending on the intersection.
- 4) 5.2% Not Sure

12. **LIMITED SIGHT DISTANCE** sign (W14-4), TMUTCD Section 2C-39

What is the purpose of this sign?

- 1) 31.7% To warn drivers that shadows make it difficult to see cars coming from the other direction.
- 2)* 44.9% To let drivers know they should be prepared to stop with little warning.
- 3) 8.6% To let drivers with eyesight problems know they should use caution in this area.
- 4) 14.8% Not Sure



W14-4

13. **Solid White Edge Line** marking, TMUTCD Section 3B-6

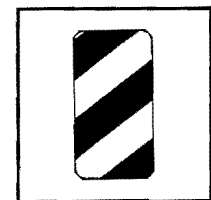
What is the purpose of the solid white line on the right side of the roadway?

- 1) 9.6% To let you know there is no curb on this road.
- 2) 10.4% To let you know that you should not cross this line for any reason.
- 3)* 74.7% To let you know where the edge of your driving path is.
- 4) 5.3% Not Sure

14. **Type 3 Object Marker** (OM-3R), TMUTCD Section 3C-1

What does this marker tell you?

- 1) 14.8% You should reduce your speed.
- 2)* 61.9% There is something at the edge of the roadway you should avoid hitting.
- 3) 3.9% You should drive to the right of this post.
- 4) 19.4% Not Sure

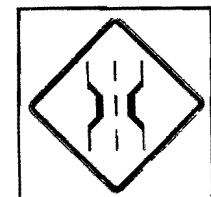


OM-3R

15. **Narrow Bridge** sign (W5-2a), TMUTCD Section 2C-21

What does this sign mean?

- 1) 4.2% Passing is not allowed on the bridge ahead.
- 2) 10.4% A one-lane bridge is ahead.
- 3)* 81.7% A narrow bridge is ahead.
- 4) 3.7% Not Sure

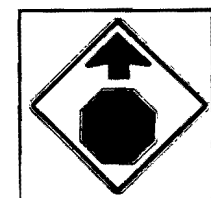


W5-2a

16. **Stop Ahead** sign (W3-1a), TMUTCD Section 2C-15

What is this sign telling you to do?

- 1) 2.1% Stop when you see this sign.
- 2)* 87.4% Be prepared for a STOP sign ahead.
- 3) 7.6% At the next STOP sign you should go straight after you stop.
- 4) 2.9% Not Sure



W3-1a

17. **Double Solid White Lane Line** marking, TMUTCD Section 3B-2

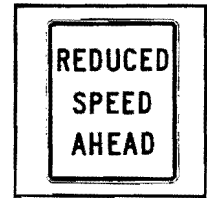
Which one of the following statements is true about the double white lines on the pavement?

- 1)* 61.0% It is illegal to change lanes across these lines.
- 2) 22.1% You may change lanes across these lines with caution, if necessary.
- 3) 6.9% You may change lanes across these lines from left to right, but not from right to left.
- 4) 10.0% Not Sure

18. **REDUCED SPEED AHEAD** sign (R2-5a), TMUTCD Section 2B-14

What does this sign mean?

- 1) 1.9% The speed limit will be higher ahead.
- 2) 3.7% The speed limit ahead will be strictly enforced by the police.
- 3)* 93.2% The speed limit will be lower ahead.
- 4) 1.1% Not Sure

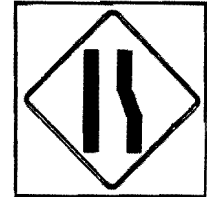


R2-5a

19. **Lane Reduction Transition** sign (W4-2R), TMUTCD Section 2C-19

What does this sign mean?

- 1)* 61.2% There are fewer lanes ahead and traffic on your right will move into your lane.
- 2) 22.8% There is a one-lane road ahead.
- 3) 11.3% There are narrow lanes ahead.
- 4) 4.6% Not Sure



W4-2R

20. **Single Broken Yellow Centerline** marking, TMUTCD Section 3B-1

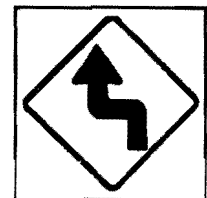
Which one of the following statements is true about the dashed yellow center line?

- 1)* 76.8% This is a two-way road where you are allowed to pass.
- 2) 12.2% This is a two-way road where you are not allowed to pass.
- 3) 8.2% This is a one-way road where you are allowed to change lanes.
- 4) 2.8% Not Sure

21. **Reverse Turn** sign (W1-3L), TMUTCD Section 2C-6

What does this sign mean?

- 1) 25.6% Winding road ahead.
- 2) 5.3% You will make a turn to the right, then turn to the left ahead.
- 3)* 66.5% You will make a turn to the left, then turn to the right ahead.
- 4) 2.7% Not Sure



W1-3L

22. **Flashing Red Beacon** signal, TMUTCD Section 4B-5

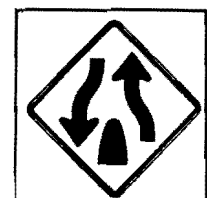
If your direction of travel faces the blinking red light, what color light would the intersecting traffic see?

- 1) 13.8% Blinking red
- 2) 41.0% Blinking yellow
- 3)* 41.1% Either red or yellow, depending on the intersection.
- 4) 4.1% Not Sure

23. **Divided Highway Ends** sign (W6-2), TMUTCD Section 2C-24

What is this sign telling you?

- 1)* 50.7% There is two-way traffic ahead.
- 2) 6.0% There is one-way traffic ahead.
- 3) 37.8% There is a divided highway ahead.
- 4) 5.6% Not Sure



W6-2

24. **No-Passing Zone** markings, TMUTCD Section 3B-3

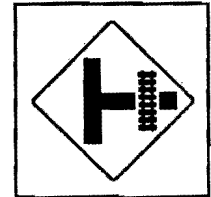
If you are traveling in the right lane, which of the following statements is true about the center line?

- 1) 5.8% This is a two-way road where you are allowed to pass.
- 2)* 88.0% This is a two-way road where you are not allowed to pass.
- 3) 3.2% This is a one-way road where you are allowed to change lanes.
- 4) 3.0% Not Sure

25. **Parallel RR Advance Warning** sign (W10-3), TMUTCD Section 8B-3

What does this sign mean?

- 1) 0.9% If you turn onto the side road, you will cross a gravel road.
- 2) 21.7% You will cross a railroad track, then come to an intersection ahead.
- 3)* 69.3% If you turn onto the side road, you will cross a railroad track.
- 4) 8.1% Not Sure

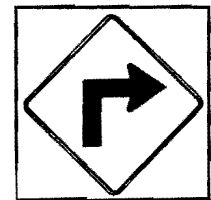


W10-3

26. **Turn** sign (W1-1R), TMUTCD Section 2C-4

What does this sign mean?

- 1) 10.7% There is an intersecting road to the right ahead.
- 2)* 31.9% You should drive 30 miles per hour or less to make the next turn.
- 3) 45.2% You should turn right at the next intersection.
- 4) 12.2% Not Sure



W1-1R

27. **GROOVED PAVEMENT AHEAD** sign (W8-12), TMUTCD Section 2C-30.5

What is the purpose of this sign?

- 1) 16.5% To let motorists know the road will be slippery when wet.
- 2) 39.5% To let motorists know the road will be noisier ahead.
- 3)* 29.2% To let motorcyclists know they should use caution.
- 4) 14.7% Not Sure

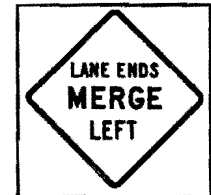


W8-12

28. **LANE ENDS MERGE LEFT** sign (W9-2L), TMUTCD Section 2C-19

What should you do in response to this sign?

- 1)* 64.0% Be aware that traffic will be coming into your lane from the right.
- 2) 11.6% Move to the right lane.
- 3) 16.8% Prepare to exit on the left.
- 4) 7.6% Not Sure

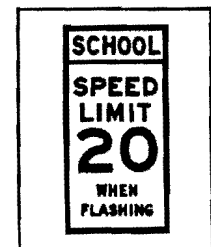


W9-2L

29. **SCHOOL SPEED LIMIT** sign (S5-1), TMUTCD Section 7B-12

At what point can you speed up again after passing this sign?

- 1) 5.7% After you cross the school crosswalk.
- 2) 10.5% After you go past the block of the school building.
- 3)* 79.0% When you see a Speed Limit sign.
- 4) 4.8% Not Sure



S5-1

30. **PROTECTED LEFT ON GREEN** sign (R10-9a), TMUTCD Section 2B-37
If you want to turn left at this intersection and the green light is on, what should you do?

- 1) 34.7% Yield to oncoming traffic. They will have a green light also.
- 2) 47.5% Wait for a green arrow. Then turn left.
- 3)* 15.5% Turn left. Oncoming traffic will have a red light.
- 4) 2.3% Not Sure



R10-9a

31. **Single Broken White Lane Line** marking, TMUTCD Section 3B-2
Which one of the following statements is true about the dashed white line?

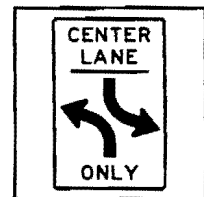
- 1)* 50.3% This is a one-way road where you are allowed to change lanes.
- 2) 4.2% This is a one-way road where you are not allowed to change lanes.
- 3) 42.2% This is a two-way road where you are allowed to pass.
- 4) 3.3% Not Sure

32. **Flashing Yellow Ball** signal, TMUTCD Section 4B-5
You are approaching a blinking yellow signal, how should you respond?

- 1) 9.3% Treat the intersection as if it has a STOP sign.
- 2) 8.8% Stop. Wait for the light to turn green.
- 3)* 80.7% Go through the intersection with caution.
- 4) 1.2% Not Sure

33. **Two-Way Left Turn Lane** sign (R3-9b), TMUTCD Section 2B-19
Which one of the following statements is true when you see this sign?

- 1)* 44.6% The center lane is to be used only for making left turns.
- 2) 6.7% You will be able to make only left turns at the next intersection.
- 3) 43.7% The center lane is to be used only for making left and right turns.
- 4) 5.0% Not Sure



R3-9b

34. **PROTECTED LEFT ON GREEN ARROW** sign (R10-9), TMUTCD Section 2B-37
Which one of the following statements is true with regards to a left turn at this intersection?

- 1) 27.0% You are allowed to turn **only** when the green arrow is on.
- 2)* 53.0% You are allowed to turn when the green ball is on if it is safe to do so.
- 3) 16.6% You are protected from oncoming traffic if you turn from the turn lane when either the green arrow or the green ball is on.
- 4) 3.3% Not Sure

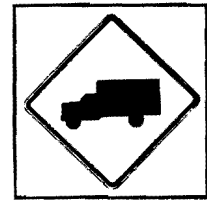


R10-9

35. **Truck Crossing** sign (W11-10), TMUTCD Section 2C-31

What does this sign mean?

- 1) 2.0% Be prepared for fire trucks entering or crossing the roadway in this area.
- 2) 28.7% This is a warning that this road is heavily used by large trucks.
- 3)* 66.1% Be prepared for trucks entering or crossing the roadway in this area.
- 4) 3.2% Not Sure

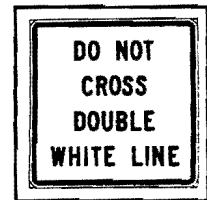


W11-10

36. **DO NOT CROSS DOUBLE WHITE LINE** sign (R4-3B), TMUTCD Section 2B-23.2

What does the sign on the right mean?

- 1)* 72.6% Do not change lanes or turn across the double white lines.
- 2) 9.6% Do not pass. Two-way traffic.
- 3) 11.7% Do not change lanes.
- 4) 6.1% Not Sure

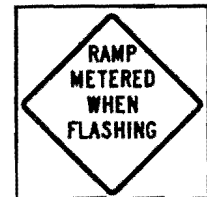


R4-3B

37. **RAMP METERED WHEN FLASHING** sign (W19-3), TMUTCD Section 2C-41

What does this sign mean?

- 1)* 45.7% When the yellow lights are flashing, a traffic signal at the entrance to the freeway is in use.
- 2) 19.9% Only a certain number of cars are allowed on the ramp when the yellow light are flashing.
- 3) 7.6% You must pay a toll to use the freeway entrance ramp.
- 4) 26.8% Not Sure



W19-3

38. **ROUGH ROAD** sign (W8-8), TMUTCD Section 2C-30.2

What is the purpose of this sign?

- 1) 7.2% To let motorcyclists know they should use caution.
- 2) 2.5% To let motorists know the road will be noisier ahead.
- 3)* 88.7% To let motorists know the pavement is in poor condition.
- 4) 1.7% Not Sure

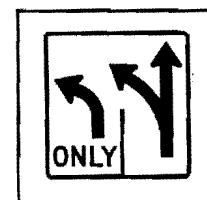


W8-8

39. **Double Turn** sign (R3-8L), TMUTCD Section 2B-17

Which is the most correct statement about this sign?

- 1)* 65.0% To go straight, you must be in the lane on the right.
- 2) 18.4% You may go straight or turn left in the left lane.
- 3) 13.0% You must go straight if you are in the lane on the right.
- 4) 3.7% Not Sure

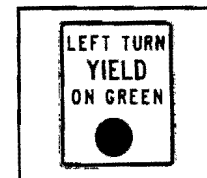


R3-8L

40. **LEFT TURN YIELD ON GREEN** Ball sign (R10-12), TMUTCD Section 2B-37

If you have a green signal, what should you do to turn left?

- 1)* 74.5% Stop and wait for a gap in traffic. Then turn left.
- 2) 13.6% Wait for a green arrow. Then turn left.
- 3) 4.3% Turn left. Oncoming traffic will have a red light.
- 4) 7.6% Not Sure



R10-12

41. **Preferential Lane (diamond) marking, TMUTCD Section 3B-22**

Why is the white diamond painted on the pavement?

- 1) 4.3% This is a symbol used for aircraft speed control.
- 2)* 65.3% This lane is to be used only by certain vehicles.
- 3) 2.5% This is a two-way road.
- 4) 27.9% Not Sure

42. **Yellow Arrow signal, TMUTCD Section 4B-5**

What does it mean when the yellow arrow is on?

- 1) 6.1% You should not enter the intersection.
- 2) 7.1% Your time to turn is about to begin.
- 3)* 80.4% Your time to turn is about to end.
- 4) 6.4% Not Sure

43. **Steady Red X Lane-Use Control signal, TMUTCD Section 4E-9**

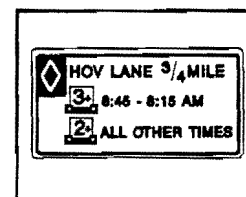
What does the red "X" signal mean?

- 1) 2.2% Stop here.
- 2)* 74.9% Do not drive in this lane.
- 3) 3.9% This is a signal for buses.
- 4) 19.0% Not Sure

44. **HOV RESTRICTION sign (R3-14), TMUTCD Section 2B-20**

It is 7:30 AM, what vehicles are allowed to enter the HOV lane?

- 1) 9.9% Carpools with 2 or more people.
- 2)* 45.7% Carpools with 3 or more people.
- 3) 11.2% Carpools with more than 3 people.
- 4) 33.2% Not Sure



R3-14

45. **Warning Sign Shape and Color, TMUTCD Sections 2A-10,11**

What does a sign this color and shape mean?

- 1)* 58.1% Warning
- 2) 19.7% Directions or Guidance
- 3) 12.9% Construction Area
- 4) 9.4% Not Sure

46. **Guide Sign Color, TMUTCD Section 2A-11**

What is a sign with a green background used for?

- 1)* 75.1% To provide directions or guidance.
- 2) 7.6% To provide general warnings to drivers.
- 3) 2.9% To provide warning for construction areas.
- 4) 14.3% Not Sure

