TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-91/1261		

4. Title and Subtitle	5. Report Date
Assessment and Improvement of Motorist Understanding of Traffic Control Devices	June 1991
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
John M. Mounce, H.G. Hawkins Jr., and Katie N. Womack	Research Report 1261-1

9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Study No. 2-18-91-1261

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation; Transportation Planning Division P.O. Box 5051 Austin, Texas 78763	Interim: September 1990 June 1991
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with DOT, FHWA.
Research Study Title: Assessment and Improvement of Motorist Understanding of Traffic Control Devices.

16. Abstract

A three-year study of motorist understanding of traffic control devices is currently under 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 would be evaluated for possible improvement through revision to standards or public education.

This interim report outlines research activity directed to literature assimilation, selection methodology for traffic control devices of study, development of survey instrument and administration procedures, pilot survey results, and continuation of study. Survey data collection, analysis and evaluation for comprehension improvement will continue in the second and third years of effort. Results and recommendations will be part of the final report, published at the conclusion of the study.

17. Key Words	18. Distribution Statement
Traffic Control Devices, Motorist Comprehension	No restrictions. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	116	

Form DOT F 1700.7 (8-69)

ASSESSMENT AND IMPROVEMENT OF MOTORIST UNDERSTANDING OF TRAFFIC CONTROL DEVICES

by

John M. Mounce
Research Engineer

H. Gene Hawkins, Jr.
Assistant Research Engineer

Katie N. Womack
Associate Research Sociologist

Research Report 2-18-91-1261-1
Interim

Sponsored by
Texas Department of Transportation
in Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843

June, 1991

METRIC (SI*) CONVERSION FACTORS

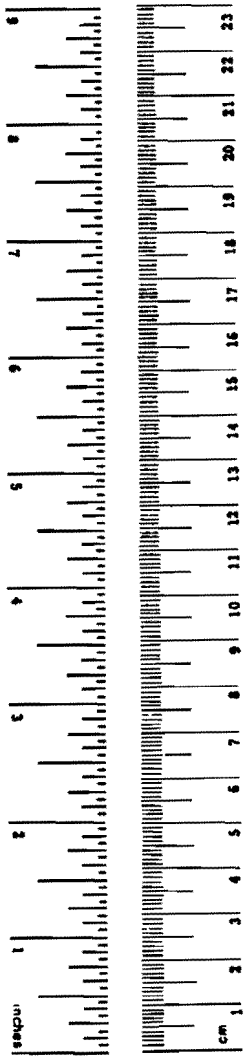
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

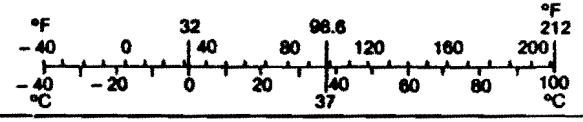


APPROXIMATE CONVERSIONS TO SI UNITS

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
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
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

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

A three-year study of motorist understanding of traffic control devices is currently under 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 would be evaluated for possible improvement through revision to standards or public education.

This interim report outlines research activity directed to literature assimilation, selection methodology for traffic control devices of study, development of survey instrument and administration procedures, pilot survey results, and continuation of study. Survey data collection, analysis and evaluation for comprehension improvement will continue in the second and third years of effort. Results and recommendations will be part of the final report, published at the conclusion of the study.

IMPLEMENTATION STATEMENT

The anticipated results of this study would be 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. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas State Department of Highways and Public Transportation. This report does not constitute a standard, specification, or regulation.

SUMMARY

Traffic control devices 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.

This report documents the first year's efforts of the research study. These efforts included a review of related literature, selecting the devices to be included in the survey, preparing a pre-test survey, a pilot survey, and the final motorist survey, and administering the pre-test and pilot surveys.

Testing motorists' comprehension of traffic control devices is not a new idea. Several previous research studies (1 - 7) have addressed comprehension of traffic control devices in one manner or another. A few of these studies have been comprehensive in nature and evaluated a variety of devices. The findings of these comprehensive studies were used as a starting point to identify those devices which have been shown to have poor comprehension in the past. Appendix B summarizes the findings of the comprehensive studies. These results were then expanded with the findings of more limited studies of driver comprehension. As part of the overall selection process, the comprehension of individual devices was indicated with a score between 0 and 3, with 3 indicating that a device was poorly understood.

There are too many devices in the 1980 edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) to include all the devices in a motorists survey. Therefore, a selection process was developed to identify the relative importance of including

various traffic control devices in the survey. The selection procedure included several separate steps, including a canvass of SDHPT personnel, a poll of transportation professionals, an initial ranking, and a final ranking. The final ranking provided a prioritized listing of critical traffic control devices. The results of the final ranking assisted the research team in selecting 60 devices for inclusion in the pre-test survey. The results of the pre-test survey were used to select 46 devices for the pilot and final motorists surveys.

Several SDHPT personnel were contacted by telephone to obtain an indication of their opinions on the comprehension levels of Texas drivers and to get a preliminary indication of problematic traffic control devices. The information collected from the canvass was used to identify those devices which would be evaluated for inclusion in the survey.

A poll was taken of 49 transportation professional to identify the need to include 131 traffic control devices in the survey. The results of the poll provided an indication of how traffic engineers, law enforcement officers, and other transportation professionals felt about the importance of surveying a number of devices. As part of the poll evaluation, all the devices in the survey were given a score between 0 and 3, with a 3 indicating that a large number of the professionals felt that it was important to include the device in the survey.

The ranking procedures were based on scoring each device on a number of different factors. The initial ranking was based on five factors: the results of the poll of transportation professionals, consequence of misunderstanding a device, driver education, the frequency of use of the device, and special interest of the research team. A prioritized ranking of the total score was used to identify devices for which previous research was sought. The final ranking used the five factors described above and added the score for previous research findings. The total final score provided a prioritized listing of devices for the survey. This prioritized listing was used to select the devices for the pre-test survey.

Some of the devices which were highly ranked in the final ranking were not included in the pre-test survey. There were a number of reasons for not including a device, including:

an abundance of previous research on the device, inability to include the device in the format of the survey, or inclusion of a closely related device in the survey. The devices included in the pre-test and pilot/final survey instruments are shown in Table S-1.

Table S-1. Traffic Control Devices in Pre-Test and Pilot/Final Surveys

Pre-Test Survey	Pilot/Final Survey	Device Name	Designation	TMUTCD Section
Yes		Flashing Yellow Arrow - LCS	----	----
Yes		STOP Sign Shape	----	2A-10
Yes	Yes	Warning Sign Shape and Color	----	2A-10,11
Yes	Yes	Guide Sign Color	----	2A-11
Yes	Yes	YIELD	R1-2	2B-7
	Yes	REDUCED SPEED AHEAD	R2-5a	2B-14
Yes	Yes	SPEED ZONE AHEAD	R2-5c	2B-14
Yes		Turn Prohibition	R3-1, R3-2	2B-15
Yes	Yes	Mandatory Movement (post)	R3-7L	2B-17
Yes	Yes	Double Turn (post)	R3-8L	2B-17
Yes	Yes	Two-Way Left Turn Lane (post)	R3-9b	2B-19
Yes	Yes	HOV RESTRICTION	R3-14	2B-20
Yes	Yes	SLOWER TRAFFIC KEEP RIGHT	R4-3	2B-23
Yes	Yes	DO NOT CROSS DOUBLE WHITE LINE	R4-3B	2B-23.2
Yes	Yes	Keep Right (symbol)	R4-7	2B-25
Yes	Yes	PROTECTED LEFT ON GREEN ARROW	R10-9	2B-37
Yes	Yes	PROTECTED LEFT ON GREEN	R10-9a	2B-37
Yes		NO TURN ON RED	R10-11a	2B-37
Yes	Yes	LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37
Yes	Yes	Turn	W1-1R	2C-4
Yes	Yes	Curve	W1-2L	2C-5
Yes	Yes	Reverse Turn	W1-3L	2C-6
Yes	Yes	Stop Ahead (symbol)	W3-1a	2C-15
Yes		Merge	W4-1R	2C-18
Yes		Added Lane	W4-3R	2C-18.1
Yes	Yes	Lane Reduction Transition	W4-2R	2C-19
Yes	Yes	LANE ENDS MERGE LEFT	W9-2L	2C-19
Yes	Yes	Narrow Bridge (symbol)	W5-2a	2C-21
Yes	Yes	Divided Highway Ends (symbol)	W6-2	2C-24
Yes	Yes	Slow Down on Wet Road	W8-5	2C-30
	Yes	ROUGH ROAD	W8-8	2C-30.2
Yes	Yes	GROOVED PAVEMENT AHEAD	W8-12	2C-30.5
Yes	Yes	Truck Crossing (symbol)	W11-10	2C-31
Yes	Yes	LIMITED SIGHT DISTANCE	W14-4	2C-39
Yes	Yes	WATCH FOR ICE ON BRIDGE	W19-2	2C-41
Yes	Yes	RAMP METERED WHEN FLASHING	W19-3	2C-41

Table S-1. Traffic Control Devices in Pre-Test and Pilot/Final Surveys (continued)

Pre-Test Survey	Pilot/Final Survey	Device Name	Designation	TMUTCD Section
Yes		Hospital (symbol)	D9-2	2D-46
Yes	Yes	Single Broken Yellow Centerline	----	3B-1
Yes		Double Solid Yellow Centerline	----	3B-1
Yes	Yes	Two-Way Left Turn Markings	----	3B-1
Yes	Yes	Single Broken White Lane Line	----	3B-2
Yes	Yes	Double Solid White Lane Line	----	3B-2
Yes	Yes	No Passing Zone Markings	----	3B-3
Yes	Yes	Solid White Edge Line	----	3B-6
Yes	Yes	Stop Line Preferential Lane Marking	----	3B-17
Yes		(diamond)	----	3B-22
Yes		Type 1 Object Marker	OM-1	3C-1
Yes	Yes	Type 2 Object Marker (vert)	OM-2V	3C-1
Yes		Type 3 Object Marker	OM-3R	3C-1
Yes	Yes	Yellow Ball - Traffic Signal	----	4B-5
Yes		Yellow Arrow - Traffic Signal	----	4B-5
Yes	Yes	Flashing Red Ball - Signal	----	4B-5
Yes	Yes	Flashing Yellow Ball - Signal	----	4B-5
Yes	Yes	Flashing Red - Beacon	----	4B-5
Yes		Flashing Yellow - Beacon	----	4B-5
Yes	Yes	Flashing DON'T WALK (words)	----	4D-2
Yes		Steady Red X - LCS	----	4E-9
Yes		Advance School Crossing	S1-1	7B-9
Yes	Yes	SCHOOL BUS STOP AHEAD	S3-1	7B-11
Yes	Yes	SCHOOL SPEED LIMIT	S5-1	7B-12
Yes	Yes	RR Advance Warning	W10-1	8B-3
Yes		RR Parallel Advance Warning	W10-3	8B-3

Questions were then developed for those devices selected for the survey. These questions were worded in order to identify what problems exist, for whom these problems exist, and the pervasiveness of such problems. Each question was in a multiple choice format, with one desirable response, two responses within the realm of possible misunderstanding, and a "not sure" response. These choices were based on previous studies, expert opinion, and confusing or conflicting information that is currently provided to motorists.

Three different survey instruments were developed. The first was a pre-test survey on 60 traffic control devices. This was followed by a pilot survey and then the final survey,

both with questions on 46 devices. All three surveys were presented on video tape. The video tape began with an explanation of the purpose of the survey and instructions for taking the survey. This was followed by two pictures for each of the devices in the survey. The first picture presented an in-context picture of the device. This was followed by a close-up picture of the device. A question was asked about the device and the test subject chose an answer from one of four multiple choices shown on the close-up slide.

The pre-test survey was conducted at two locations in Bryan/College Station: a shopping mall and the driver's license station. The total length of the pre-test survey required that it be divided into two separate videotapes. A total of 38 drivers were shown at least one of the two pre-test video tapes. The findings of the pre-test survey were used to modify the survey instrument. Devices with very high comprehension rates were eliminated and weaknesses in the survey format were corrected. Questions were improved and response choices were modified. The timing of the survey was also shortened. These changes resulted in the pilot survey instrument.

The pilot survey contained 46 questions and was administered to 165 volunteers at the 1991 Houston Auto Show. The pilot survey was in the same format as the pre-test survey, but it was considerably shorter. Table S-2. shows those devices with the lowest percentage of correct responses.

The results of the pilot survey were used to make some very minor changes in the survey instrument, resulting in the final motorists survey. The final survey will be administered at drivers license stations in 12 cities in Texas. The target sample size for the final survey is 2,000 drivers. A representative quota sample will be collected at each survey site. The quotas for each site will be representative of the region with respect to gender, age, and ethnicity. The quotas were developed from 1988 population estimates obtained from the State Population Center located at Texas A&M University.

Table S-2. Poorly Understood Devices in Pilot Survey

Device Name	TMUTCD Designation	Percent Selecting Correct Response
Two-Way Left Turn Marking	----	20.6
GROOVED PAVEMENT AHEAD	W8-12	30.9
PROTECTED LEFT ON GREEN	R10-9a	30.9
Two-Way Left Turn Lane (post)	R3-9B	37.6
Turn	W1-1R	38.2
Flashing Red-Beacon	----	38.8
Curve	W1-2R	43.6
Flashing Yellow-Beacon	----	49.1
LIMITED SIGHT DISTANCE	W19-3	57.0
RAMP METERED WHEN FLASHING	W14-4	59.4
HOV RESTRICTION	R3-14	63.6
Double Solid White Lane Line	----	64.8
Warning Sign Shape and Color	----	67.9
Lane Reduction Transition	W4-2	69.7
PROTECTED LEFT ON GREEN ARROW	R10-9	69.7
SPEED ZONE AHEAD	R2-5c	70.9
Slow Down On Wet Road	W8-5	73.3
Type 3 Object Marker	OM-3R	73.3
LANE ENDS MERGE RIGHT	W9-2L	73.3
Divided Highway Ends	W6-2	74.5
SLOWER TRAFFIC KEEP RIGHT	R4-3	76.4
Double Turn (post)	R3-8	76.4
SCHOOL-SPEED LIMIT	S5-1	77.0
DO NOT CROSS DOUBLE WHITE LINE	R4-3B	77.6
Reverse Turn	W1-3L	78.2
Steady Red X-Lane Control Signal	----	78.8
Keep Right	R4-7	82.4
Solid White Edge Line	----	83.0

TABLE OF CONTENTS

Page

ABSTRACT i

IMPLEMENTATION STATEMENT ii

DISCLAIMER ii

SUMMARY iii

LIST OF FIGURES xi

LIST OF TABLES xiii

SECTION I
Scope of Work 1

SECTION II
Literature Review 7

SECTION III
Selection of Traffic Control Devices 19

SECTION IV
Survey Development 37

SECTION V
Pilot Survey Results 47

SECTION VI
Study Continuation 51

SECTION VII
References 53

APPENDIX A.
Summary of MUTCD Development A-1

APPENDIX B.
Summary of Findings of Comprehensive Research Studies B-1

TABLE OF CONTENTS (continued)

Page

APPENDIX C.
Format of Poll of Transportation Professionals C-1

APPENDIX D.
Summary of Transportation Professional Poll Results D-1

APPENDIX E.
Summary of Comments From Transportation Professionals E-1

APPENDIX F.
Prioritized Results of Final Ranking Procedure F-1

APPENDIX G.
Survey of Driver Understanding of Traffic Control Devices G-1

APPENDIX H.
Motorist Survey Administration H-1

APPENDIX I.
Survey Results I-1

LIST OF FIGURES

Page

Figure 1. Example of Database Record 13

Figure 2. Quota Sample Design 39

Figure 3. Texas Department of Public Safety Traffic Law Enforcement Division Regional Boundaries and District Lines 40

Figure 4. Selected Survey Counties 43

Figure 5. Schedule of Study Activities 52

LIST OF TABLES

Page

Table 1. Sign and Shape Recommendations of MVASHD 9

Table 2. Sign and Color Recommendations of NCSHS 9

Table 3. 30 Problem Signs Selected for Redesign in FHWA Study 15

Table 4. 11 Seriously Misunderstood Signs From 1978 TTI Study 17

Table 5. Targeted Traffic Control Devices from 1981 TTI Study 18

Table 6. Summary of Texas Traffic Control Devices 19

Table 7. TxDOT Canvass Summary 21

Table 8. Breakdown of Poll Respondents 24

Table 9. Ranked Order of Top 51 Devices in Poll of Transportation Professionals 26

Table 10. Summary of Ranking Factors and Relative Weighing 28

Table 11. Criteria for Professional Opinion Scoring 29

Table 12. Criteria for Consequence Scoring 29

Table 13. Criteria for Driver Education Scoring 30

Table 14. Criteria for Frequency Use 31

Table 15. Criteria for Research Team Special Interests 31

Table 16. Criteria for Comprehension Scoring 32

Table 17. Summary of Highest Final Scores 33

Table 18. List of 60 Devices in Pre-test Survey 34

Table 19. List of 46 Devices in Pilot and Final Motorist Survey 36

LIST OF TABLES (continued)

Page

Table 20. Quota Sample Survey 42

Table 21. Pilot Study Demographics 47

Table 22. Pilot Survey Results 48

SECTION I - SCOPE OF WORK

INTRODUCTION

The increasing complexity of traffic systems has required the use of numerous colors, shapes, symbols, and verbal messages to advise the driver about the road ahead. Engineers and researchers have made considerable efforts to simplify the traffic control system to promote the greatest public understanding, and the National Committee on Uniform Traffic Control Devices has this as its primary goal. But even under optimal conditions, such as urban congestion with unfamiliar drivers, the need for accurate comprehension is intensified. Thus, the increased complexity of traffic control devices (TCD's) is apt to generate more confusion on the roadways, more accidents, and the potential for more tort liability cases.

Background

Previous research in Texas (1,2) documented drivers' lack of operational knowledge and appropriate driving response to numerous TCDs commonly in use. 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. Recent surveys (9) in Houston have reported problems with both general and specific TCDs utilized in construction and maintenance work zones.

Confusion, misunderstanding, and lack of familiarity with TCDs many 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; and
- A limited explanation of TCDs given in the driver education and licensing process.

All these factors combined increase the probability that the driver will encounter information that is difficult to process.

Objective

The proposed study will assess the current public understanding of the more complex traffic control devices currently in use in Texas including signs, signals, and pavement markings applied in various roadway contexts (urban/rural, etc.). This assessment will be made by conducting a statistically valid survey of Texas motorists by age, sex, education, driving experience, ethnic background, linguistic ability, and geographic region.

The anticipated results of the study would be a series of recommendations which will identify those traffic control devices for which improved comprehension is needed and possible through emphasis with driver education or modification of device application. Implementation of the recommendations for driver education or traffic control device modification will result in a safer driving environment, provide engineers with valuable information on the human element of the highway system, and possibly reduce liability exposure.

WORK PLAN

The following work tasks were established as an outline for the completion of the study objectives.

Task 1.1 Literature Review

A detailed literature search on motorist comprehension and response to TCDs employed both independently and as an interactive system will be performed. It will also address the Manual on Uniform Traffic Control Devices (MUTCD), development of the TCD standards, and previous evaluations of the effectiveness of signs, signals, and markings. This will include input from both district and division staff to support identification of

problematic TCDs.

Task 1.2 Establish Sampling Plan

Establishment of the sampling plan involves the following steps:

(1) Select the geographic areas of interest.

(2) Using the latest available census data, determine for each geographic area of Texas the age, sex, and ethnic representation for the driving population.

(3) Establish appropriate sample size for each geographic area.

Task 1.3 Develop Survey Methodology

Development of the survey procedures and instrument for testing motorist understanding of traffic control devices and systems includes the following:

(1) Use the previous results to identify those aspects of TCD application and interaction that are not definitively documented and also the areas where there is a lack of understanding among motorists. These will be the focal points of the survey.

(2) Investigate and designate optimal survey procedure parameters; i.e., survey type, time, communication medium, incentives, etc.

(3) Develop preliminary alternative survey instruments for evaluation by pretest.

(4) Conduct pilot surveys to revise and document survey methodology effectiveness.

(5) Obtain State Department of Highways and Public Transportation (SDHPT) approval of survey instrument and procedures (including sampling plan).

Task 1.4 Submit Interim Report

Prepare an interim report documenting the findings of the literature review, sampling plan, and survey methodology.

Task 2.1 Conduct Motorist Survey

The motorist survey will be conducted at sites and in compliance with the established

sampling plan and methodology.

Task 2.2 Analysis of Survey Data

All survey information will be converted for computer data entry and statistical processing. These results will indicate level of motorist understanding for the bank of TCDs and systems of devices under assessment across all specified sociodemographic variables.

These results will be further analyzed for potential methods of selected improvement in TCD comprehension necessitating further in-depth study and additional survey testing.

Task 2.3 Submit Preliminary Findings

Preliminary survey findings will be assimilated and submitted as a technical memorandum for review.

Task 3.1 Evaluation of Survey Results

Evaluate final survey results for motorist understanding of traffic control devices applied singly or as a system. For those TCDs exhibiting less than adequate comprehension levels, establish feasibility and potential effectiveness of proposed improvement methods.

Task 3.2 Recommendations for Improvement

Based on evaluations recommended actions for improvement of motorist understanding of independent or interactive TCDs will be formulated with implementation guidelines. These recommendations will encompass agency, administration, division, and district level improvements.

Task 3.3 Submit Final Report

A final report will be prepared and submitted documenting all study activities, results, and recommendations.

ADVISORY COMMITTEE

At the initiation of this study, an advisory committee was formed for consultation regarding selection of problematic traffic control devices and survey development. This committee has reviewed and approved all research activity discussed in this report. The committee is made of the following individuals excluding responsible researchers:

- Mr. Lewis Rhodes, Safety and Traffic Operations (D-18STO), State Department of Highways and Public Transportation
- Lieutenant Dwain Cox, Law Enforcement, Texas Department of Public Safety
- Inspector John Hall, Driver Licensing, Texas Department of Public Safety
- Mr. John Copeland, Research and Planning (D-10A), State Department of Highways and Public Transportation
- Mr. Mike Leary, Planning and Research, Federal Highway Administration
- Mr. Bob Musselman, Planning and Research, Federal Highway Administration

SECTION II - LITERATURE REVIEW

INTRODUCTION

An early effort of this research study was to review previous literature addressing the development of traffic control device standards and motorists comprehension of traffic control devices. Research results addressing traffic control devices were identified and obtained from a variety of sources. The information obtained from the collected information was used to document the development of traffic control device standards and to determine previous research about comprehension of specific traffic control devices. The research results addressing specific traffic control devices was used in the final ranking procedure, as discussed in Section III. The results of the literature review are discussed on the following pages.

DEVELOPMENT OF TRAFFIC CONTROL DEVICE STANDARDS

Some of the earliest uses of highway markings date back to the Roman Empire and were used to indicate mileage to the center of Rome. Stone markers and wood stumps were used during the eighteenth and nineteenth centuries to mark trails in the United States and indicate distances to major cities. But it was not until the automobile boom at the beginning of the twentieth century that the need for traffic control devices became imperative. The low speeds and low traffic volumes during the first part of the twentieth century meant that the primary driver need was for directions. This was especially true as automobile touring became popular and drivers began to venture into the countryside. Much of the early directional signing was erected and maintained by local automobile clubs. The Buffalo, New York Automobile Club performed one of the earliest examples of extensive roadway signing in 1905 (10).

Regulatory signing and control devices became necessary as traffic volumes and speeds increased. The first roadway centerline was used on curves and bridges in Michigan

in 1911 (10). Cleveland, Ohio is generally credited with the first electrical traffic signal in the United States in 1914, although this claim is subject to some debate (11). The first STOP sign in the United States was installed in Detroit in 1915 (10). The early traffic signals assumed a variety of appearances, with numerous meanings for any given indication. It was not until 1920 that the first three-color traffic signal was placed in operation in the city of Detroit (11).

Early Efforts in Standardizing Traffic Control Devices

The wide variation in traffic control devices which existed in the early 1920's prompted an interest in establishing uniform standards for traffic control devices, particularly signs. In one of the earliest efforts, three highway department officials from Indiana, Minnesota, and Wisconsin made a trip through several states in order to work out a basis for uniformity in signing and markings. The results were reported to the Mississippi Valley Association of State Highway Departments (MVASHD) in 1923, and the resulting agreement established sign shape standards upon which modern signs are largely based (11).

The MVASHD plan classified signs according to their intended purpose and assigned distinctive shapes to each classification as summarized in Table 1. All signs used black letters or symbols on a white background. The maximum size of signs was 24 inches, because that was the maximum width of the sign making equipment available at the time. The round and octagon shapes were selected for the locations with the fewest number of installations because these sign shapes resulted in the largest wastage of material due to cutting. The practice of embossing the sign message on metal sign blanks became widely accepted about this time. Prior to this point, most signs were hand painted, which became labor intensive and expensive. The speed of the fabrication process was greatly increased by developing a procedure of stamping the message on the sign, dipping the entire sign in paint, and then running a black paint roller over the message.

Table 1. Sign Shape Recommendations of MVASHD

Shape	Meaning	Use	Danger Level
Round	Railroad Crossing	Advance warning of railroad crossing.	Highest
Octagon	Stop	Stop at intersections.	Second Highest
Diamond	Slow	Ordinary conditions of danger requiring caution at all times.	Third Highest
Square	Caution	Intermittent danger condition requiring little more than ordinary care.	Least
Rectangular	Regulation or Information	Regulatory or direction information.	None

Source: Reference (11)

One year later in 1924, the First National Conference on Street and Highway Safety (NCSHS) (12) made several recommendations to improve the uniformity of traffic control devices, with sign color being among the most significant of the recommendations. Table 2 describes these color recommendations.

Table 2. Sign and Signal Color Recommendations of NCSHS

Background Color	Letter or Symbol Color	Meaning
Red	White	Stop
Green	White	Proceed
Yellow	Black	Caution
Purple	White	Cross Roads
White	Black	Direction and Distance Information

Source: Reference (12)

First National Signing Manuals

The first national manual for signing was the *Manual and Specifications for the Manufacture, Display, and Erection of U.S. Standard Road Markers and Signs* (13), published by the American Association of State Highway Officials (AASHO) in January 1927. This manual addressed only signs for rural areas and set forth the design and use for each type of sign. The shapes of the MVASHD plan were used. Slow, caution, and STOP signs were black on yellow. All other signs were black on white. The manual also contained detailed specifications for materials and manufacturing of various types of wood and metal signs. A second edition, published in April 1929, addressed the use of illumination or reflecting elements in signs. The illumination was placed behind the sign, with the idea of showing the shape of the sign at night. It was thought that drivers would respond to the shape of the sign and that illumination of the message was not necessary. In 1931, a revised edition of the AASHO manual added a number of new signs.

During the time that AASHO was developing its rural signing manual, the NCSHS continued to give attention to the use of traffic control devices in urban areas. In 1926, the Second National Conference on Street and Highway Safety accepted an offer by the American Engineering Council to make a national survey of existing traffic control devices and to prepare recommendations (11). Thirty-five states and over one hundred cities were included in the survey. The information obtained from the surveys was used to prepare the *Report of the Committee of American Engineering Council on Street Traffic Signs, Signals, and Markings* (14) for urban traffic control devices. A revised version of this report was presented to the Third Conference on Street and Highway Safety in May 1930 and adopted as the first urban manual addressing the use of traffic control devices. The *Manual on Street Traffic Signs, Signals and Markings* (15) addressed urban traffic control devices and conformed with the AASHO rural manual in virtually all respects, with the following exceptions: material addressing traffic signals, pavement markings, and safety zones was added, smaller signs were allowed for urban use, and red letters on a yellow background was

designated for STOP signs.

National Manual on Uniform Traffic Control Devices

The conflicts of having two separate manuals, one for rural areas and one for urban conditions, was quickly recognized and efforts began toward establishing a single manual of standards for traffic control devices. These initial efforts resulted in the publication of the first edition of the *Manual on Uniform Traffic Control Devices* in 1935 (16). This manual sets forth the basic principles that govern the design and usage of traffic control devices. These devices are used to direct and assist vehicle operators in the guidance and navigation tasks required to safely traverse any facility open to public travel. Subsequent editions of the national MUTCD were published in 1942 (War Emergency Edition) (17), 1948 (18), 1961 (19), 1971 (20), 1978 (21), and 1988 (22). Revisions were made to the 1935 (23), 1948 (24), 1971 (25), and 1978 (26) editions. Each edition was developed by or with the assistance of a committee which has changed in name and personnel over the years. The evolution of the national MUTCD is a long and complex story that is described in two publications (11, 27), however, the major highlights of the MUTCD's development are summarized in Appendix A.

The newest edition of the MUTCD is currently being prepared by the Federal Highway Administration, with input from the National Committee on Uniform Traffic Control Devices. The new manual will be completely rewritten in a revised format. The intent of the revised format is to provide a more usable document and one which better identifies standards, guidance, and options. Development of the new MUTCD is just beginning and the new edition is not expected to be available for several years.

Texas Manual on Uniform Traffic Control Devices

The *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) established standards for all traffic control devices in the State of Texas and is based on the National

MUTCD. The TMUTCD basically follows the National MUTCD, although some modifications have been made to meet State laws or more closely fit conditions in Texas. One of the most important differences is that the TMUTCD contains many signs that are not part of the national manual. The first actual edition of the Texas MUTCD was published in 1954 (28) and was based on the 1948 national MUTCD (18). Ensuing editions of the TMUTCD were published in 1967 (29), 1973 (30), and 1980 (31), which is the current edition. The 1980 Texas edition is based on the 1978 national MUTCD, and the 1980 Texas edition has been revised four times.

TRAFFIC CONTROL DEVICES RESEARCH FINDINGS

The primary purpose of the literature review was to identify previous research which addressed how well motorists comprehend specific traffic control devices. The literature review began with a search of the Transportation Research Information Services (TRIS) database. This search produced citations and abstracts for 720 potential references. Addition reference material was identified through the Texas Transportation Institute and Texas A&M University libraries. Information from the citations (without abstracts) was then entered into a microcomputer database. Figure 1 provides an example of a database record. The computerized database provided a means of identifying the devices that each reference addresses and the ability to quickly locate references which addressed a specific device. After eliminating references which could not be used in the study (because of duplicate entries, foreign language, or irrelevant subject matter), the database contained 608 references which addressed some aspect of traffic control devices. Of these, 152 were identified as related to the study objectives and were obtained for review.

```
TITLE     MOTORISTS' COMPREHENSION OF REGULATORY, WARNING,
          AND SYMBOL SIGNS (FINAL REPORT) VOLUME I: EXECUTIVE
          SUMMARY
AUTHOR    KNOBLAUCH, PIETRUCHA
SOURCE    FHWA-RD-86-111
DATE      1987/02
ID        T0334
SUBJECTS  DRIVER COMPREHENSION, SURVEY DESIGN, SIGN DESIGN
LOCATION  GHO
```

Figure 1. Example of Database Record

There are several studies of driver understanding of traffic control devices which are comprehensive in nature and address a number of devices. These studies provided an excellent starting point for determining how well various devices were understood by motorists. General descriptions of these research studies are provided in the following paragraphs. The findings of these studies which relate to specific traffic control devices are described later. Appendix B summarizes the signs that were evaluated in these comprehensive studies.

Motorists' Comprehension of Regulatory, Warning, and Symbol Signs, Volumes 1, 2, and 3.

This study (3, 4, 5) represents one, if not the, most comprehensive evaluation of driver understanding of traffic control devices. The purpose of this FHWA sponsored study was to identify deficiencies in signing, develop and test alternative sign designs, and to make recommendations for needed changes to the MUTCD. Deficiencies in regulatory, warning, and symbol signs were identified from the results of previous research. A multi-phase laboratory procedure was used to identify the effectiveness of specific sign alternatives and to select the best design for each sign. The results of the evaluation were used to make recommendations to the MUTCD.

This study contains a detailed literature review which evaluated over 150 reports, papers, and articles addressing a wide variety of signs. The literature review represented the most exhaustive evaluation of previous research on driver comprehension up to that

time. It was divided into four major subject areas: literature reviews and historical perspectives, motorist information requirements and sign design principles, evaluation techniques, and sign comprehension criteria and human performance testing.

This study was not able to determine what the minimum acceptable comprehension level should be for any given or group of signs. Therefore, a Problem Sign Identification (PSI) process and a Problem Severity Rating (PSR) were developed to identify the most problematic signs. The PSI process summarized information from three sources (literature, experts, and tort liability) to identify signs which exhibited comprehension problems. These signs were then rated using the PSR to identify the most critical of the signs. The PSR assigned values of 1, 2, or 3 to each of three factors which affect comprehension -- consequence of miscomprehension (the worst case of motorists response if a sign is misunderstood), type of miscomprehension (the degree to which the sign is confused with similar signs), and degree of miscomprehension (previous research findings on motorist comprehension). Signs which received a score of 9 were determined to be the most problematic. Those signs with a PSR of 6, 7, 8, or 9 are listed in Appendix B. The results of the PSI and PSR were used to select 30 signs for the redesign process. These 30 signs are listed in Table 3 and also in Appendix B. One or more alternative designs were developed for each of the 30 signs and tested in several evaluation procedures.

Table 3. 30 Problem Signs Selected for Redesign in FHWA Study

Name of Device	Designation
Two-Way Left Turn Lane (overhead)	R3-9a
Keep Right (symbol)	R4-7
Turn	W1-1
Curve	W1-2
Reverse Turn	W1-3
Reverse Curve	W1-4
Winding Road	W1-5
Cross Road	W2-1
Stop Ahead (symbol)	W3-1a
Yield Ahead (symbol)	W3-2a
Merge	W4-1
Lane Reduction Transition	W4-2
Added Lane	W4-3
Narrow Bridge (symbol)	W5-2a
Divided Highway Ends (symbol)	W6-2
Hill (symbol)	W7-1
Pavement Ends (symbol)	W8-3a
SOFT SHOULDER	W8-4
Slow Down on Wet Road	W8-5
Low Shoulder (symbol)	W8-9a
Uneven Pavement (symbol)	*
Advance Pedestrian Crossing	W11-2
Pedestrian Crossing	W11A-2
Arrow Clearance, Ft In	W12-2T
Advance One Lane Road	CW20-4
Advance Flagger (symbol)	CW20-7a
Worker (symbol)	CW21-1a
Advance School Crossing	S1-1
School Crossing	S2-1
SCHOOL BUS STOP AHEAD	S3-1

* Sign not in TMUTCD

The first laboratory screening procedure tested responses of subjects to all of the alternative sign designs. Pictures of signs in a test booklet were shown to drivers and they were asked to state the meaning of each sign. The question was open ended, no multiple choice type answers were provided. The results of this screening allowed the less effective redesigned signs to be eliminated from the process. The second laboratory procedure also utilized a test booklet to show drivers pictures of the various alternative signs. This process allowed the most effective alternatives for each of the 30 problematic signs to be identified.

The most effective alternative was then tested in the HYSIM driving simulator at FHWA. Recommendations for changes to the MUTCD were based on the results of the HYSIM simulator results.

Motorists' Understanding of Traffic Control Studies, Test I and II

In 1979 and 1980, the American Automobile Association conducted two studies of driver understanding of traffic control devices (6, 7). These studies utilized motion pictures of traffic control devices to represent driving scenes to test subjects from all over the United States. The 1979 study tested the reactions of 3,164 subjects to 23 different scenes of 16 devices. The 1980 study was shown to over 1,700 subjects and included 19 scenes of 19 devices. Three of the scenes were the same as the 1979 study. Drivers were shown a movie where different traffic control devices were shown. A multiple choice question was asked about each device and the driver was asked to select the meaning from one of the choices. A number of the scenes tested in these studies represent traffic control devices which are not described in the MUTCD (such as a single solid yellow line). Additionally, several of the devices are inaccurately described in the study (such as an Advance School Crossing sign (S1-1) being described as a School Zone sign). Neither report contained conclusions which identified specific devices as problematic or not being well understood by motorists. The findings of these two studies are summarized in Appendix B, except for those devices which are not defined in the MUTCD.

TTI Study

The Texas Transportation Institute has conducted two previous studies on comprehension of traffic control devices (1, 2). Both studies surveyed drivers by presenting pictures of a highway scene in a test booklet. Subjects then selected the meaning of the sign from a list of multiple choice answers. The 1978 study tested 27 different devices and had over 400 subjects. Of the 27 devices evaluated, 11 were identified as "seriously misunderstood" by drivers. These 11 devices are listed in Table 4. The findings of the study

are summarized in Appendix B.

Table 4. 11 Seriously Misunderstood Signs from 1978 TTI Study

Seriously Misunderstood Traffic Control Device
Crossing Signs: Advance vs At-Grade Crossing
Slippery When Wet symbol sign
Curve vs. Turn symbol sign
Pavement Width Transition symbol sign
Double Turn symbol sign
Climbing Lane Ahead
Yield to Traffic in Center Lane
Double Yellow Line (nature of prohibition)
Solid White Line (not discriminated from dashed)
Protected Turn Traffic Signals (green and amber arrows)
Flashing Intersection Control Beacon

The 1981 study evaluated 63 traffic control devices and attempted to access:

1) drivers' knowledge of specific traffic controls,
2) preferred or appropriate driving maneuvers elicited by commonly used traffic control devices, and
3) knowledge of standards regarding colors, shapes, and symbols surrounding the traffic communication system.

There were 19 of the 63 devices which were identified as needing improvements. These 19 devices are listed in Table 5 and the findings of the study are summarized in Appendix B.

Table 5. Targeted Traffic Control Devices from 1981 TTI Study

Name of Device
Do Not Enter symbol sign (no verbal message)
Stop sign (no verbal message)
Yield sign (no verbal message)
One-Way Traffic sign (no verbal message)
Prohibited Right Turn symbol sign
Keep Right symbol sign
YIELD TO TRAFFIC IN CENTER LANE sign
Double Turn symbol sign
Large Arrow sign
NO PASSING ZONE sign
Turn sign
School Crossing sign
Chevron sign
Detour Arrow (no verbal message)
Double Solid Yellow Center marking
Broken Yellow Center marking
Two-Way Left Turn Lane marking
Flashing Red Beacon
Flashing DON'T WALK

SUMMARY

The findings of these comprehensive studies were used to categorize how well motorist understand traffic control devices. Comprehension scores of 0 through 3 were assigned to each device which received an initial ranking of 5 through 9 (see Initial Ranking, Section III). A score of 3 indicates that research has shown the device is not well understood or that it was not addressed in these comprehensive studies. A score of 0 indicates that the device has high comprehension levels. The ranking procedure and the manner in which comprehension fits into the ranking procedure are described in the following section of this report.

SECTION III - SELECTION OF TRAFFIC CONTROL DEVICES

INTRODUCTION

The 1980 edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) (31) provides the standards for all traffic control devices used in the State of Texas. This document contains over 500 different signs, plus a large number of markings and signal indications. Table 6 summarizes the number of devices in each category of the TMUTCD. A survey which addressed every one of these devices would be very cumbersome and time consuming. Therefore, a selection procedure was developed to determine which devices were the most appropriate to include in the motorist survey.

Table 6. Summary of Texas Traffic Control Devices

Type of Traffic Control Device	Number of Devices
Regulatory Signs	158
Warning Signs	119
Guide Signs	201
Civil Defense Signs	7
Construction Signs	37
School Signs	7
Pavement Markings	22
Object Markers and Delineators	6
Barricades and Channelizing Devices	7
Traffic Signals	14

The selection procedure included several separate steps, including a canvass of SDHPT personnel, a poll of transportation professionals, an initial ranking, and a final ranking. The final ranking provided a prioritized listing of critical traffic control devices. The results of

the final ranking assisted the research team in selecting 60 devices for inclusion in the pre-test survey. The results of the pre-test survey were used to select 46 devices for the pilot and final motorists survey. A review of previous research on comprehension of traffic control devices was a parallel effort to the selection procedure. The findings of the literature review are described in Section II and were used in determining the final ranking for the most critical traffic control devices.

The canvass of SDHPT provided an opportunity to obtain a Texas perspective of driver comprehension of traffic control devices. The results of the canvass were combined with preliminary findings of the literature review to identify 131 devices that were candidates for the motorists survey. A poll on these 131 devices was prepared and sent to transportation professionals in Texas. This poll provided a means for indicating the relative importance of a large number of devices between various subgroups of transportation professionals. The results of the poll were combined with four other factors (consequence of misunderstanding, driver education, frequency of use, and special interest) in the initial ranking of critical traffic control devices. Findings of previous research efforts were collected for the most critical devices in the initial ranking. The results of previous research were then used to develop a final ranking of critical traffic control devices. The results of the final ranking indicated the relative need for including a given device in the motorist survey. The research team then selected 60 devices from this list for the pilot study. The results of the pilot survey were used to further narrow the number of devices to 46 for the final motorists survey. Each of these efforts are described in the following sections.

CANVASS OF SDHPT PERSONNEL

The nationwide bias of available published traffic control device research was an early concern of the research team. The fact that the TMUTCD includes many signs that are not in the National MUTCD means that these signs have not been addressed in previous national research studies. Therefore, one of the efforts of the selection procedure was to contact selected SDHPT personnel in an attempt to identify traffic control devices unique

to Texas which might not be well understood by motorists.

The SDHPT canvass was conducted by telephone and directed toward staff personnel of selected districts. The research team felt that the three staff positions were most likely to be familiar with how well drivers understood traffic control devices. Those positions are the district traffic engineer, the district maintenance engineer, and the district public affairs officer. The research team also wanted to obtain opinions representing various geographical and population types. Table 7 summarizes the positions, districts, and individuals which were contacted in the canvass. This table shows that rural, suburban, and urban districts representing every part of the state were contacted. Several districts with large Hispanic populations were also included because of potential comprehension difficulties due to language barriers.

Table 7. SDHPT Canvass Summary

Names indicate individuals contacted in canvass.

District and City	Traffic Engineer	Maintenance Engineer	Public Affairs Officer
1 - Paris	Jerry Keesler	J.B. Hutchison	
2 - Ft. Worth	Wallace Ewell		
4 - Amarillo		Leon Wood	
9 - Waco			Helen Havelka
11 - Lufkin			James Blackburn
12 - Houston			Janelle Gbur
15 - San Antonio	Pat Irwin		
23 - Brownwood		Tom Newborn	
24 - El Paso	Manny Aguilera		

In general, the opinions obtained in the canvass indicated that a few devices may not be well understood by motorists. In particular, the meanings of some symbol signs are not

well recognized, but it was pointed out that the symbol signs are better understood in areas with a large Hispanic population. The narrow bridge and lane reduction symbol signs were indicated to be symbols which are not well understood by drivers. It was also suggested that drivers do not understand the meanings of different sign colors. Permissive phasing for left turn movements at signalized intersections was also mentioned as potentially confusing for drivers. The fact that there are several different signs for left turn phasing was suggested as one explanation for the confusion. Another explanation was inconsistent applications between districts or between a district and the local agencies. Freeway guide signs were also identified as a source of driver confusion.

A common statement was that enforcement of traffic control devices should be improved. The lack of enforcement may be the reason that many drivers do not pay attention to these devices. Better enforcement was cited as a more desirable solution when compared to changing the design or use of traffic control devices.

Several general comments were addressed within the broad context of the use and application of traffic control devices. One comment, which is common to many traffic engineers, is that there are too many signs. The large number of signs may be attributed to the increase in tort claims and the tendency to install a sign if there is any doubt about the need for a sign. Tort claim concern was indicated to be an important consideration in the use of traffic control devices. Another comment was that signs do not always agree with the immediate environment. Examples are the presence of construction signs when no construction activities are taking place and disagreement between overhead guide signs and the lanes below. In the second example, freeway lanes may have been shifted and narrowed, but the overhead signs were not changed accordingly. Another comment was the increasing numbers of older drivers and the need to accommodate their needs.

Another concern expressed in the canvass was the inadequacy of the *Texas Drivers Handbook* (32) in addressing traffic control devices. In some cases, the meaning of the devices as indicated in the handbook disagrees with the meaning provided in the TMUTCD.

Many of the devices are not contained in the handbook. This is a concern because the handbook is the only document that the state gives to drivers to educate them on the meaning of traffic control devices.

It should be noted that the above statements summarize the opinions of one or more selected individuals and that these opinions may or may not be an accurate evaluation of traffic control devices in a broad sense. Therefore, the information obtained from the canvass was used with care in this study and instant credibility was not given to any single opinion.

POLL OF TRANSPORTATION PROFESSIONALS

The opinions of a large number of transportation officials were desired by the research team to help determine which devices to include in the motorist survey. These opinions were obtained by distributing a poll on traffic control devices to traffic engineers, law enforcement officers, and other transportation officials. The poll illustrated 131 different traffic control devices which were scored to indicate the need to include the device in the motorist survey. The results of the survey were then tabulated to indicate the rankings of the devices.

The research team recognized that the best method of obtaining the opinions of transportation officials was to distribute an easy to complete survey form. The form used in the poll of transportation officials is contained in Appendix C. The form was prepared after the SDHPT canvass was completed and preliminary findings of the literature review were available. The poll included most of the devices identified in the canvass and literature review as devices which may not be adequately understood by motorists. A number of other devices were also added by the research team and the Advisory Committee. The form consisted of instructions, a graphic illustration of each sign, and descriptions of signal indications or pavement markings. Signs were listed in alphabetical order according to the MUTCD designation for the sign. Descriptive devices were listed at the end

according to the general category of the device (traffic signal, pedestrian signal, intersection beacon, lane-use control signal, and pavement markings). The end of the form included a space for comments. The instructions asked that each devices be given a score of 0 to 3 according to the following description:

Should this traffic control device be included in the motorist survey?

0 - Device should not be included in survey
1 - Uncertain whether device should be in survey
2 - Devices should be included in survey if possible
3 - Devices should definitely be included in survey

The poll was returned by a total of 49 transportation officials. The respondents represented a variety of individuals from urban, rural, law enforcement, and other areas. Both SDHPT and non-SDHPT personnel responded to the poll. Almost half of the respondents were from the Houston area. Table 8 provides a breakdown of the subgroups of the respondents.

Table 8. Breakdown of Poll Respondents

	Houston	non-Houston	SDHPT	non-SDHPT	Urban	Rural	Law	Other*
Houston	x	x	6	15	14	0	5	2
non-Houston	x	x	12	16	12	4	5	7
SDHPT	6	12	x	x	14	4	0	0
non-SDHPT	15	16	x	x	12	0	10	9
Totals	21	28	18	31	26	4	10	9

* Other category includes researchers and airport personnel

Tabulating the results of the poll was a difficult process. The objectives of the

tabulation were to provide an indication of the relative importance of each device and to provide insight into how the various subgroups evaluated each device. It was decided that an average score would not provide a true indication of the relative importance of each device because the average would not indicate how many respondents felt it important to include a given device in the motorist survey. Therefore, the percentage of respondents which gave a device a particular score was used to provide an indication of the relative importance. These percentages were then arranged in descending order to provide an ordered ranking of the importance of including the traffic control devices in the motorist survey, according to the opinions of the transportation professionals which responded to the poll. Table 9 gives the ranked order of the top 51 devices in the poll according to the percentage of respondents which gave each device a score of 2 or 3. Boldface type is used to indicate those devices which were one of 60 included in the pilot motorist survey. A more detailed summary of the results of the poll is given in Appendix D.

Table 9 shows that not all devices which were highly ranked in the poll were included in the pilot motorist survey. Reasons for this were varied and included the ability to use the device within the limits imposed by the format of the motorist survey and the rankings of each device within the subgroups of the poll. The variation in responses by the subgroups is evident in the table contained in Appendix D. The general subgroup trends that are evidenced in this table include:

- SDHPT respondents tended to emphasize devices which were more common to rural areas.
- Urban area respondents emphasized traffic signal related devices more frequently than rural area respondents.
- Rural area respondents emphasized devices related to high-speed highways more frequently than urban area respondents.
- Law enforcement officials tended to place emphasis on devices which were subject to enforcement and less emphasis on those devices which did not contain an enforceable message.

Table 9. Ranked Order of Top 51 Devices in Poll of Transportation Professionals

Rank[1]	Traffic Control Device	TMUTCD Designation	TMUTCD Section	Percentage[2]
1T	Permitted/Protected Left Turn	—	4B-5	87.5
1T	**Yellow Arrow - Traffic Signal**	—	**4B-5**	**87.5**
3	Red Arrow - Traffic Signal	—	4B-5	85.7
4T	Low Shoulder (symbol)	W8-9a	2C-30.3	83.7
4T	Flashing Yellow X - LCS	—	4E-9	83.7
4T	**PROTECTED LEFT ON GREEN**	**R10-9a**	**2B-37**	**83.7**
7	Pavement Ends (symbol)	W8-3a	2C-28	82.6
8T	**Double Solid White Lane Line**	—	**3B-2**	**81.6**
8T	Steady Yellow X - LCS	—	4E-9	81.6
8T	**Added Lane**	**W4-3R**	**2C-18.1**	**81.6**
8T	**Narrow Bridge (symbol)**	**W5-2a**	**2C-21**	**81.6**
12T	**Two-Way Left Turn Markings**	—	—	**81.3**
12T	Hazardous Cargo Permitted	R14-2	2B-43.1	81.3
12T	Hazardous Cargo Prohibited	R14-3	2B-43.1	81.3
15T	**Type 3 Object Marker**	**OM-3R**	**3C-1**	**79.6**
15T	School Crossing	S2-1	7B-10	79.6
15T	**LEFT TURN YIELD ON GREEN Ball**	**R10-12**	**2B-37**	**79.6**
18	Flashing Don't Walk (symbol)	—	4D-2	79.2
19T	**PROTECTED LEFT ON GREEN ARROW**	**R10-9**	**2B-37**	**77.6**
19T	**Steady Red X - LCS**	—	**4E-9**	**77.6**
19T	Pedestrian Crossing	W11A-2	2C-32	77.6
19T	**Two-Way Left Turn Lane (post)**	**R3-9b**	**2B-19**	**77.6**
19T	**Advance School Crossing**	**S1-1**	**7B-9**	**77.6**
19T	**Lane Reduction Transition**	**W4-2R**	**2C-19**	**77.6**
19T	Single Solid White Lane Line	—	3B-2	77.6
26	**Preferential Lane Marking (diamond)**	—	**3B-22**	**77.1**
27	Chevron	W1-8	2C-10	75.5
28	**No Passing Zone Markings**	—	**3B-3**	**73.9**
29T	Two-Way Left Turn Lane (overhead)	R3-9a	2B-19	73.5
29T	**Type 2 Object Marker (vert)**	**OM-2V**	**3C-1**	**73.5**
29T	Type 2 Object Marker (horz)	OM-2H	3C-1	73.5
29T	Advance Pedestrian Crossing	W11-2	2C-31	73.5
33T	**Double Solid Yellow Centerline**	—	**3B-1**	**72.9**
33T	**Flashing Yellow Ball - Signal**	—	**4B-5**	**72.9**
35T	**RAMP METERED WHEN FLASHING**	**W19-3**	**2C-41**	**71.4**
35T	**Flashing DON'T WALK (words)**	—	**4D-2**	**71.4**
35T	Type 4 End of Road Markers	OM-4R	3C-4	71.4
35T	**Type 1 Object Marker**	**OM-1**	**3C-1**	**71.4**
35T	**LIMITED SIGHT DISTANCE**	**W14-4**	**2C-39**	**71.4**
40	**Turn Prohibition**	**R3-1, R3-2**	**2B-15**	**69.4**
41T	**Flashing Yellow - Beacon**	—	**4B-5**	**68.8**
41T	**Stop Line**	—	**3B-17**	**68.8**
41T	**Single Broken Yellow Centerline**	—	**3B-1**	**68.8**
41T	**Flashing Red Ball - Signal**	—	**4B-5**	**68.8**
45T	**Slow Down on Wet Road**	**W8-5**	**2C-30**	**67.3**
45T	**Stop Ahead (symbol)**	**W3-1a**	**2C-15**	**67.3**
47T	Green Arrow - Traffic Signal	—	4B-5	66.7
47T	**Solid White Edge Line**	—	**3B-6**	**66.7**
47T	**Flashing Red - Beacon**	—	**4B-5**	**66.7**
47T	**Single Broken White Lane Line**	—	**3B-2**	**66.7**
47T	Pavement Word/Symbol Markings	—	3B-20	66.7

[1] Ranked order of device according to the percentage giving a score of 2 or 3.

[2] Percentage of the 49 respondents which gave a device a score of 2 or 3.

Bold indicates those devices which were one of the 60 included in the pilot motorist survey.

T indicates a tie in ranking

Several transportation professionals made comments about devices which were not included in the poll. These comments were useful and identified several additional devices which the research team added to the selection process. A summary of the comments are provided in Appendix E. Three of the signs that received comments were eventually selected for inclusion in the pilot survey. These three signs are the Railroad Advance Warning (W10-3), the Truck Crossing symbol (W11-10), and the WATCH FOR ICE ON BRIDGE (W19-2).

RANKING PROCEDURES

While the poll of transportation professionals provided a useful indication of the relative importance of various traffic control devices, these results did not give explicit consideration to several important factors related to motorist understanding of traffic control devices. Therefore, the research team develop a ranking procedure which gave explicit consideration to six factors: professional opinion, consequence of misunderstanding, previous research, inclusion in the *Texas Drivers Handbook* (32), frequency of use in the field, and any special interest on the part of the research team. Each device was given a score for each of the six factors. These scores were then added together to provide a total score for each device. The total score provided a rough indication of the importance of including the traffic control device in the survey.

The ranking procedure was divided into two efforts. The initial ranking was based on five of the six factors (previous research was not included) and identified those devices about which previous research was needed. Information about the results of previous research on motorist comprehension was collected and the score for the six factor was determined. The final ranking was then completed using all six factors.

The relative importance of a given factor was indicated by the highest possible score that could be given. Table 10 indicates the six factors used in the ranking procedure, the range of scores used for each factor, and the relative weighing each factor received. The

following paragraphs summarize how the score for each factor was determined, along with a description of the results of the initial and final rankings.

Table 10. Summary of Ranking Factors and Relative Weighing

Factor	Range of Possible Scores	Relative Weighing of Factor
Professional Opinion	0-3	25 %
Consequence of Misunderstanding	0-3	25 %
Inclusion in Texas Drivers Handbook	0-1	8 %
Frequency of Use	0-1	8 %
Special Interest	0-1	8 %
Previous Research Findings	0-3	25 %
Total Score	0-12	100 %

Professional Opinion

The professional opinion factor incorporated the findings of the poll of transportation professionals into the ranking procedure. This factor was one of three major factors which received a weighing of 25 percent of the total score in the final ranking. Scores of 0, 1, 2, or 3 were used to represent how the transportation officials felt about including a device in the motorist survey. The higher scores indicated a greater desire to include the device in the motorist survey. The score was determined after reviewing the percentage of the 49 transportation professionals which gave a device a 2 or 3 in the poll. Table 11 describes the criteria used in determining the score for a given device.

Table 11. Criteria for Professional Opinion Scoring

Score	Transportation Professionals Giving a Device a 2 or 3 in Poll	Number of Devices
3	≥ 65 percent	54
2	≥ 50 and < 65 percent	33
1	≥ 35 and < 50 percent	28
0	< 35 percent	17

Consequence of Misunderstanding

The consequence of not understanding the meaning of a device was the second major factor used in the ranking process. This factor had a weighing of 25 percent of the total score of the final ranking. Scores of 0, 1, 2, or 3 were used to indicate the severity of misunderstanding the traffic control device. A score of 3 was used to indicate a head-on collision between two vehicles, or a collision with a pedestrian, train, or fixed object, all of which are likely to result in fatality. A score of 2 was used to indicate a right angle collision or a loss of vehicle control, which would likely result in serious injury. A score of 1 was used to indicate a property damage only collision, which would result from a low speed collision or damage to the pavement. The opinions of the research team were used to determine the score for each device according to the criteria contained in Table 12.

Table 12. Criteria for Consequence Scoring

Score	General Description of Consequence	Number of Devices
3	Misunderstanding resulting in potential fatal injury.	37
2	Misunderstanding resulting in potential serious injury.	33
1	Misunderstanding resulting in potential property damage.	26
0	Misunderstanding resulting in loss of direction or no consequence.	43

Inclusion in Texas Drivers Handbook

The probability of a driver having been informed of the meaning of a device was one of three minor factors included in the ranking procedure. This factor considered whether a driver was given the meaning of a traffic control device in the *Texas Drivers Handbook* (32). This handbook is provided to all driver license applicants and is available in English and Spanish language versions. This factor had a weighing of 8⅓ percent of the total score. Scores of 0 or 1 were used to indicate whether a device was defined in the drivers handbook. A score of 1 indicates that a the meaning of the device is not included in the handbook while a score of 0 indicates that the device is defined in the handbook. Table 13 describes the criteria used for evaluated driver education. It should be noted that no consideration was given to whether the *Texas Drivers Handbook* definition of the device agreed with the definition contained in the Texas MUTCD. It should also be noted that the September 1988 version of the handbook was used for the evaluation. This version has since been succeeded by November 1990 version.

Table 13. Criteria for Driver Education Scoring

Score	Educational Exposure to Device	Number of Devices
1	Meaning of device not in Texas Drivers Handbook.	65
0	Meaning of device given in Texas Drivers Handbook.	74

Frequency of Use

The need for a driver to know the meaning of a device was included in the ranking procedure by considering the frequency of use. This factor also had a weighing of 8⅓ percent of the total score. Scores of 0 or 1 were used to indicate whether a device is commonly used. A score of 1 indicates that a motorist is likely to see the device in a typical driving environment, while a score of 0 indicates that the device in not seen on a regular

basis. The opinions of the research team were used to determine the score for each device according to the criteria contained in Table 14.

Table 14. Criteria for Frequency of Use

Score	Frequency of Device in Driving Environment	Number of Devices
1	Device is commonly used.	92
0	Device is rarely used.	47

Special Interest

The third minor factor in the ranking process was used to give special emphasis to devices the research team or the advisory committee felt should be included in the motorist survey. Special emphasis might be given to a device for several different reasons. Some examples include recent evidence suggesting comprehension difficulties, geographical or societal concerns which are not evidenced in other research, professional experiences in use of the device, or concerns related to tort liability. The weighing for this factor was 8⅓ percent. A device was given a score of 1 if there was a desire to give special emphasis to that device. Likewise, a score of 0 was used to indicate that there was no need for special emphasis. Table 15 describes the criteria used for this factor of the ranking process.

Table 15. Criteria for Research Team Special Interest

Score	Special Interest of Research Team	Number of Devices
1	Research team had special interest in including device in motorist survey.	27
0	Research team had no special interest in including device in motorist survey.	115

Initial Ranking Results

The initial ranking was determined by adding the scores of the five factors just described. The total scores were then arranged in descending order to provide a prioritized listing of the traffic control devices being considered for the motorist survey. A 9 was the highest possible score that could be given to any device. Devices which received a score of 5 or higher were identified as needing additional information from previous research studies on motorists comprehension.

Previous Research Findings

The results of previous research findings were applied to the top ranked devices from the initial ranking. The results of the literature review were used to determine the score for the comprehension of these devices. This factor was weighted as 25 percent of the total final score. Scores of 0, 1, 2, or 3 were used to represent how well motorists understood the meaning of a given traffic control devices according to the results of previous research studies. A high score indicates that motorist do not have a clear understanding of the meaning of a devices. The research findings described in Section II were used to determine which score to give a particular device. Table 16 describes the criteria used in determining the score for a given device.

Table 16. Criteria for Comprehension Scoring

Score	General Description of Comprehension	Number of Devices
3	Significant comprehension difficulties or no data available	53
2	Notable comprehension difficulties	9
1	Minor comprehension difficulties	12
0	Device well understood	6

Final Ranking

The final ranking was determined by adding the scores of all six of the factors. The total final scores were then arranged in descending order to provide a prioritized listing of the traffic control devices being considered for the motorist survey. A 12 was the highest possible score that could be given to any device. Table 17 lists those devices which received a score of 12, 11, or 10. The prioritized results of the ranking process are summarized in Appendix F, which gives the total score for each device, along with the score for each of the six factors making up the total.

Table 17. Summary of Highest Final Scores

Final Score	Number of Devices Receiving Final Score	Device Name
12	3	PROTECTED LEFT ON GREEN ARROW Single Broken Yellow Centerline No Passing Zone Markings
11	8	PROTECTED LEFT ON GREEN LEFT TURN YIELD ON GREEN Ball Slow Down on Wet Road Pedestrian Crossing Stop Line Type 2 Object Marker (vert) Type 3 Object Marker Advance School Crossing
10	10	Two-Way Left Turn Lane (overhead) Two-Way Left Turn Lane (post) Keep Right (symbol) Lane Reduction Transition Advance Pedestrian Crossing Double Solid Yellow Centerline Two-Way Left Turn Markings Permitted/Protected Left Turn School Crossing SCHOOL SPEED LIMIT

PRE-TEST SURVEY

A total of 60 devices were selected for inclusion in the pre-test survey. However, these 60 devices do not represent the top 60 devices in the final ranking. A number of the devices near the top of the ranking were not included in the pre-test survey for a number of reasons.

Typical reasons include: an abundance of previous research indicating the device is not understood well, inability to include the device in the format of the survey, or inclusion of a closely related device in the survey. Table 18 list the 60 devices which were selected for the pre-test study.

Table 18. List of 60 Devices in Pre-test Survey

Device Name	Designation	TMUTCD Section
Flashing Yellow Arrow - LCS	----	----
Warning Sign Shape and Color	----	2A-10,11
Guide Sign Color	----	2A-11
STOP Sign Color	----	2A-11
YIELD	R1-2	2B-7
SPEED ZONE AHEAD	R2-5c	2B-14
Turn Prohibition	R3-1, R3-2	2B-15
Mandatory Movement (post)	R3-7L	2B-17
Double Turn (post)	R3-8L	2B-17
Two-Way Left Turn Lane (post)	R3-9b	2B-19
HOV RESTRICTION	R3-14	2B-20
SLOWER TRAFFIC KEEP RIGHT	R4-3	2B-23
DO NOT CROSS DOUBLE WHITE LINE	R4-3b	2B-23.2
Keep Right (symbol)	R4-7	2B-25
PROTECTED LEFT ON GREEN ARROW	R10-9	2B-37
PROTECTED LEFT ON GREEN	R10-9a	2B-37
NO TURN ON RED	R10-11a	2B-37
LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37
Turn	W1-1R	2C-4
Curve	W1-2L	2C-5
Reverse Turn	W1-3L	2C-6
Stop Ahead (symbol)	W3-1a	2C-15
Merge	W4-1R	2C-18
Added Lane	W4-3R	2C-18.1
Lane Reduction Transition	W4-2R	2C-19
LANE ENDS MERGE LEFT	W9-2L	2C-19
Narrow Bridge (symbol)	W5-2a	2C-21
Divided Highway Ends (symbol)	W6-2	2C-24
Slow Down on Wet Road	W8-5	2C-30
GROOVED PAVEMENT AHEAD	W8-12	2C-30.5
Truck Crossing (symbol)	W11-10	2C-31
LIMITED SIGHT DISTANCE	W14-4	2C-39
WATCH FOR ICE ON BRIDGE	W19-2	2C-41
RAMP METERED WHEN FLASHING	W19-3	2C-41

Table 18. List of 60 Devices in Pre-test Survey (continued)

Device Name	Designation	TMUTCD Section
Hospital (symbol)	D9-2	2D-46
Single Broken Yellow Centerline	----	3B-1
Two-Way Left Turn Markings	----	3B-1
Double Solid Yellow Centerline	----	3B-1
Single Broken White Lane Line	----	3B-1
Double Solid White Lane Line	----	3B-2
No Passing Zone Markings	----	3B-2
Solid White Edge Line	----	3B-3
Stop Line	----	3B-6
Preferential Lane Marking (diamond)	----	3B-17
Type 1 Object Marker	----	3B-22
Type 2 Object Marker (vert)	OM-1	3C-1
Type 3 Object Marker	OM-2V	3C-1
Yellow Ball - Traffic Signal	OM-3R	3C-1
Yellow Arrow - Traffic Signal	----	4B-5
Flashing Yellow Ball - Signal	----	4B-5
Flashing Red Ball - Signal	----	4B-5
Flashing Yellow - Beacon	----	4B-5
Flashing Red - Beacon	----	4B-5
Flashing DON'T WALK (words)	----	4D-2
Steady Red X - LCS	----	4E-9
Advance School Crossing	S1-1	7B-9
SCHOOL BUS STOP AHEAD	S3-1	7B-11
SCHOOL SPEED LIMIT	S5-1	7B-12
RR Advance Warning	W10-1	8B-3
RR Parallel Advance Warning	W10-3	8B-3

Pre-test studies indicated fourteen (14) devices which were clearly understood by an were subsequently dropped from further survey evaluation. The pilot and final motorist survey addressed a total of 46 traffic control devices. These devices are listed in Table 19. These are the devices which were included in the pilot survey and submitted to SDHPT for approval.

Table 19. List of 46 Devices in Pilot and Final Motorist Survey.

Device Name	Designation	TMUTCD Section
Warning Sign Shape and Color	----	2A-10,11
Guide Sign Color	----	2A-11
YIELD	R1-2	2B-7
REDUCED SPEED AHEAD	R2-5a	2B-14
SPEED ZONE AHEAD	R2-5c	2B-14
Mandatory Movement (post)	R3-7L	2B-17
Double Turn (post)	R3-8L	2B-17
Two-Way Left Turn Lane (post)	R3-9b	2B-19
HOV RESTRICTION	R3-14	2B-20
SLOWER TRAFFIC KEEP RIGHT	R4-3	2B-23
DO NOT CROSS DOUBLE WHITE LINE	R4-3B	2B-23.2
Keep Right (symbol)	R4-7	2B-25
PROTECTED LEFT ON GREEN ARROW	R10-9	2B-37
PROTECTED LEFT ON GREEN	R10-9a	2B-37
LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37
Turn	W1-1R	2C-4
Curve	W1-2L	2C-5
Reverse Turn	W1-3L	2C-6
Stop Ahead (symbol)	W3-1a	2C-15
Lane Reduction Transition	W4-2R	2C-19
LANE ENDS MERGE LEFT	W9-2L	2C-19
Narrow Bridge (symbol)	W5-2a	2C-21
Divided Highway Ends (symbol)	W6-2	2C-24
Slow Down on Wet Road	W8-5	2C-30
ROUGH ROAD	W8-8	2C-30.2
GROOVED PAVEMENT AHEAD	W8-12	2C-30.5
Truck Crossing (symbol)	W11-10	2C-31
LIMITED SIGHT DISTANCE	W14-4	2C-39
WATCH FOR ICE ON BRIDGE	W19-2	2C-41
RAMP METERED WHEN FLASHING	W19-3	2C-41
Two-Way Left Turn Markings	----	3B-1
Single Broken Yellow Centerline	----	3B-1
Single Broken White Lane Line	----	3B-2
Double Solid White Lane Line	----	3B-2
No Passing Zone Markings	----	3B-3
Solid White Edge Line	----	3B-6
Preferential Lane Marking (diamond)	----	3B-22
Type 3 Object Marker	OM-3R	3C-1
Flashing Yellow Ball - Signal	----	4B-5
Yellow Arrow - Traffic Signal	----	4B-5
Flashing Red - Beacon	----	4B-5
Flashing Yellow - Beacon	----	4B-5
Steady Red X - LCS	----	4E-9
SCHOOL SPEED LIMIT	S5-1	7B-12
RR Advance Warning	W10-1	8B-3
RR Parallel Advance Warning	W10-3	8B-3

SECTION IV - SURVEY DEVELOPMENT

ASSESSMENT INSTRUMENT

The survey to assess motorist understanding of traffic control devices was intended to cover a fairly broad base, both geographically, numerically, and in terms of subject matter. Therefore, the survey instrument was developed to include a large number of TCD's (within the range of practicality in terms of respondent cooperation). As described in the previous section, a thorough critique was made of previous literature, professional and practitioners' opinions to compile the list of TCD's to be included in the survey. Once the list of TCD's had been compiled, a multiple choice question was developed for each TCD.

In the course of deriving the list of TCD's to be studied, an important step in instrument development was to ascertain how these TCD's had been misunderstood in previous studies. The questions were designed with one desirable response, two responses within the realm of possible misunderstanding, and a "not sure" response. These choices were derived based on previous studies, expert opinion, and confusing or conflicting information that is currently provided to motorists.

The questions developed for the assessment instrument were generally designed as a problem identification tool. The instrument was not intended to explain why misunderstanding exists or to provide solutions to problem TCD's. Rather, the instrument was designed to identify what problems exist, for whom these problems exist, and the pervasiveness of such problems. The objective of the second phase of this study, subsequent to the statewide survey, is to study the problematic TCD's in greater detail using different techniques designed to identify solutions to the problems.

After pre-testing and pilot-testing the survey instrument and administration procedures as described in a subsequent section of this report, the study advisory panel reviewed and approved the assessment instrument. The final format of the survey instrument was a

videotape presentation of forty-six (46) TCD's. In the presentation, each 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 the four response choices. The video was timed to allow at least three seconds of viewing time for each device in-context. The questions were narrated and response choices were verbally given by the respondent who entered the data on-site with a lap-top computer. Sixteen background questions were asked at the end of the videotape presentation. These questions were designed to provide information regarding the respondent's demographic characteristics and driving experience. Appendix G shows each TCD and the response choices that were used in the assessment instrument.

Sampling Plan

A successful survey relies heavily on a good sampling plan. The sampling plan for this survey was developed to provide statewide representation of the driving population in proportion to the demographic characteristics of Texas adults. It was determined that a representative quota sample would allow for results to be obtained with a high level of confidence, given a sample size of 2000. In this manner 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 quota sample design is shown in Figure 2.

To determine the quota sample for the state, six geographic regions were delineated. These regions are shown on the map in Figure 3, and correspond to Texas Department of Public Safety (DPS) regional boundaries. The proportion of the population age 16 and above for each region was calculated using 1988 population estimates from the State Population Center located at Texas A&M University. These estimates are the most current and accurate estimates available at the time of this study. The population estimates determined the target number of respondents from each region. Likewise, the composition

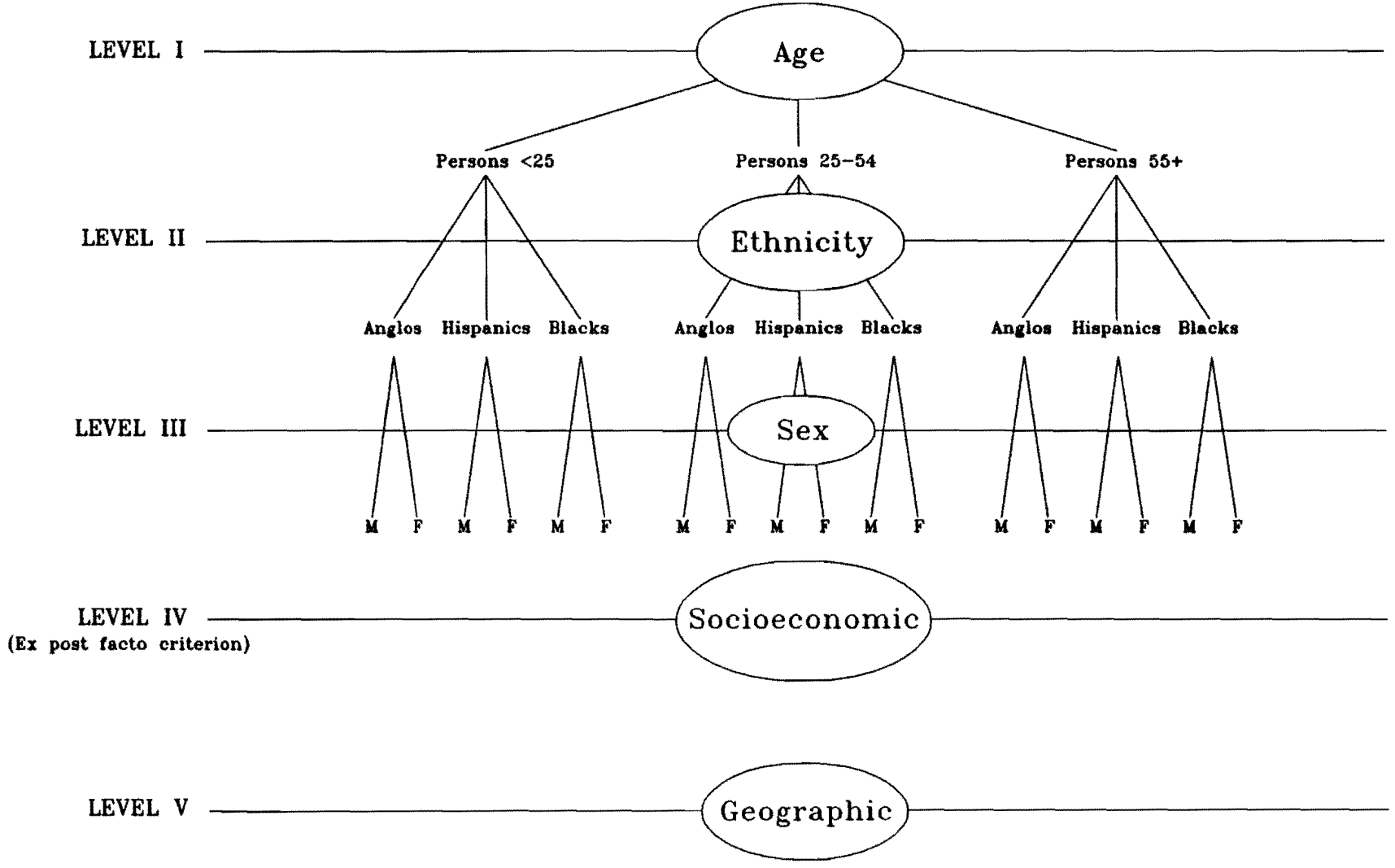


Figure 2. Quota Sample Design

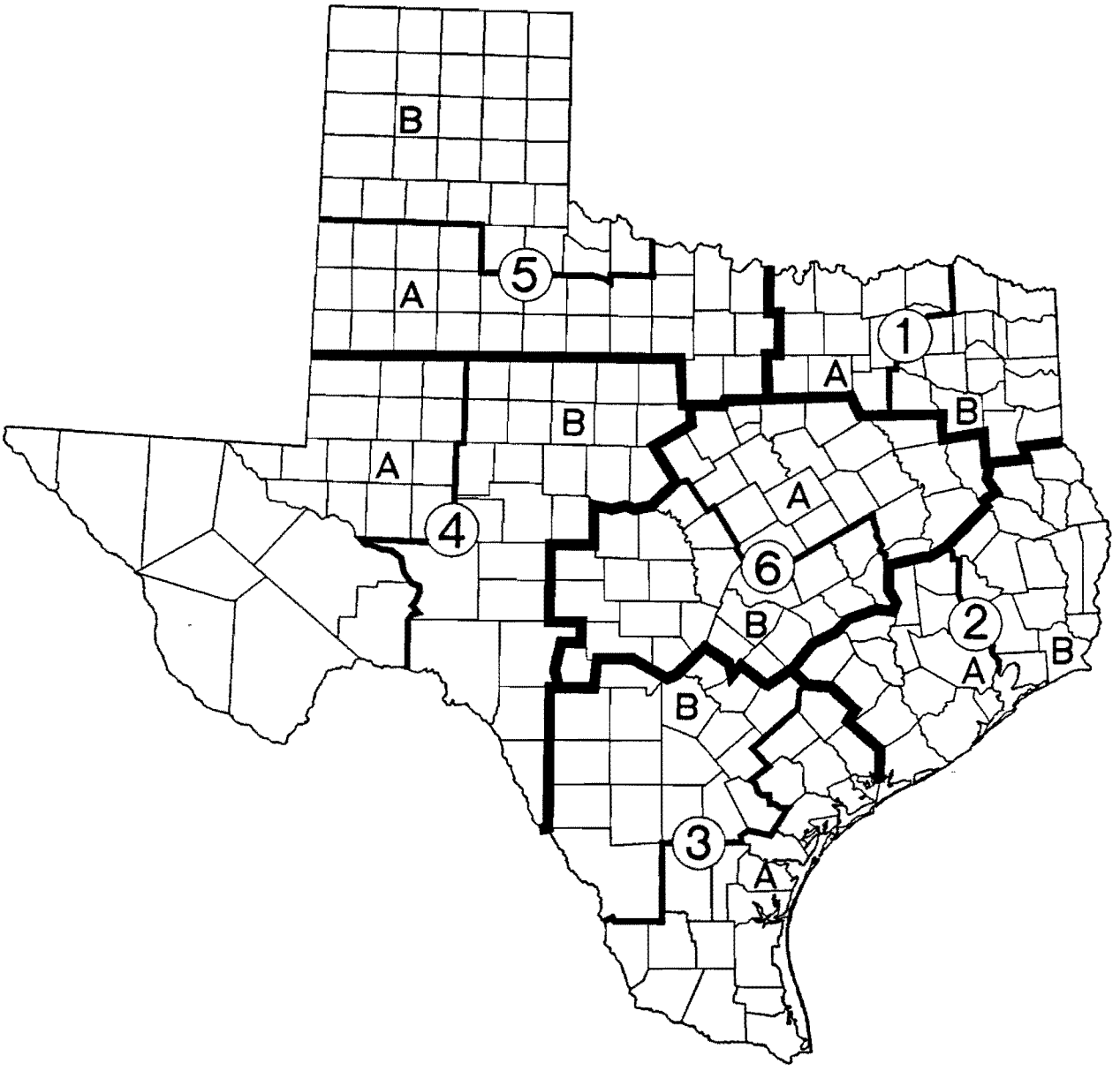


Figure 3. Texas Department of Public Safety Traffic Law Enforcement Division Regional Boundaries and District Lines

of the population in terms of age, sex, and ethnicity were calculated for each region. Using a sample size of 2000, the number of respondents to meet the quota for each region and for each demographic variable is given in Table 20. The final step in the survey design was to select cities to serve as data collection sites. In each region a small city (under 50,000 population) and a large city (over 50,000 population) was selected that met two criteria. First, the city had to be a location for a driver licensing station (the chosen site for data collection activities to take place). Second, cities were selected that most closely matched the region in terms of ethnic composition. The selected survey counties are shown in Figure 4 along with a list of the cities selected for the survey.

Survey Administration

The sampling plan set forth the quotas for each population subgroup that should be represented in the study. It was reasoned that a logical place to recruit volunteers for the survey was in DPS driver licensing (DL) offices. These offices are used by drivers in all demographic subgroups and in each socioeconomic group as well. Further, drivers with all ranges of driving experience, from newly licensed to professional drivers, conduct business in the driver license offices.

Surveyors were instructed to approach potential respondents without regard to individual characteristics, in order to avoid introducing bias into the sample. Although a quota was targeted in each DL station, the clientele of the station was presumed to match regional demographics. Therefore, screening respondents was not necessary. The only screening question was to ascertain that the potential respondent was a driver.

A training session was held with surveyors and detailed instructions were provided (see Appendix H). Care was taken such that the survey administration would be consistent, regardless of the surveyor.

Table 20.

Quota Sample for Survey

N=2000

	REGION					
	North-East	South-East	South	West	North-West	Central
	546	538	346	170	132	268
Sex						
Male	262	269	166	83	63	131
Female	284	269	180	87	69	137
Age						
<25	109	108	80	40	29	67
25-54	306	312	176	87	65	131
55+	131	118	90	43	38	70
Ethnicity						
Anglo	415	365	146	95	106	204
Black	82	97	17	9	8	32
Hispanic	49	76	183	66	18	32

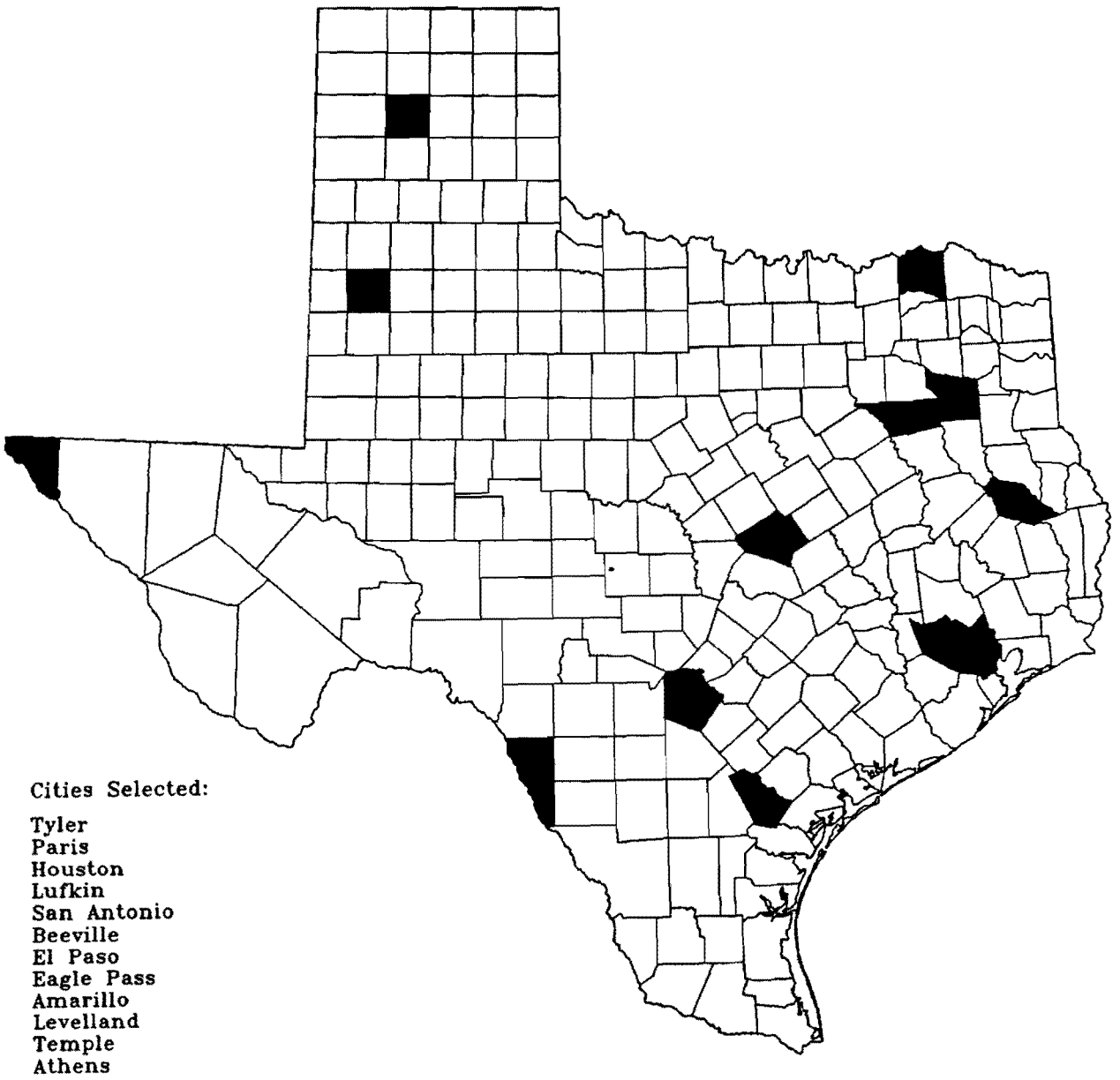


Figure 4. Selected Survey Counties

Pre-Test and Pilot Surveys

In its early stages of development the survey instrument was pre-tested for content clarification. The original assessment instrument consisted of 60 items, and the videotape presentation was 34 minutes long. This format was determined to be beyond the acceptable time limit to expect widespread cooperation from potential respondents. Therefore, in order to check the clarity of each question, the instrument was given in two parts during the pre-test.

At this stage, a response form was completed by the respondent while viewing the videotape. Space was provided and the respondent was encouraged to comment on each question. Further, upon completion of the survey, the fact that the instrument was being pre-tested was explained to the respondent, and a critique was solicited.

The pre-test was conducted in two locations in the Bryan/College Station area--a shopping mall and the driver license station. A total of 38 drivers were given at least one part of the assessment instrument.

The pre-test results were used primarily to refine the survey instrument. For example, questions that were answered correctly by over 95 percent of the respondents were considered to be well understood and were eliminated from the instrument. Response choices that were never selected were considered to be poor choices and were modified. Additionally, the pre-test revealed that 15-20 minutes would be the maximum effective time for the instrument; that responses would be more accurately and efficiently recorded by the surveyor; that introductory remarks needed to be more concise; narration needed to be faster; and several slides needed to be clearer.

Once the results of the pre-test were presented to the study advisory panel and the above mentioned modifications were made, a pilot test was conducted. The pilot test was conducted at the 1991 Houston Automobile Show.

The purpose of the pilot test was:

1) to finalize the questions including modifications based on pre-test results;
2) to test administration procedures, i.e., data entry and videotape set-up;
3) to obtain a broader public reaction to the survey; and
4) to provide on-site experience for those who would be administering the survey in driver license stations at a later date.

The videotape presentation was given to 165 volunteers at the Auto Show. These respondents were not selected (or sampled) from the Auto Show population. They were walk-up volunteers. The results of the pilot test are provided in Section V of this report.

SECTION V - PILOT SURVEY RESULTS

As previously mentioned, a pilot test of the final forty-six (46) traffic control devices was conducted in February, 1991 in Houston, Texas at the Annual Automobile Show.

The videotape presentation was given to 165 "walk-up" volunteers from the touring population. These respondents were not selected (or sampled); yet, all were licensed drivers. A summary of demographic information from the pilot survey respondents is given in Table 21.

Table 21. Pilot Study Demographics

1. What is your sex?
   - 69.7 Male
   - 29.7 Female

2. What is your age?
   - 40.0 16 - 24 (exact age if 25)
   - 22.4 25 - 34
   - 28.5 35 - 44
   - 7.3 45 - 54
   - 1.2 55 - 64
   - 65 +

3. What is the last year of school you completed?
   - 16.4 Less than high school
   - 18.8 High school graduate (or equivalent)
   - 3.0 Technical/Business school
   - 37.6 Some college
   - 17.6 College Graduate
   - 6.1 Graduate school

4. What is your family background?
   - 72.1 Anglo
   - 4.8 Black
   - 15.5 Hispanic
   - 6.1 Other (Specify: 40% Asian)

5. Is English the primary language spoken in your home?
   - 93.3 Yes
   - 5.5 No

6. Is driving a vehicle a major part of your job (other than driving to and from work)?
   - 35.2 Yes
   - 57.0 No
   - 7.3 Does not apply
   - 8.5 Outside city limits
   - 45.5 About half within city limits and half outside city limits

7. About how many miles do you drive during an average year?
   - 20.0 Less than 10,000 miles
   - 24.2 10,000 to 15,000 miles
   - 25.5 15,001 to 20,000 miles
   - 13.9 20,001 to 30,000 miles
   - 15.2 Over 30,000 miles

8. What type of driving do you most of the time?
   - 44.8 Within city limits
   - 8.5 Outside city limits
   - 45.5 About half within and half outside city limits

9. How many times a year do you take a trip and travel more than 300 miles (roundtrip)?
   - 9.1 None
   - 20.6 1 time
   - 57.6 2 to 10 times
   - 11.5 More than 10 times

10. How long have you had a driver's license?
    - 90.3 years (or months)
    - 5.5 Less than one (1) year

11. How long have you had a Texas driver's license?
    - 90.3 years (or months)
    - 5.5 No Texas driver's license

12. What type of driver's license do you have?
    - 76.6 Operator's
      Commercial Vehicle (Class A 11.4 or Class B 2.9)
    - 9.1 Motorcycle

13. What type of vehicle do you drive?
    - 84.8 Passenger
    - 13.9 Truck

Appendix I gives complete response breakdowns for all forty-six (46) devices presented for pilot survey at the Auto Show. Table 22 highlights those twenty-eight (28) traffic control devices from the pilot survey which are indicated to be understood at a level (85%) less than desirable by these respondents. Further inspection of Table 22 indicates that twelve (12) devices surveys were comprehended by the pilot sample at a level (65%) deemed less than adequate.

Table 22. Pilot Survey Results

Survey Question No.	TCD Description	MUTCD Designation	% Correct	% Incorrect	% Not Sure
1	"Slow Down on Wet Road" *Warning Sign*	W8-5	73.3	26.0	0.7
3	"SPEED ZONE AHEAD" *Regulatory Sign*	R2-5	70.9	21.2	7.9
6	"Two-Way Left Turn" *Pavement Marking*	—	20.6	73.9	5.5
8	"Curve" *Warning Sign*	W1-2R	43.6	55.8	0.6
9	"Keep Right" *Regulatory Sign*	R4-8	82.4	17.0	0.6
10	"SLOWER TRAFFIC KEEP RIGHT" *Regulatory Sign*	R4-3	76.4	23.6	0.0
11	"Flashing Yellow Beacon" *Signal*	—	49.1	47.3	3.6
12	"LIMITED SIGHT DISTANCE" *Warning Sign*	W14-4	57.0	33.3	9.7
13	"Solid White Edge Line *Pavement Marking*	—	83.0	14.6	2.4
14	"Type 3 Object Marker"	OM-3R	73.3	16.3	10.4
17	"Double Solid White Lane Line" *Pavement Marking*	—	64.8	30.9	4.3
19	"Lane Reduction Transition" *Warning Sign*	W4-2	69.7	24.8	5.5
21	"Reverse Turn" *Warning Sign*	W1-3R	78.2	20.6	1.2
22	"Flashing Red Beacon" *Signal*	—	38.8	57.0	4.2
23	"Divided Highway" *Warning Sign*	W6-2	74.5	21.8	3.7
26	"Turn" *Warning Sign*	W1-1R	38.2	47.2	14.6
27	"GROOVED PAVEMENT" *Warning Sign*	W8-12	30.9	50.5	18.6
28	"LANE ENDS MERGE RIGHT" *Warning Sign*	W9-2	73.3	21.8	4.9
29	"School-Speed Limit 20 When Flashing" *Warning Sign*	S5-1	77.0	14.6	8.4
30	"PROTECTED LEFT ON GREEN ARROW" *Regulatory Sign*	R10-9	30.9	66.3	1.6

Table 22. Pilot Survey Results (continued)

Survey Question No.	TCD Description	TMUTCD Designation	% Correct	% Incorrect	% Not Sure
33	"Center Lane Only" *Regulatory Sign*	R3-9B	37.6	56.9	5.5
34	"PROTECTED LEFT ON GREEN ARROW *Regulatory Sign*	R10-9	69.7	27.9	2.4
36	"DO NOT CROSS DOUBLE WHITE LINE" *Regulatory Sign*	R4-3B	77.6	18.8	3.6
37	"RAMP METERED WHEN FLASHING" *Warning Sign*	W19-3	59.4	28.4	12.2
39	"Lane Use Control" *Regulatory Sign*	R3-8	76.4	20.0	3.6
43	"Steady Red X Lane Control" *Signal*	—	78.8	9.1	12.1
44	"Buses and 4 Rider Carpool Only" *Regulatory Sign*	R3-14	63.6	29.1	7.3
45	Warning Sign Shape and Color	—	67.9	27.2	4.9

However, the results of this pilot survey must be qualified in two respects. First, correct response follows a strict and appropriate legal definition. And second, the survey sample did not necessarily represent the region demographic character. Specifically, the pilot survey respondents were over represented by younger, more educated, anglo males. Therefore, extrapolation of results, while revealing in many respects, is limited.

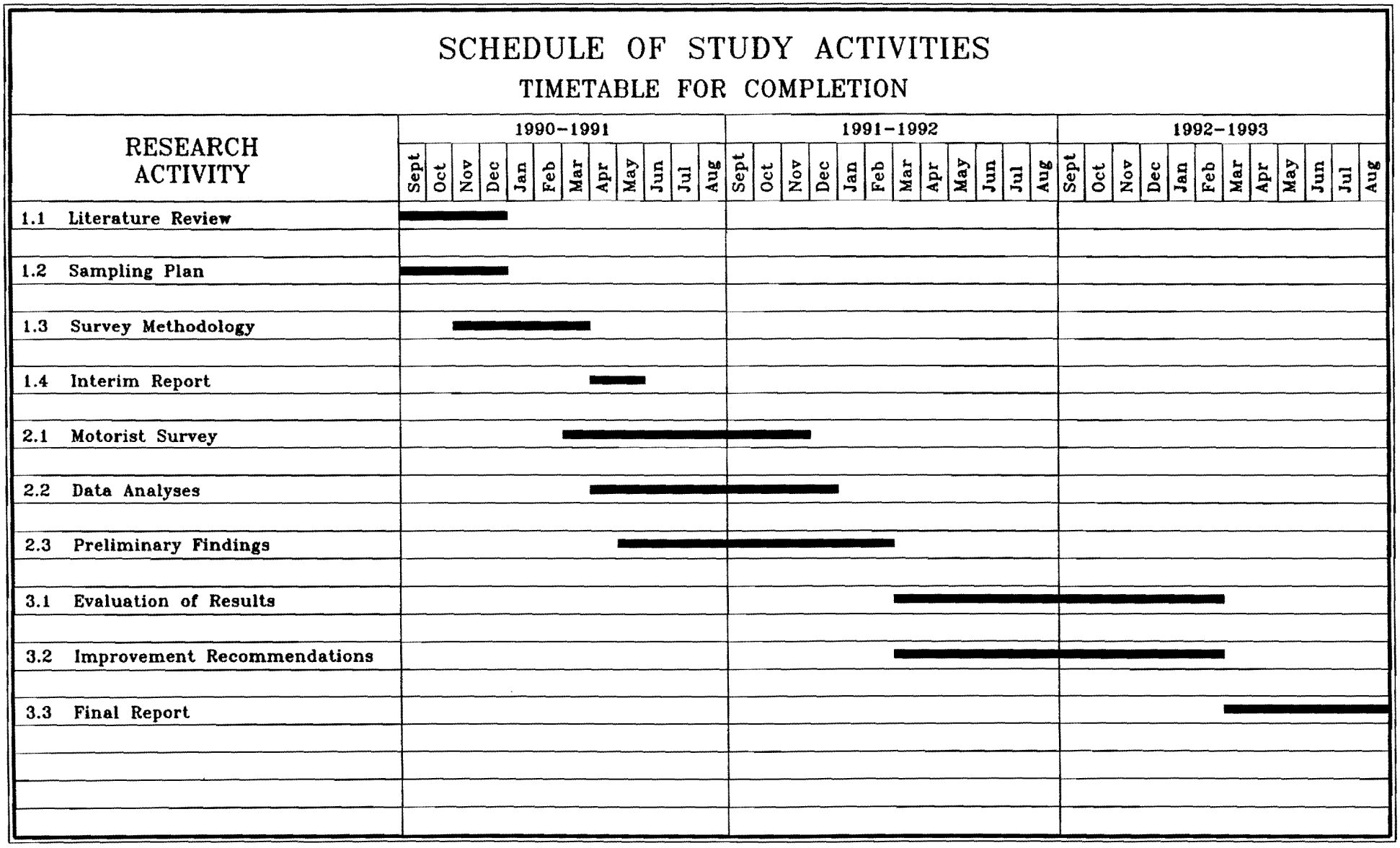
SECTION VI - STUDY CONTINUATION

The survey instrument and methodology were submitted by recommendation of the study advisory committee to the Texas State Department of Highways and Public Transportation and the Federal Highway Administration for approval in December, 1990. Approval, with minor revisions was granted in March, 1991.

Task 2.1, "Conduct Motorist Survey" was initiated in April, 1991 and continues statewide. This activity, along with ongoing analysis, is projected to be near completion by December, 1991.

Figure 5 illustrated a current time table for completion and projection of study tasks for the expected duration of the project. It is anticipated that preliminary results will be available regarding motorist understanding of traffic control devices in early 1992.

Figure 5. Schedule of Study Activities



SECTION VII - REFERENCES

1. Koppa, R.J., P.K. Guseman, *Public Understanding of Traffic Control Devices in Texas*, Research Report 232-1F, Texas Transportation Institute, College Station, Texas, November 1978.

2 Womack, K.N., P.K. Guseman, R.D. Williams, *Measuring the Effectiveness of Traffic Control Devices: An Assessment of Driver Understanding*, Texas Transportation Institute, College Station, Texas, September 1981.

3. Knoblauch, R.L, M.T. Pietrucha, *Motorists' Comprehension of Regulatory, Warning, and Symbol Signs, Volume I: Executive Summary*, FHWA-RD-86-111, Federal Highway Administration, Washington, D.C., February 1987.

4. Knoblauch, R.L, M.T. Pietrucha, *Motorists' Comprehension of Regulatory, Warning, and Symbol Signs, Volume II: Technical Report*, FHWA-RD-86-112, Federal Highway Administration, Washington, D.C., February 1987.

5. Knoblauch, R.L, M.T. Pietrucha, *Motorists' Comprehension of Regulatory, Warning, and Symbol Signs, Volume III: Appendices*, FHWA-RD-86-113, Federal Highway Administration, Washington, D.C., February 1987.

6. Hulbert, Slade, Jinx Beers, Paul Fowler, *Motorists' Understanding of Traffic Control Devices*, American Automobile Association Foundation for Traffic Safety, Falls Church, Virginia, March 1979.

7. Hulbert, Slade, Paul Fowler, *Motorists' Understanding of Traffic Control Devices, Test II*, American Automobile Association Foundation for Traffic Safety, Falls Church, Virginia, December 1980.

8. *"Research Problem Statements on Traffic Control Devices"*, Committee on Traffic Control Devices, Transportation Research Circular 335, August, 1988.

9. M.A. Ogden, K.N. Womack, and J.M. Mounce. "Motorist Comprehension of Signing Applied in Urban Arterial Work Zones", Transportation Research Record, 1281, 1990.

10. *American Highways, 1776-1976*, Federal Highway Administration, Washington, D.C., 1976.

11. Sessions, Gordon, *Traffic Control Devices: Historical Aspects Thereof*, Institute of Traffic Engineers, Washington, D.C., 1971.

12. *First National Conference on Street and Highway Safety*, Washington, D.C., December 15-16, 1924.

13. *Manual and Specifications for the Manufacture, Display, and Erection of U.S. Standard Road Markers and Signs*, American Association of State Highway Officials, Washington, D.C., January 1927.

14. *Report on the Committee of American Engineering Council on Street Traffic Signs, Signals, and Markings*, American Engineering Council, 1929.

15. American Engineering Council, *Manual on Street Traffic Signs, Signals and Markings*, National Conference on Street and Highway Safety, Washington, D.C, September 15, 1930.

16. *Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, National Conference on Street and Highway Safety, Washington, D.C., November 1935, reprinted September 1937.

17. *War Emergency Edition, Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, Institute of Traffic Engineers, National Conference on Street and Highway Safety, Washington, D.C., November 1942.

18. *Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, Institute of Traffic Engineers, National Conference on Street and Highway Safety, Public Roads Administration, Washington, D.C., August 1948.

19. *Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, Institute of Traffic Engineers, National Committee on Uniform Traffic Laws and Ordinances, National Association of County Officials, American Municipal Association, Bureau of Public Roads, Washington, D.C., June 1961.

20. *Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, Institute of Traffic Engineers, National Committee on Uniform Traffic Laws and Ordinances, National Association of Counties, National League of Cities, Federal Highway Administration, Washington, D.C., 1971.

21. *Manual on Uniform Traffic Control Devices for Streets and Highways*, Federal Highway Administration, Washington, D.C., 1978.

22. *Manual on Uniform Traffic Control Devices for Streets and Highways*, Federal Highway Administration, Washington, D.C., 1988.

23. *Revisions to the Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, National Conference on Street and Highway Safety, Washington, D.C., February 1939.

24. *Revisions to the Manual on Uniform Traffic Control Devices for Streets and Highways*, American Association of State Highway Officials, Institute of Traffic Engineers, National Committee on Uniform Traffic Laws and Ordinances, Bureau of Public Roads, Washington, D.C., September 1954.

25. *Official Rulings on Requests for Interpretations, Changes, and Experimentation, Volumes I-VIII*, Federal Highway Administration, Washington, D.C., 1971-1977

26. *Revisions Number 1-4 to the 1978 MUTCD*, Federal Highway Administration, Washington, D.C., 1979-1986.

27. Hawkins, H.G., "History of the National MUTCD," *Compendium of Technical Papers, 61st Annual Meeting*, Institute of Transportation Engineers, Washington, D.C., September 1991.

28. *Texas Manual on Uniform Traffic Control Devices*, Texas Highway Department, Austin, Texas, 1954.

29. *Texas Manual on Uniform Traffic Control Devices*, Texas Highway Department, Austin, Texas, 1967.

30. *Texas Manual on Uniform Traffic Control Devices*, Texas Highway Department, Austin, Texas, 1973.

31. *Texas Manual on Uniform Traffic Control Devices*, Texas Department of Highways and Public Transportation, Austin, Texas, 1980.

32. *Texas Driver Handbook*, Texas Department of Public Safety, Austin, Texas, September 1988.

APPENDIX A.
SUMMARY OF MUTCD DEVELOPMENT

Date	Publication	Sponsoring Committee	Number of Pages	Notes
1/27	MSDESRMS	AASHO	75	First national rural manual. Addressed only signs.
4/29	MSDESRMS	AASHO	unknown	Second edition of AASHO Manual.
12/31	MSDESRMS	AASHO	unknown	Revision of second edition of AASHO Manual.
5/30	MSTSSM	NCSHS	62	First national urban manual. Addressed signs, signals, markings, and safety zones.
11/35	1935 MUTCD	JCUTCD	unknown	First edition of MUTCD. Addressed signs, signals, markings, and islands.
9/37	1935 MUTCD Reprint	JCUTCD	166	Reprint of 1935 edition with no revisions.
2/39	Revisions to 1935 MUTCD	JCUTCD	25	Revision issued as supplement to 1935 MUTCD.
11/42	1942 MUTCD, War Emergency Edition	JCUTCD	208	New edition issued to address war related conditions.
8/48	1948 MUTCD	JCUTCD	223	Post war edition, contained significant changes.
9/54	Revisions to 1948 MUTCD	NJCUTCD	15	Revision issued as supplement to 1948 MUTCD.
6/61	1961 MUTCD	NJCUTCD	333	Added 2 parts addressing construction and civil defense.
10/71	1971 MUTCD	NJCUTCD	377	Wider use of symbols. Added parts for general provisions and school areas. Moved civil defense to signing part. Expanded guide sign section.
11/71	OROR Vol 1, 1971 MUTCD	NJCUTCD	6	First revision to 1971 MUTCD.
1/72	MUTCD Errata, 1971 MUTCD	NJCUTCD	2	Contained editorial changes to the 1971 MUTCD.
4/72	OROR Vol 2, 1971 MUTCD	NJCUTCD	19	Second revision to 1971 MUTCD.
3/73	OROR Vol 3, 1971 MUTCD	NACUTCD	37	Third revision to 1971 MUTCD.
10/73	OROR Vol 4, 1971 MUTCD	NACUTCD	20	Fourth revision to 1971 MUTCD.

Appendix A. Summary of MUTCD Development (continued)

Date	Publication	Sponsoring Committee	Number of Pages	Notes
6/74	OROR Vol 5, 1971 MUTCD	NACUTCD	32	Fifth revision to 1971 MUTCD.
6/75	OROR Vol 6, 1971 MUTCD	NACUTCD	75	Sixth revision to 1971 MUTCD.
9/76	OROR Vol 7, 1971 MUTCD	NACUTCD	73	Seventh revision to 1971 MUTCD.
12/77	OROR Vol 8, 1971 MUTCD	NACUTCD	94	Eighth revision to 1971 MUTCD.
12/77	Errata OROR Vol 8, 1971 MUTCD	NACUTCD	1	Corrected 1 page printing error in OROR Vol 8
9/78	1978 MUTCD	NACUTCD	425	New edition of MUTCD. Added parts addressing railroad-highway grade crossings and bicycle facilities. Distributed as loose-leaf pages in binder.
12/79	Revision 1, 1978 MUTCD	NACUTCD	68	Revisions contained pen and ink changes, OROR, and replacement pages.
12/83	Revision 2, 1978 MUTCD	NACUTCD	87	Revisions contained pen and ink changes, OROR, and replacement pages.
9/84	Revision 3, 1978 MUTCD	NACUTCD	85	Revisions contained OROR and replacement pages.
3/86	Revision 4, 1978 MUTCD	NCUTCD	81	Revisions contained OROR and replacement pages.
5/88	1988 MUTCD	NCUTCD	473	New edition of MUTCD printed as bound document. Included Revision 5 to 1978 MUTCD.

Abbreviations

AASHO	American Association of State Highway Officials
JCUTCD	Joint Committee on Uniform Traffic Control Devices
MSSDESRMS	Manual and Specifications for the Manufacture, Display, and Erection of U.S. Standard Road Markers and Signs
MSTSSM	Manual on Street Traffic Signs, Signals, and Markings
MUTCD	Manual on Uniform Traffic Control Devices
NACUTCD	National Advisory Committee on Uniform Traffic Control Devices
NCSHS	National Conference on Street and Highway Safety
NCUTCD	National Committee on Uniform Traffic Control Devices
NJCUTCD	National Joint Committee on Uniform Traffic Control Devices
OROR	Official Rulings on Request for Interpretations, Changes, and Experimentation

APPENDIX B.
SUMMARY OF FINDINGS OF COMPREHENSIVE RESEARCH STUDIES

Sign	TMUTCD Designation	TMUTCD Section	FHWA[1]	FHWA[2]	AAA[3]	AAA[4]	TTI[5]	TTI[6]
Warning Sign Shape and Color	—	2A-10,11		53				
Construction Sign Color	—	2A-11				74		
STOP	R1-1	2B-4						78
YIELD	R1-2	2B-7		6		45		83
SPEED ZONE AHEAD	R2-5c	2B-14		6				
Turn Prohibition	R3-1 R3-2	2B-15			90, 92		91	89
U-Turn Prohibition	R3-4	2B-16			97			
Double Turn (post)	R3-8	2B-17					66	53
Two-Way Left Turn Lane (overhead)	R3-9a	2B-19	✓	8				20
Restricted Lane	R3-11	2B-20				76, 84		
DO NOT PASS	R4-1	2B-21		6				
Keep Right (symbol)	R4-7	2B-25	✓	8		35	74	67
DO NOT ENTER	R5-1	2B-26		8				45
ONE WAY (arrow)	R6-1	2B-29					81	72
LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37		8				
Turn	W1-1	2C-4	✓	7			79	62
Curve	W1-2	2C-5	✓	8			79	95
Reverse Turn	W1-3	2C-6	✓	7				
Reverse Curve	W1-4	2C-7	✓	7				
Winding Road	W1-5	2C-8	✓	8				
Chevron	W1-8	2C-10				46		23
Cross Road	W2-1	2C-11	✓	8				92
Stop Ahead (symbol)	W3-1a	2C-15	✓	8		84		42
Yield Ahead (symbol)	W3-2a	2C-16	✓	7		86		
Signal Ahead (symbol)	W3-3	2C-17			94			94
Merge	W4-1	2C-18	✓	8			79	76
Lane Reduction Transition	W4-2	2C-19	✓	7	87		61	68
Added Lane	W4-3	2C-18.1	✓	7		7		
Narrow Bridge (symbol)	W5-2a	2C-21	✓	8				
ONE LANE BRIDGE	W5-3	2C-22		6				
Divided Highway (symbol)	W6-1	2C-23					51	
Divided Highway Ends (symbol)	W6-2	2C-24	✓	9				
Two-Way Traffic (symbol)	W6-3	2C-25			93		93	98
Hill (symbol)	W7-1	2C-26	✓	7				
PAVEMENT ENDS	W8-3	2C-28					84	
Pavement Ends (symbol)	W8-3a	2C-28	✓	7				
SOFT SHOULDER	W8-4	2C-29	✓	7			88	
Slow Down on Wet Road	W8-5	2C-30	✓	8			77	50
Low Shoulder (symbol)	W8-9a	2C-30.3	✓	8				63
Uneven Pavement (symbol)	•		✓	8				
Advance Pedestrian Crossing	W11-2	2C-31	✓	7				
Pedestrian Crossing	W11A-2	2C-32	✓	7				86
Arrow Clearance, Ft In	W12-2T	2C-34	✓	7				
NO PASSING ZONE	W14-3	2C-38		6				27
LIMITED SIGHT DISTANCE	W14-4	2C-39		8				
Overhead Guide with EXIT ONLY	E SERIES	2F-42				44		
Two-Way Left Turn Markings	—	3B-1			24, 69	26, 79		
Double Solid Yellow Centerline	—	3B-1					76	
Single Solid White Lane Line	—	3B-2					35	
Red Arrow - Traffic Signal	—	4B-5			71, 75			
Yellow Arrow - Traffic Signal	—	4B-5			89		45	
Green Arrow - Traffic Signal	—	4B-5			51	59	76	
Flashing Red - Beacon	—	4B-5						87
Flashing Yellow - Beacon	—	4B-5					54	54
Flashing DON'T WALK (words)	—	4D-2					42	65
Steady Red X - LCS	—	4E-9			80			
Advance One Lane Road	CW20-4	6B-18	✓	7				
Advance Lane Closed	CW20-5	6B-19		6				

Sign	TMUTCD Designation	TMUTCD Section	FHWA[1]	FHWA[2]	AAA[3]	AAA[4]	TTI[5]	TTI[6]
Advance Flagger (symbol)	CW20-7a	6B-20	✓	8				62
Worker (symbol)	CW21-1a	6B-23	✓	8				
ROAD MACHINERY	CW21-3	6B-25		6				
Advance School Crossing	S1-1	7B-9	✓	8	18		39	21
School Crossing	S2-1	7B-10	✓	8	45		39	50
SCHOOL BUS STOP AHEAD	S3-1	7B-11	✓	8				
RR Crossbuck	R15-1	8B-2		8			76	
RR Advance Warning	W10-1	8B-3		8		97	76	17

1 Indicates 30 signs selected for redesign in FHWA study (23, 24, 25)
2 Indicates Problem Severity Rating for signs with PSR of 6-9 on a scale of 3-9 in FHWA study (23, 24, 25).
3 Indicates percentage giving correct meaning of device in the 1979 AAA study (26).
4 Indicates percentage giving correct meaning of device in the 1980 AAA study (27).
5 Indicates percentage giving correct meaning of device in the 1978 TTI study (28).
6 Indicates percentage giving correct meaning of device in the 1981 TTI study (29).
* Sign not included in TMUTCD. Sign legend is the reverse image of W8-9a sign.

APPENDIX C
PRESURVEY OF TRAFFIC CONTROL DEVICES
HPR PROJECT 1261

Each of the following traffic control devices is being considered for inclusion in a survey to be given to motorists to assess their understanding of these devices. Your help in deciding which devices to include in the survey is needed. Please rank each of the following devices from 0 to 3 as described below:

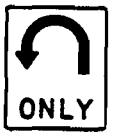
Should this traffic control device be included in the motorist survey?

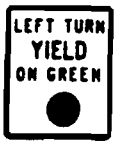
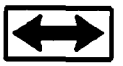
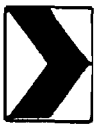
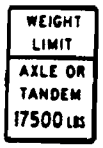
0 - Device should not be included in survey
1 - Uncertain whether device should be in survey
2 - Devices should be included in survey if possible
3 - Devices should definitely be included in survey

Name: _____ Phone: _____

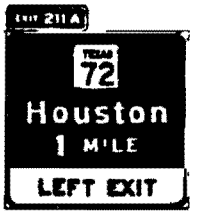
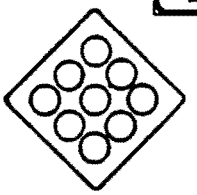
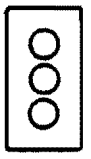
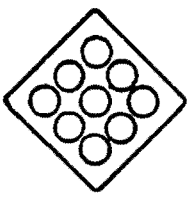
Agency/Office: _____

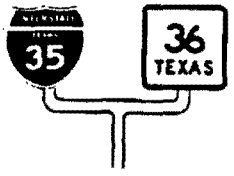
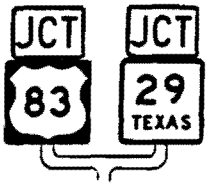
Device	Picture	Rank	Device	Picture	Rank
R1-1		1	R2-5c		6
R1-2		2	R3-1		7
R2-1		3	R3-5L		8
R2-5a		4	R3-6L		9
R2-5b		5	R3-7L(R)	 	10

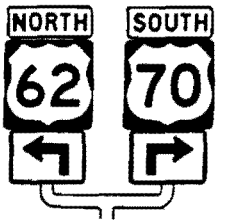
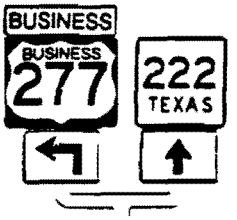
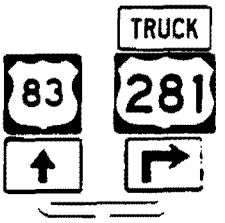
Device	Picture	Rank	Device	Picture	Rank
R3-8L		11	R4-3B		20
R3-8U		12	R4-7		21
R3-9a		13	R4-7a		22
R3-9b		14	R5-1		23
R3-14		15	R5-1a		24
R4-1		16	R6-1R		25
R4-2		17	R6-2R		26
R4-3		18	R10-9		27
R4-3A		19	R10-9a		28

Device	Picture	Rank	Device	Picture	Rank
R10-11a		29	W1-5R		38
R10-12		30	W1-6		39
R11-2		31	W1-7		40
R12-1		32	W1-8		41
R12-2Tb		33	W2-1		42
W1-1R		34	W3-1a		43
W1-2R		35	W3-2a		44
W1-3R		36	W3-3		45
W1-4R		37	W4-1R		46

Device	Picture	Rank	Device	Picture	Rank
W4-2R		47	W8-4		56
W4-3R		48	W8-5		57
W5-1		49	W8-9a		58
W5-2a		50	W8-12		59
W6-1		51	W9-2R		60
W6-2		52	W10-1		61
W6-3		53	W11-2		62
W7-1		54	W11A-2		63
W8-3a		55	W12-2T		64

Device	Picture	Rank	Device	Picture	Rank
W13-1		65	D9-2		74
W14-3		66	D13-1		75
W14-4		67	E4-1, E1-5, E11-1		76
W19-3		68	E4-1, E1-5, E11-2a		77
W19-4		69	OM-1		78
M1-5		70	OM-2H		79
M4-9R		71	OM-2V		80
D5-2(T)		72	OM-3		81
D5-6T		73	OM-4R		82

Device	Picture	Rank
I-5		83
S1-1		84
S2-1		85
S3-1		86
S5-1		87
S5-2		88
Route Marker Assembly		89
Junction Assembly		90

Device	Picture	Rank
Advance Route Turn Assembly		91
Advance Route Turn Assembly		92
Advance Route Turn Assembly		93
Directional Assembly		94
Reassurance Assembly		95
Trailblazer Assembly		96

Device	Rank
Traffic Signal Indications	
Red Ball	**97**
Yellow Ball	**98**
Green Ball	**99**
Red Arrow	**100**
Yellow Arrow	**101**
Green Arrow	**102**
Flashing Red Ball	**103**
Flashing Yellow Ball	**104**
Permitted/Protected Left Turn	**105**
Pedestrian Signal Indications	
Don't Walk (words)	**106**
Flashing Don't Walk (words)	**107**
Walk (words)	**108**
Don't Walk (symbols)	**109**
Flashing Don't Walk (symbols)	**110**
Walk (symbols)	**111**
Intersection Control Beacon	
Flashing Red Ball	**112**
Flashing Yellow Ball	**113**

Device	Rank
Lane-Use Control Signals	
Steady Downward Green Arrow	**114**
Steady Yellow X	**115**
Flashing Yellow X	**116**
Steady Red X	**117**
Pavement Markings	
Single Broken Yellow Centerline	**118**
Double Solid Yellow Centerline	**119**
Single Broken White Lane Line	**120**
Single Solid White Lane Line	**121**
Double Solid White Lane Line	**122**
Solid White Edge Line	**123**
2 Way Left Turn Lane Markings	**124**
No-Passing Zone Markings	**125**
Stop Lines	**126**
Pavement Word and Symbol Markings	**127**
Preferential Lane Marking (diamond)	**128**

Device	Picture	Rank
R14-2		**129**
R14-3		**130**
R15-1		**131**

PLEASE ADD ANY ADDITIONAL DEVICES TO BE INCLUDED IN THE SURVEY

Thank you for your help.

APPENDIX D.

SUMMARY OF TRANSPORTATION PROFESSIONAL POLL RESULTS

The table in this appendix is divided into eleven columns. The meaning of each of these columns is described below:

Column 1	The rank of the device according to the percentage of all 49 respondents which gave the device a score of 2 or 3.
Column 2	The name of the device.
Column 3	The TMUTCD designation for that device.
Column 4	The TMUTCD section number for that device.
Column 5	The percentage of all 49 respondents which gave the device a score of 3.
Column 6	The percentage of all 49 respondents which gave the device a score of 2 or 3.
Column 7	The percentage of non-Houston respondents which gave the device a score of 2 or 3.
Column 8	The percentage of SDHPT respondents which gave the device a score of 2 or 3.
Column 9	The percentage of urban respondents which gave the device a score of 2 or 3.
Column 10	The percentage of rural respondents which gave the device a score of 2 or 3.
Column 11	The percentage of law enforcement respondents which gave the device a score of 2 or 3.

Appendix D. Summary of Poll of Transportation Professionals

POLL NO	SIGN OR DEVICE	DESIGNATION	TMUTCD SECTION	RANK 3 ALL	% RESP 3 ALL	RANK 2 OR 3 ALL	% RESP 2 OR 3 ALL	RANK 2 OR 3 NON-HOU	% RESP 2 OR 3 NON-HOU	RANK 2 OR 3 SDHPT	% RESP 2 OR 3 SDHPT	RANK 2 OR 3 URBAN	% RESP 2 OR 3 URBAN	RANK 2 OR 3 RURAL	% RESP 2 OR 3 RURAL	RANK 2 OR 3 LAW	% RESP 2 OR 3 LAW
105	Permitted/Protected Left Turn	—	4B-5	1	70.8	1	87.5	3	92.6	2	88.9	1	92.3	15	75.0	10	80.0
101	Yellow Arrow - Traffic Signal	—	4B-5	6	62.5	1	87.5	3	92.6	6	83.3	1	92.3	15	75.0	10	80.0
100	Red Arrow - Traffic Signal	—	4B-5	5	65.3	3	85.7	5	89.3	6	83.3	1	92.3	15	75.0	27	70.0
58	Low Shoulder (symbol)	W8-9a	2C-30.3	24	51.0	4	83.7	10	85.7	1	94.4	13	80.8	1	100.0	1	100.0
116	Flashing Yellow X - LCS	—	4E-9	11	53.1	4	83.7	16	82.1	6	83.3	6	84.6	15	75.0	10	80.0
28	PROTECTED LEFT ON GREEN	R10-9a	2B-37	11	55.1	4	83.7	10	85.7	32	72.2	6	84.6	46	50.0	10	80.0
55	Pavement Ends (symbol)	W8-3a	2C-28	10	55.1	7	82.6	15	84.0	20	77.8	4	88.5	15	75.0	45	66.7
122	Double Solid White Lane Line	—	3B-2	7	61.2	8	81.6	10	85.7	32	72.2	6	84.6	46	50.0	10	80.0
115	Steady Yellow X - LCS	—	4E-9	14	53.1	8	81.6	26	78.6	6	83.3	6	84.6	15	75.0	27	70.0
48	Added Lane	W4-3R	2C-18.1	27	49.0	8	81.6	1	92.9	32	72.2	13	80.8	15	75.0	10	80.0
50	Narrow Bridge (symbol)	W5-2a	2C-21	11	55.1	8	81.6	5	89.3	32	72.2	19	76.9	15	75.0	10	80.0
124	Two-Way Left Turn Markings	—	—	8	58.3	12	81.3	14	85.2	20	77.8	19	76.9	15	75.0	2	90.0
129	Hazardous Cargo Permitted	R14-2	2B-43.1	1	70.8	12	81.3	23	81.5	6	83.3	13	80.8	1	100.0	25	77.8
130	Hazardous Cargo Prohibited	R14-3	2B-43.1	3	68.8	12	81.3	23	81.5	6	83.3	13	80.8	1	100.0	25	77.8
81	Type 3 Object Marker	OM-3R	3C-1	14	53.1	15	79.6	16	82.1	6	83.3	19	76.9	1	100.0	46	60.0
85	School Crossing	S2-1	7B-10	37	42.9	15	79.6	10	85.7	2	88.9	19	76.9	15	75.0	10	80.0
30	LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37	4	67.3	15	79.6	1	92.9	6	83.3	6	84.6	1	100.0	73	50.0
110	Flashing Don't Walk (symbol)	—	4D-2	40	41.7	18	79.2	23	81.5	19	82.4	12	84.0	15	75.0	46	60.0
27	PROTECTED LEFT ON GREEN ARROW	R10-9	2B-37	9	56.5	19	77.6	33	75.0	57	61.1	30	73.1	46	50.0	2	90.0
117	Steady Red X - LCS	—	4E-9	27	49.0	19	77.6	33	75.0	57	61.1	37	69.2	1	100.0	2	90.0
63	Pedestrian Crossing	W11A-2	2C-32	53	34.7	19	77.6	16	82.1	2	88.9	19	76.9	15	75.0	10	80.0
14	Two-Way Left Turn Lane (post)	R3-9b	2B-19	14	53.1	19	77.6	5	89.3	6	83.3	19	76.9	1	100.0	46	60.0
84	Advance School Crossing	S1-1	7B-9	44	40.8	19	77.6	16	82.1	2	88.9	19	76.9	15	75.0	27	70.0
47	Lane Reduction Transition	W4-2R	2C-19	24	51.0	19	77.6	5	89.3	20	77.8	13	80.8	15	75.0	46	60.0
121	Single Solid White Lane Line	—	3B-2	14	53.1	19	77.6	16	82.1	6	83.3	4	88.5	46	50.0	46	60.0
128	Preferential Lane Marking (diamond)	—	3B-22	21	52.1	26	77.1	53	66.7	32	72.2	6	84.6	46	50.0	27	70.0
41	Chevron	W1-8	2C-10	34	44.9	27	75.5	33	75.0	20	77.8	19	76.9	1	100.0	46	60.0
125	No Passing Zone Markings	—	3B-3	26	50.0	28	73.9	32	76.0	6	83.3	36	72.0	15	75.0	10	80.0
13	Two-Way Left Turn Lane (overhead)	R3-9a	2B-19	14	53.1	29	73.5	5	89.3	20	77.8	19	76.9	15	75.0	94	40.0
80	Type 2 Object Marker (vert)	OM-2V	3C-1	30	46.9	29	73.5	26	78.6	42	66.7	46	65.4	1	100.0	27	70.0
79	Type 2 Object Marker (horz)	OM-2H	3C-1	30	46.9	29	73.5	26	78.6	42	66.7	46	65.4	1	100.0	27	70.0
62	Advance Pedestrian Crossing	W11-2	2C-31	53	34.7	29	73.5	33	75.0	6	83.3	30	73.1	46	50.0	10	80.0
119	Double Solid Yellow Centerline	—	3B-1	40	41.7	33	72.9	46	70.4	32	72.2	19	76.9	46	50.0	27	70.0
104	Flashing Yellow Ball - Signal	—	4B-5	21	52.1	33	72.9	31	77.8	57	61.1	30	73.1	46	50.0	2	90.0
68	RAMP METERED WHEN FLASHING	W19-3	2C-41	37	42.9	35	71.4	42	71.4	6	83.3	37	69.2	15	75.0	27	70.0
107	Flashing DON'T WALK (words)	—	4D-2	48	38.8	35	71.4	33	75.0	42	66.7	19	76.9	78	25.0	46	60.0
82	Type 4 End of Road Markers	OM-4R	3C-4	14	53.1	35	71.4	42	71.4	32	72.2	37	69.2	1	100.0	46	60.0
78	Type 1 Object Marker	OM-1	3C-1	14	53.1	35	71.4	33	75.0	42	66.7	46	65.4	1	100.0	27	70.0
67	LIMITED SIGHT DISTANCE	W14-4	2C-39	44	40.8	35	71.4	16	82.1	32	72.2	66	57.7	1	100.0	10	80.0
7	Turn Prohibition	R3-1, R3-2	2B-15	44	40.8	40	69.4	16	82.1	42	66.7	46	65.4	1	100.0	46	60.0
113	Flashing Yellow - Beacon	—	4B-5	35	43.8	41	68.8	46	70.4	42	66.7	37	69.2	46	50.0	2	90.0
126	Stop Line	—	3B-17	40	41.7	41	68.8	53	66.7	20	77.8	37	69.2	46	50.0	10	80.0
118	Single Broken Yellow Centerline	—	3B-1	47	39.6	41	68.8	61	63.0	42	66.7	13	80.8	78	25.0	46	60.0
103	Flashing Red Ball - Signal	—	4B-5	21	52.1	41	68.8	40	74.1	57	61.1	46	65.4	46	50.0	2	90.0
57	Slow Down on Wet Road	W8-5	2C-30	27	49.0	45	67.3	26	78.6	32	72.2	46	65.4	46	50.0	10	80.0
43	Stop Ahead (symbol)	W3-1a	2C-15	48	38.8	45	67.3	42	71.4	20	77.8	37	69.2	15	75.0	46	60.0
102	Green Arrow - Traffic Signal	—	4B-5	32	45.8	47	66.7	53	66.7	42	66.7	46	65.4	46	50.0	46	60.0
123	Solid White Edge Line	—	3B-6	35	43.8	47	66.7	61	63.0	20	77.8	30	73.1	78	25.0	27	70.0
112	Flashing Red - Beacon	—	4B-5	32	45.8	47	66.7	40	74.1	42	66.7	39	61.5	46	50.0	2	90.0
120	Single Broken White Lane Line	—	3B-2	40	41.7	47	66.7	76	59.3	57	61.1	30	73.1	78	25.0	27	70.0
127	Pavement Word/Symbol Markings	—	3B-20	57	33.3	47	66.7	76	59.3	42	66.7	39	61.5	46	50.0	10	80.0
12	U-TURN ONLY	R3-8U	2B-17	81	24.5	52	65.3	33	75.0	57	61.1	46	65.4	46	50.0	73	50.0
44	Yield Ahead (symbol)	W3-2a	2C-16	37	42.9	52	65.3	49	67.9	20	77.8	37	69.2	15	75.0	73	50.0
74	Hospital (symbol)	D9-2	2D-46	48	38.8	52	65.3	49	67.9	20	77.8	46	65.4	15	75.0	27	70.0

Appendix D. Summary of Poll of Transportation Professionals (continued)

POLL NO	SIGN OR DEVICE	DESIGNATION	TMUTCD SECTION	RANK 3 ALL	% RESP 3 ALL	RANK 2 OR 3 ALL	% RESP 2 OR 3 ALL	RANK 2 OR 3 NON-HOU	% RESP 2 OR 3 NON-HOU	RANK 2 OR 3 SDHPT	% RESP 2 OR 3 SDHPT	RANK 2 OR 3 URBAN	% RESP 2 OR 3 URBAN	RANK 2 OR 3 RURAL	% RESP 2 OR 3 RURAL	RANK 2 OR 3 LAW	% RESP 2 OR 3 LAW
114	Steady Green Arrow - LCS	—	4E-9	52	37.5	55	64.6	61	63.0	92	44.4	59	61.5	78	25.0	2	90.0
109	Don't Walk (symbol)	—	4D-2	90	21.3	56	63.8	64	61.5	56	64.7	45	68.0	15	75.0	94	40.0
52	Divided Highway Ends (symbol)	W6-2	2C-24	66	28.6	57	63.3	49	67.9	71	55.6	46	65.4	46	50.0	73	50.0
45	SIGNAL AHEAD	W3-3	2C-17	53	34.7	57	63.3	65	60.7	57	61.1	37	69.2	78	25.0	46	60.0
11	Double Turn (post)	R3-8L	2B-17	48	38.8	57	63.3	42	71.4	57	61.1	66	57.7	15	75.0	46	60.0
59	GROOVED PAVEMENT AHEAD	W8-12	2C-30.5	53	34.7	60	61.2	65	60.7	20	77.8	46	65.4	15	75.0	73	50.0
15	HOV RESTRICTION	R3-14	2B-20	89	22.4	60	61.2	94	50.0	80	50.0	59	61.5	46	50.0	46	60.0
69	RAMP SIGNAL AHEAD	W19-4	2C-41	63	30.6	60	61.2	56	64.3	42	66.7	59	61.5	46	50.0	73	50.0
21	Keep Right (symbol)	R4-7	2B-25	81	24.5	60	61.2	56	64.3	71	55.6	66	57.7	46	50.0	27	70.0
77	Overhead Guide	E SERIES	2F-42	63	30.6	60	61.2	26	78.6	32	72.2	66	57.7	15	75.0	73	50.0
9	Optional Movement	R3-6L	2B-17	66	28.6	65	59.2	56	64.3	71	55.6	77	53.8	46	50.0	46	60.0
46	Merge	W4-1R	2C-18	59	32.7	65	59.2	87	53.6	42	66.7	30	73.1	78	25.0	116	30.0
86	SCHOOL BUS STOP AHEAD	S3-1	7B-11	81	24.5	65	59.2	81	57.1	71	55.6	59	61.5	78	25.0	27	70.0
5	REDUCED SPEED 30	R2-5b	2B-14	61	31.3	68	58.3	46	70.4	102	38.9	58	64.0	113	0.0	27	70.0
54	Hill (symbol)	W7-1	2C-26	61	31.3	68	58.3	76	59.3	92	44.4	80	52.0	78	25.0	27	70.0
49	ROAD NARROWS	W5-1	2C-20	103	18.4	70	57.1	65	60.7	42	66.7	66	57.7	46	50.0	73	50.0
20	DO NOT CROSS DOUBLE WHITE LINE	R4-3B	2B-23.2	72	26.5	70	57.1	65	60.7	71	55.6	66	57.7	78	25.0	46	60.0
87	SCHOOL SPEED LIMIT	S5-1	7B-12	81	24.5	70	57.1	65	60.7	57	61.1	66	57.7	46	50.0	46	60.0
29	NO TURN ON RED	R10-11a	2B-37	81	24.5	70	57.1	65	60.7	71	55.6	66	57.7	15	75.0	73	50.0
53	Two-Way Traffic (symbol)	W6-3	2C-25	95	20.4	70	57.1	56	64.3	80	50.0	66	57.7	78	25.0	73	50.0
8	Mandatory Movement (overhead)	R3-5L	2B-17	92	20.8	75	56.3	65	60.7	71	55.6	77	53.8	78	25.0	46	60.0
111	Walk (symbol)	—	4D-2	100	19.1	76	55.3	86	53.8	68	58.8	80	52.0	15	75.0	94	40.0
51	Divided Highway (symbol)	W6-1	2C-23	72	26.5	77	55.1	81	57.1	80	50.0	66	57.7	46	50.0	94	40.0
60	LANE ENDS MERGE RIGHT	W9-2R	2C-19	66	28.6	77	55.1	56	64.3	71	55.6	82	50.0	78	25.0	46	60.0
76	Overhead Guide with EXIT ONLY	E SERIES	2F-42	72	26.5	77	55.1	49	67.9	57	61.1	82	50.0	15	75.0	73	50.0
65	Advisory Speed Plate	W13-1	2C-35	57	33.3	80	54.2	76	59.3	68	58.8	65	60.0	46	50.0	116	30.0
64	Arrow Clearance, Ft In	W12-2T	2C-34	81	24.5	81	53.1	81	57.1	42	66.7	66	57.7	15	75.0	94	40.0
37	Reverse Curve	W1-4R	2C-7	66	28.6	81	53.1	65	60.7	92	44.4	82	50.0	78	25.0	73	50.0
38	Winding Road	W1-5R	2C-8	88	22.9	83	52.1	76	59.3	102	38.9	90	46.2	78	25.0	73	50.0
36	Reverse Turn	W1-3L	2C-6	59	32.7	84	51.0	65	60.7	102	38.9	90	46.2	78	25.0	73	50.0
42	Cross Road	W2-1	2C-11	95	20.4	84	51.0	87	53.6	80	50.0	90	46.2	46	50.0	46	60.0
98	Yellow Ball - Traffic Signal	—	4B-5	65	29.2	86	50.0	92	51.9	80	50.0	77	53.8	78	25.0	27	70.0
66	NO PASSING ZONE	W14-3	2C-38	72	26.5	87	49.0	81	57.1	57	61.1	82	50.0	46	50.0	94	40.0
40	Large Double Headed Arrow	W1-7	2C-9	95	20.4	87	49.0	94	50.0	115	33.3	90	46.2	78	25.0	94	40.0
10	Mandatory Movement (post)	R3-7L	2B-17	81	24.5	87	49.0	87	53.6	80	50.0	99	42.3	46	50.0	46	60.0
83	Airport (symbol)	I-5	2D-49	106	16.3	87	49.0	99	46.4	20	77.8	46	65.4	1	100.0	131	10.0
92	Advance Route Turn Assembly 2	—	2D-30	90	21.3	91	48.9	96	48.1	68	58.8	82	50.0	15	75.0	94	40.0
4	REDUCED SPEED AHEAD	R2-5a	2B-14	92	20.8	92	47.9	85	55.6	115	33.3	89	48.0	113	0.0	46	60.0
35	Curve	W1-2L	2C-5	72	26.5	93	46.9	65	60.7	102	38.9	99	42.3	78	25.0	94	40.0
34	Turn	W1-1R	2C-4	72	26.5	93	46.9	65	60.7	102	38.9	99	42.3	78	25.0	94	40.0
106	DON'T WALK (words)	—	4D-2	110	14.6	95	45.8	104	44.4	80	50.0	82	50.0	78	25.0	116	30.0
56	SOFT SHOULDER	W8-4	2C-29	95	20.4	96	44.9	99	46.4	92	44.4	82	50.0	78	25.0	116	30.0
39	Large Arrow	W1-6	2C-9	106	16.3	96	44.9	107	42.9	102	38.9	99	42.3	78	25.0	125	20.0
108	WALK (words)	—	4D-2	117	12.5	98	43.8	111	40.7	80	50.0	90	46.2	78	25.0	116	30.0
131	RR Crossbuck	R15-1	8B-2	72	26.5	99	42.9	87	53.6	115	33.3	107	38.5	113	0.0	27	70.0
93	Advance Route Turn Assembly 3	—	2D-30	100	19.1	100	42.6	104	44.4	91	47.1	105	41.7	46	50.0	94	40.0
99	Green Ball - Traffic Signal	—	4B-5	79	25.0	101	41.7	114	37.0	71	55.6	90	46.2	78	25.0	46	60.0
90	Junction Assembly	—	2D-29	92	20.8	101	41.7	92	51.9	92	44.4	113	36.0	46	50.0	94	40.0
17	PASS WITH CARE	R4-2	2B-22	113	14.3	103	40.8	87	53.6	102	38.9	107	38.5	113	0.0	73	50.0
88	END SCHOOL ZONE	S5-2	7B-12	113	14.3	103	40.8	116	35.7	92	44.4	99	42.3	78	25.0	73	50.0
22	KEEP RIGHT (words)	R4-7a	2B-25	124	10.2	103	40.8	99	46.4	115	33.3	114	34.6	78	25.0	94	40.0
2	YIELD	R1-2	2B-7	66	28.6	103	40.8	99	46.4	123	27.8	90	46.2	113	0.0	73	50.0
91	Advance Route Turn Assembly 1	—	2D-30	116	12.8	107	40.4	104	44.4	100	41.2	112	37.5	78	25.0	73	50.0
89	Route Marker Assembly	—	2D-28	102	18.8	108	39.6	96	48.1	102	38.9	125	28.0	15	75.0	94	40.0

Appendix D. Summary of Poll of Transportation Professionals (continued)

POLL NO	SIGN OR DEVICE	DESIGNATION	TMUTCD SECTION	RANK 3 ALL	% RESP 3 ALL	RANK 2 OR 3 ALL	% RESP 2 OR 3 ALL	RANK 2 OR 3 NON-HOU	% RESP 2 OR 3 NON-HOU	RANK 2 OR 3 SDHPT	% RESP 2 OR 3 SDHPT	RANK 2 OR 3 URBAN	% RESP 2 OR 3 URBAN	RANK 2 OR 3 RURAL	% RESP 2 OR 3 RURAL	RANK 2 OR 3 LAW	% RESP 2 OR 3 LAW
71	DETOUR	M4-9R	2D-25	110	14.6	108	39.6	107	42.9	80	50.0	106	40.0	78	25.0	116	30.0
33	WEIGHT LIMIT AXLE OR TANDEM	R12-ZTb	2B-41	118	12.2	110	38.8	116	35.7	80	50.0	90	46.2	113	0.0	94	40.0
61	RR Advance Warning	W10-1	8B-3	66	28.6	110	38.8	99	46.4	92	44.4	107	38.5	113	0.0	46	60.0
6	SPEED ZONE AHEAD	R2-5c	2B-14	110	14.6	112	37.5	111	40.7	123	27.8	98	44.0	113	0.0	46	60.0
97	Red Ball - Traffic Signal	----	4B-5	79	25.0	112	37.5	120	33.3	80	50.0	99	42.3	78	25.0	46	60.0
18	SLOWER TRAFFIC KEEP RIGHT	R4-3	2B-23	113	14.3	114	36.7	107	42.9	102	38.9	114	34.6	113	0.0	73	50.0
96	Trailblazer	----	2D-33	109	14.9	115	36.2	96	48.1	100	41.2	124	29.2	46	50.0	125	20.0
24	WRONG WAY	R5-1a	2B-27	103	18.4	116	34.7	113	39.3	115	33.3	107	38.5	113	0.0	94	40.0
75	CROSSOVER	D13-1	2D-52	118	12.2	116	34.7	107	42.9	102	38.9	129	23.1	46	50.0	73	50.0
23	DO NOT ENTER	R5-1	2B-26	95	20.4	118	32.7	116	35.7	115	33.3	107	38.5	113	0.0	116	30.0
19	DO NOT DRIVE ON SHOULDER	R4-3A	2B-23.1	126	8.2	118	32.7	123	28.6	102	38.9	114	34.6	113	0.0	94	40.0
94	Directional Assembly	----	2D-31	129	6.4	120	29.8	114	37.0	128	23.5	130	20.8	78	25.0	94	40.0
16	DO NOT PASS	R4-1	2B-21	118	12.2	121	28.6	116	35.7	115	33.3	114	34.6	113	0.0	73	50.0
70	County Route Marker	M1-5	2D-11	118	12.2	122	26.5	127	21.4	92	44.4	119	30.8	78	25.0	116	30.0
3	SPEED LIMIT	R2-1	2B-10	103	18.4	122	26.5	121	32.1	129	22.2	119	30.8	113	0.0	94	40.0
25	ONE WAY (arrow)	R6-1R	2B-29	124	10.2	122	26.5	121	32.1	123	27.8	119	30.8	113	0.0	94	40.0
73	PICNIC AREA	D5-6T	2D-42	126	8.2	125	24.5	129	17.9	102	38.9	119	30.8	78	25.0	125	20.0
1	STOP	R1-1	2B-4	106	16.3	125	24.5	123	28.6	123	27.8	119	30.8	113	0.0	94	40.0
26	ONE WAY (words)	R6-2R	2B-29	130	6.1	125	24.5	126	25.0	129	22.2	126	26.9	113	0.0	94	40.0
95	Reassurance Assembly	----	2D-32	123	10.6	128	23.4	125	25.9	122	29.4	130	20.8	78	25.0	116	30.0
72	REST AREA	D5-2(T)	2D-42	126	8.2	129	22.4	130	14.3	102	38.9	126	26.9	78	25.0	125	20.0
31	ROAD CLOSED	R11-2	2B-39	118	12.2	129	22.4	127	21.4	123	27.8	114	34.6	113	0.0	125	20.0
32	WEIGHT LIMIT	R12-1	2B-41	131	4.1	131	18.4	130	14.3	129	22.2	126	26.9	113	0.0	125	20.0

APPENDIX E.
SUMMARY OF COMMENTS FROM TRANSPORTATION PROFESSIONALS

A number of transportation professionals made comments about various traffic control devices in the poll of transportation officials.

Designation	Device Name	TMUTCD Section	No. of Comments	Comment
R1-3	4-WAY Supplemental Plate	2B-4	1	add to survey
R1-4	ALL-WAY	2B-4	1	add to survey
R3-4	U-turn Prohibition	2B-16	1	add to survey
R5-2	No Trucks	2B-28	1	add to survey
R6-3	Divided Highway Crossing	2B-30	1	add to survey
R7-8	Handicapped Parking	2B-31.1	2	difference between this and D9-6
R10-3	PUSH BUTTON FOR GREEN LIGHT	2B-37	1	relationship between sign position and crosswalk
R20-3	OBSERVE WARNING SIGNS STATE LAW	6B-10.3	1	add to survey
W2-6	HIGHWAY INTERSECTION 1000 FEET	2C-14.1	1	does public think their road will continue
W6-4	END FREEWAY 1/2 MILE	2C-25.1	1	add to survey
W10-2	Railroad Advance Warning (major +)	8B-3	1	add to survey
W10-3	Railroad Advance Warning (major T)	8B-3	2	add to survey
W10-4	Railroad Advance Warning (minor T)	8B-3	2	add to survey
W11-8	Fire Truck Crossing	2C-31	1	add to survey
W11-10	Truck Crossing	2C-31	2	add to survey
W12-1	Double Arrow	2C-33	1	add to survey
W12-5	LOAD ZONED BRIDGE	2C-34.1	1	add to survey
W14-1	DEAD END	2C-37	1	difference between this and W14-2
W14-2	NO OUTLET	2C-37	1	difference between this and W14-1
W19-2	WATCH FOR ICE ON BRIDGE	2C-41	2	add to survey
D9-6	Handicapped Services	2D-46	2	difference between this and R7-8
D9-10	Tourist Information	2D-46	1	add to survey
M1-2	Interstate Business Loop	2D-11	1	difference between this and M1-3
M1-3	Interstate Business Spur	2D-11	1	difference between this and M1-2
---	Red pavement marker	3A-10	1	does driver recognize red means wrong way

Designation	Device Name	TMUTCD Section	No. of Comments	Comment
---	Solid Yellow Edge Line	3B-6	1	add to survey
---	Gore Area Pavement Markings	3B-11	1	add to survey
OM-3	Type 3 Object Marker	3C-1	1	difference between left and right side markers
D	Delineators	3D-4	2	difference between single and double delineators
E5-4	Loop Exit Gore	IE(1)	1	add to survey
---	All construction signs	6B	1	add to survey
CW20-6	LANE BLOCKED 1 2 3 4	6B-34.1	1	add to survey
CW20-7a	Advance Flagger	6B-20	3	add to survey
CW21-1a	Worker	6B-23	1	add to survey
CW21-13	Shoulder Drop-Off	6B-28.3	1	add to survey
CW21-14	Uneven Lanes	6B-28.4	2	add to survey
M4-10R	Detour Arrow	6B-38	1	add to survey
M4-8	Detour Marker	6B-38	1	add to survey
---	Temporary pavement markings	TCP (5-2)	1	add to survey
---	All route markers	---	1	add to survey
---	NO THRU TRUCKS	---	1	add to survey
---	CHILDREN AT PLAY	---	1	add to survey
---	Rating TCD usage	---	1	driver opinion of TCDs

APPENDIX F.

PRIORITIZED RESULTS OF FINAL RANKING PROCEDURE

The results of the final ranking are shown on the following pages. A "Yes" in either of the first two columns indicates that the devices was included in the pre-test or pilot/final survey. The third through fifth columns give the name of the traffic control device, the designation of signs, and the section in the Texas MUTCD which addresses the device, respectively. The sixth column is the total score, which is the sum of the last six columns. The last six columns are the individual scores of the six different factors. A "-" indicates that no score was given for a device for that factor. The devices are prioritized in descending order of the total score. Within a total score, they are arranged by TMUTCD section number.

PRETST SURVY	DRIVER SURVEY	SIGN OR DEVICE	DESIG-NATION	TMUTCD SECTION	TOTAL SCORE	PROFES OPINION	COMPRE-HENSION	CONSE-QUENCE	DRIVER EDUC	FREQ OF USE	SPECIAL INTEREST
Yes	Yes	PROTECTED LEFT ON GREEN ARROW	R10-09	2B-37	12	3	3	3	1	1	1
Yes	Yes	Single Broken Yellow Centerline	----	3B-01	12	3	3	3	1	1	1
Yes	Yes	No Passing Zone Markings	----	3B-03	12	3	3	3	1	1	1
Yes	Yes	PROTECTED LEFT ON GREEN	R10-09a	2B-37	11	3	3	3	0	1	1
Yes	Yes	LEFT TURN YIELD ON GREEN Ball	R10-12	2B-37	11	3	3	3	0	1	1
Yes	Yes	Slow Down on Wet Road	W08-05	2C-30	11	3	3	2	1	1	1
		Pedestrian Crossing	W11A-02	2C-32	11	3	3	3	1	1	0
Yes		Stop Line	----	3B-17	11	3	3	3	1	1	0
Yes		Type 2 Object Marker (vert)	OM-2V	3C-01	11	3	3	3	1	1	0
Yes	Yes	Type 3 Object Marker	OM-3R	3C-01	11	3	3	3	1	1	0
Yes		Advance School Crossing	S01-01	7B-09	11	3	3	3	1	1	0
		Two-Way Left Turn Lane (overhead)	R03-09a	2B-19	10	3	3	3	1	0	0
Yes	Yes	Two-Way Left Turn Lane (post)	R03-09b	2B-19	10	3	3	3	0	1	0
Yes	Yes	Keep Right (symbol)	R04-07	2B-25	10	2	3	3	1	1	0
Yes	Yes	Lane Reduction Transition	W04-02R	2C-19	10	3	2	2	1	1	1
		Advance Pedestrian Crossing	W11-02	2C-31	10	3	3	3	0	1	0
Yes		Double Solid Yellow Centerline	----	3B-01	10	3	1	3	1	1	1
Yes	Yes	Two-Way Left Turn Markings	----	3B-01	10	3	1	3	1	1	1
		Permitted/Protected Left Turn	----	4B-05	10	3	3	3	0	1	0
		School Crossing	S02-01	7B-10	10	3	3	3	0	1	0
Yes	Yes	SCHOOL SPEED LIMIT	S05-01	7B-12	10	2	3	3	1	1	0
Yes	Yes	Warning Sign Shape and Color	----	2A-10,11	9	-	3	3	1	1	1
		Hazardous Cargo Prohibited	R14-03	2B-43.1	9	3	3	3	0	0	0
		Reverse Curve	W01-04R	2C-07	9	2	3	2	1	1	0
		Winding Road	W01-05R	2C-08	9	2	3	2	1	1	0
		Chevron	W01-08	2C-10	9	3	3	2	0	1	0
Yes	Yes	Narrow Bridge (symbol)	W05-02a	2C-21	9	3	2	3	1	0	0
		Divided Highway (symbol)	W06-01	2C-23	9	2	3	2	1	1	0
		Low Shoulder (symbol)	W08-09a	2C-30.3	9	3	3	2	1	0	0
		Advisory Speed Plate	W13-01	2C-35	9	2	3	2	1	1	0
Yes	Yes	LIMITED SIGHT DISTANCE	W14-04	2C-39	9	3	3	2	0	0	1
		Type 2 Object Marker (horz)	OM-2H	3C-01	9	3	3	1	1	1	0
Yes	Yes	Flashing Yellow Ball - Signal	----	4B-05	9	3	3	1	1	1	0
Yes	Yes	Flashing Yellow - Beacon	----	4B-05	9	3	3	1	1	1	0
		WRONG WAY	R05-01a	2B-27	8	0	3	3	1	1	0
Yes		NO TURN ON RED	R10-11a	2B-37	8	2	3	2	0	1	0
Yes	Yes	Reverse Turn	W01-03L	2C-06	8	2	3	2	0	1	0
		Large Double Headed Arrow	W01-07	2C-09	8	1	3	2	1	1	0
Yes		Merge	W04-01R	2C-18	8	2	1	2	1	1	1
Yes		Added Lane	W04-03R	2C-18.1	8	3	3	0	0	1	1
Yes	Yes	LANE ENDS MERGE LEFT	W09-02L	2C-19	8	2	3	2	0	1	0
		ROAD NARROWS	W05-01	2C-20	8	2	3	2	1	0	0
Yes	Yes	Divided Highway Ends (symbol)	W06-02	2C-24	8	2	3	1	1	1	0
Yes	Yes	GROOVED PAVEMENT AHEAD	W08-12	2C-30.5	8	2	3	1	1	0	1
Yes	Yes	Truck Crossing (symbol)	W11-10	2C-31	8	-	3	2	1	1	1
		Arrow Clearance, Ft In	W12-02T	2C-34	8	2	3	1	1	1	0
		NO PASSING ZONE	W14-03	2C-38	8	1	3	3	1	0	0

PRETST SURVY	DRIVER SURVEY	SIGN OR DEVICE	DESIG-NATION	TMUTCD SECTION	TOTAL SCORE	PROFES OPINION	COMPRE-HENSION	CONSE-QUENCE	DRIVER EDUC	FREQ OF USE	SPECIAL INTEREST
Yes	Yes	WATCH FOR ICE ON BRIDGE	W19-02	2C-41	8	-	3	2	1	1	1
Yes	Yes	Single Broken White Lane Line	----	3B-02	8	3	3	0	1	1	0
Yes	Yes	Solid White Edge Line	----	3B-06	8	3	3	1	0	1	0
Yes		Type 1 Object Marker	OM-1	3C-01	8	3	3	1	0	1	0
		Type 4 End of Road Markers	OM-4R	3C-04	8	3	3	2	0	0	0
		Red Ball - Traffic Signal	----	4B-05	8	1	3	2	1	1	0
Yes		Yellow Ball - Traffic Signal	----	4B-05	8	2	3	1	1	1	0
		Red Arrow - Traffic Signal	----	4B-05	8	3	3	2	0	0	0
		Green Arrow - Traffic Signal	----	4B-05	8	3	3	0	1	1	0
Yes		Flashing Red Ball - Signal	----	4B-05	8	3	0	2	1	1	1
Yes	Yes	Steady Red X - LCS	----	4E-09	8	3	1	3	0	0	1
Yes		SCHOOL BUS STOP AHEAD	S03-01	7B-11	8	2	3	3	0	0	0
Yes	Yes	RR Advance Warning	W10-01	8B-03	8	1	2	3	1	1	0
Yes	Yes	RR Parallel Advance Warning	W10-03	8B-03	8	0	3	3	0	1	1
Yes		STOP Sign Shape	----	2A-10	7	-	2	2	1	1	1
Yes		Turn Prohibition	R03-01 R3-2	2B-15	7	3	0	2	1	1	0
Yes	Yes	Double Turn (post)	R03-08L	2B-17	7	2	2	1	1	1	0
Yes	Yes	Turn	W01-01R	2C-04	7	1	2	2	1	1	0
Yes	Yes	Stop Ahead (symbol)	W03-01a	2C-15	7	3	2	1	0	1	0
		Yield Ahead (symbol)	W03-02a	2C-16	7	3	2	1	0	1	0
		Two-Way Traffic (symbol)	W06-03	2C-25	7	2	0	3	1	1	0
Yes	Yes	Yellow Arrow - Traffic Signal	----	4B-05	7	3	2	1	0	1	0
Yes	Yes	Flashing Red - Beacon	----	4B-05	7	3	0	2	1	1	0
		RR Crossbuck	R15-01	8B-02	7	1	1	3	1	1	0
Yes	Yes	YIELD	R01-02	2B-07	6	1	1	2	1	1	0
		DO NOT ENTER	R05-01	2B-26	6	0	1	3	1	1	0
		ONE WAY (arrow)	R06-01R	2B-29	6	0	1	3	1	1	0
Yes	Yes	Curve	W01-02L	2C-05	6	1	1	2	1	1	0
		Cross Road	W02-01	2C-11	6	2	0	2	1	1	0
		Pavement Ends (symbol)	W08-03a	2C-28	6	3	1	1	1	0	0
		DON'T WALK (words)	----	4D-02	6	1	1	3	0	1	0
		Don't Walk (symbol)	----	4D-02	6	2	1	3	0	0	0
		Signal Ahead (symbol)	W03-03	2C-17	5	2	0	1	1	1	0
		STOP	R01-01	2B-04	4	0	-	2	1	1	0
		SPEED LIMIT	R02-01	2B-10	4	0	-	2	1	1	0
		DO NOT PASS	R04-01	2B-21	4	0	-	3	1	0	0
Yes	Yes	DO NOT CROSS DOUBLE WHITE LINE	R04-03B	2B-23.2	4	2	-	2	0	0	0
		KEEP RIGHT (words)	R04-07a	2B-25	4	1	-	3	0	0	0
		ONE WAY (words)	R06-02R	2B-29	4	0	-	3	0	1	0
		Large Arrow	W01-06	2C-09	4	1	-	2	0	1	0
		Hill (symbol)	W07-01	2C-26	4	2	-	1	1	0	0
Yes	Yes	RAMP METERED WHEN FLASHING	W19-03	2C-41	4	3	-	0	0	0	1
Yes		Hospital (symbol)	D09-02	2D-46	4	3	-	0	0	1	0
		Single Solid White Lane Line	----	3B-02	4	3	-	1	0	0	0
Yes	Yes	Double Solid White Lane Line	----	3B-02	4	3	-	1	0	0	0
		Pavement Word/Symbol Markings	----	3B-20	4	3	-	0	0	1	0
Yes	Yes	Preferential Lane Marking (diamond)	----	3B-22	4	3	-	0	0	0	1

PRETST SURVY	DRIVER SURVEY	SIGN OR DEVICE	DESIG-NATION	TMUTCD SECTION	TOTAL SCORE	PROFES OPINION	COMPRE-HENSION	CONSE-QUENCE	DRIVER EDUC	FREQ OF USE	SPECIAL INTEREST
Yes		Flashing DON'T WALK (words)	----	4D-02	4	3	-	0	0	1	0
Yes	Yes	Guide Sign Color	----	2A-11	3	-	-	0	1	1	1
Yes	Yes	SPEED ZONE AHEAD	R02-05c	2B-14	3	1	-	0	0	1	1
		Mandatory Movement (overhead)	R03-05L	2B-17	3	2	-	1	0	0	0
		Optional Movement	R03-06L	2B-17	3	2	-	0	0	1	0
Yes	Yes	Mandatory Movement (post)	R03-07L	2B-17	3	1	-	1	0	1	0
		U-TURN ONLY	R03-08U	2B-17	3	3	-	0	0	0	0
Yes	Yes	HOV RESTRICTION	R03-14	2B-20	3	2	-	0	0	0	1
Yes	Yes	SLOWER TRAFFIC KEEP RIGHT	R04-03	2B-23	3	1	-	0	1	0	1
		ROAD CLOSED	R11-02	2B-39	3	0	-	2	1	0	0
		Hazardous Cargo Permitted	R14-02	2B-43.1	3	3	-	0	0	0	0
		SOFT SHOULDER	W08-04	2C-29	3	1	-	1	1	0	0
		Overhead Guide with LEFT EXIT	E SERIES	2F-42	3	2	-	0	0	1	0
		Overhead Guide with EXIT ONLY	E SERIES	2F-42	3	2	-	0	0	1	0
		Green Ball - Traffic Signal	----	4B-05	3	1	-	0	1	1	0
		Flashing Don't Walk (symbol)	----	4D-02	3	3	-	0	0	0	0
		Steady Yellow X - LCS	----	4E-09	3	3	-	0	0	0	0
		Flashing Yellow X - LCS	----	4E-09	3	3	-	0	0	0	0
	Yes	REDUCED SPEED AHEAD	R02-05a	2B-14	2	2	-	0	0	0	0
		REDUCED SPEED 30	R02-05b	2B-14	2	2	-	0	0	0	0
		WEIGHT LIMIT AXLE OR TANDEM	R12-02Tb	2B-41	2	1	-	1	0	0	0
	Yes	ROUGH ROAD	W08-08	2C-30.2	2	-	-	1	0	0	1
		RAMP SIGNAL AHEAD	W19-4	2C-41	2	2	-	0	0	0	0
		DETOUR	M04-09R	2D-25	2	1	-	1	0	0	0
		Route Marker Assembly	----	2D-28	2	1	-	0	0	1	0
		Junction Assembly	----	2D-29	2	1	-	0	0	1	0
		Advance Route Turn Assembly 1	----	2D-30	2	1	-	0	0	1	0
		Advance Route Turn Assembly 2	----	2D-30	2	1	-	0	0	1	0
		Advance Route Turn Assembly 3	----	2D-30	2	1	-	0	0	1	0
		Trailblazer	----	2D-33	2	1	-	0	0	1	0
		CROSSOVER	D13-01	2D-52	2	0	-	0	1	1	0
		WALK (words)	----	4D-02	2	1	-	0	0	1	0
		Walk (symbol)	----	4D-02	2	2	-	0	0	0	0
		Steady Green Arrow - LCS	----	4E-09	2	2	-	0	0	0	0
		PASS WITH CARE	R04-02	2B-22	1	1	-	0	0	0	0
		DO NOT DRIVE ON SHOULDER	R04-03A	2B-23.1	1	0	-	1	0	0	0
		WEIGHT LIMIT	R12-01	2B-41	1	0	-	1	0	0	0
		Directional Assembly	----	2D-31	1	0	-	0	0	1	0
		Reassurance Assembly	----	2D-32	1	0	-	0	0	1	0
		REST AREA	D05-02(T)	2D-42	1	0	-	0	0	1	0
		PICNIC AREA	D05-06T	2D-42	1	0	-	0	0	1	0
		Airport (symbol)	I-5	2D-49	1	1	-	0	0	0	0
		END SCHOOL ZONE	S05-02	7B-12	1	1	-	0	0	0	0
Yes		Flashing Yellow Arrow - LCS	----	----	0	-	-	0	0	0	0
		County Route Marker	M01-05	2D-11	0	0	-	0	0	0	0

APPENDIX G

Survey of Driver Understanding of Traffic Control Devices

QUESTIONS

1. **What does this sign mean?**

(1) _____ **Be prepared for a winding road.**
(2) _____ **Slow down when the pavement is wet.**
(3) _____ **Watch for out of control vehicles.**
(4) _____ **Not Sure.**
(5) _____

_____

2. **What is the purpose of the sign on the right of the roadway?**

(1) _____ **To let you know you are at a railroad crossing.**
(2) _____ **To let you know you will cross railroad tracks ahead.**
(3) _____ **To let you know there are two railroad tracks ahead.**
(4) _____ **Not Sure.**
(5) _____

_____

3. **What is the meaning of this sign?**

(1) _____ **The speed limit will be higher ahead.**
(2) _____ **The speed limit ahead will be strictly enforced by the police.**
(3) _____ **The speed limit will be lower ahead.**
(4) _____ **Not Sure.**
(5) _____

_____

4. **What does the yield sign tell you?**

(1) _____ **You must slow down before entering the intersection.**
(2) _____ **You may enter the intersection if it is safe to do so, otherwise, you must stop or slow down until it is safe.**
(3) _____ **You must stop at the intersection before you enter it.**
(4) _____ **Not Sure.**
(5) _____

_____

5. What does this sign mean?

(1) _____ Turn right at the next driveway if you are in this lane.
(2) _____ Turn right at the next intersection if you are in this lane.
(3) _____ You are not allowed to change lanes after you see this sign.
(4) _____ Not Sure.
(5) _____

_____

Two-Way Left Turn Markings

6. How do you use this center lane?

(1) _____ Get into this lane at the point where you are ready to turn left.
(2) _____ Get into this lane when you need to slow down in order to turn left.
(3) _____ Get into this lane when you need to speed up in order to move into the traffic lane.
(4) _____ Not Sure.
(5) _____

_____

7. When you see this sign, what should you do?

(1) _____ Don't drive on the bridge if there is ice on it.
(2) _____ Slow down and gently apply the brakes while you are on the bridge.
(3) _____ Slow down, don't brake or make sudden turning movements on the bridge.
(4) _____ Not Sure.
(5) _____

_____

8. How should you respond to this sign?

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

_____

9. What is the appropriate response to this sign?

(1) _____ Turn right.
(2) _____ Go to the right side of this sign.
(3) _____ Stay in the far right lane.
(4) _____ Not Sure.
(5) _____

_____

10. What is the meaning of this sign?

(1) _____ If you are driving slower than the speed limit, you should be in the lane on the right.
(2) _____ If you are driving slower than the other traffic, you should be in the lane on the right.
(3) _____ If you have car trouble, you should pull off on the right side of the road.
(4) _____ Not Sure.
(5) _____

_____

Flashing Yellow - Beacon

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

(1) _____ Blinking red.
(2) _____ Blinking yellow.
(3) _____ Either red or yellow, depending on the intersection.
(4) _____ Not Sure.
(5) _____

_____

12. What is the purpose of this sign?

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

_____

Solid White Edge Line

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

(1) _____ To let you know there is no curb on this road.
(2) _____ To let you know that you should not cross this line for any reason.
(3) _____ To let you know where the edge of your driving path is.
(4) _____ Not Sure.
(5) _____

_____

14. What does this marker tell you?

(1) ____ You should reduce your speed.
(2) ____ There is something at the edge of the roadway you should avoid hitting.
(3) ____ You should drive to the right of this post.
(4) ____ Not Sure.
(5) _____

_____

15. What does this sign mean?

(1) ____ Passing is not allowed on the bridge ahead.
(2) ____ A one-lane bridge is ahead.
(3) ____ A narrow bridge is ahead.
(4) ____ Not Sure.
(5) _____

_____

16. What is this sign telling you to do?

(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.
(5) _____

_____

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

(1) ____ It is illegal to change lanes across these lines.
(2) ____ You may change lanes across these lines with caution, if necessary.
(3) ____ You may change lanes across these lines from left to right, but not from right to left.
(4) ____ Not Sure.
(5) _____

_____

18. What does this sign mean?

(1) ____ The speed limit will be higher ahead.
(2) ____ The speed limit ahead will be strictly enforced by the police.
(3) ____ The speed limit will be lower ahead.
(4) ____ Not Sure.
(5) _____

_____

19. What does this sign mean?

(1) _____ There are fewer lanes ahead and traffic on your right will move into you lane.
(2) _____ There is a one-lane road ahead.
(3) _____ There are narrow lanes ahead.
(4) _____ Not Sure.
(5) _____

_____

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

Single Broken Yellow Centerline

(1) _____ This is a two-way road where you are allowed to pass.
(2) _____ This is a two-way road where you are not allowed to pass.
(3) _____ This is a one-way road where you are allowed to change lanes.
(4) _____ Not Sure.
(5) _____

_____

21. What does this sign mean?

(1) _____ Winding road ahead.
(2) _____ You will make a turn to the right, then turn to the left ahead.
(3) _____ You will make a turn to the left, then turn to the right ahead.
(4) _____ Not Sure.
(5) _____

_____

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

Flashing Red - Beacon

(1) _____ Blinking red.
(2) _____ Blinking yellow.
(3) _____ Either red or yellow, depending on the intersection.
(4) _____ Not Sure.
(5) _____

_____

23. What is this sign telling you?

(1) _____ There is two-way traffic ahead.
(2) _____ There is one-way traffic ahead.
(3) _____ There is a divided highway ahead.
(4) _____ Not Sure.
(5) _____

_____

No Passing Zone Markings

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

(1) _____ This is a two-way road where you are allowed to pass.
(2) _____ This is a two-way road where you are not allowed to pass.
(3) _____ This is a one-way road where you are allowed to change lanes.
(4) _____ Not Sure.
(5) _____

_____

25. What does this sign mean?

(1) _____ If you turn onto the side road, you will cross a gravel road.
(2) _____ You will cross a railroad track, then come to an intersection ahead.
(3) _____ If you turn onto the side road, you will cross a railroad track.
(4) _____ Not Sure.
(5) _____

_____

26. What does this sign mean?

(1) _____ There is an intersecting road to the right ahead.
(2) _____ You should drive 30 miles per hour or less to make the next turn.
(3) _____ You should turn right at the next intersection.
(4) _____ Not Sure.
(5) _____

_____

27. What is the purpose of this sign?

(1) _____ To let motorists know the road will be slippery when wet.
(2) _____ To let motorists know the road will be noisier ahead.
(3) _____ To let motorcyclists know they should use caution.
(4) _____ Not Sure.
(5) _____

_____

28. What should you do in response to this sign?

(1) _____ Be aware that traffic will be coming into your lane from the right.
(2) _____ Move to the right lane.
(3) _____ Prepare to exit on the left.
(4) _____ Not Sure.
(5) _____

_____

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

(1) _____ After you cross the school crosswalk.
(2) _____ After you go past the block of the school building.
(3) _____ When you see a Speed Limit sign.
(4) _____ Not Sure.
(5) _____

_____

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

(1) _____ Yield to oncoming traffic. They will a have a green light also.
(2) _____ Wait for a green arrow. Then turn left.
(3) _____ Turn left. Oncoming traffic will have a red light.
(4) _____ Not Sure.
(5) _____

_____

Single Broken White Lane Line

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

(1) _____ This is a one-way road where you are allowed to change lanes.
(2) _____ This is a one-way road where you are not allowed to change lanes.
(3) _____ This is a two-way road where you are allowed to pass.
(4) _____ Not Sure.
(5) _____

_____

Flashing Yellow Ball - Signal

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

(1) _____ Treat the intersection as if it has a STOP sign.
(2) _____ Stop. Wait for the light to turn green.
(3) _____ Go through the intersection with caution.
(4) _____ Not Sure.
(5) _____

_____

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

(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.
(5) _____

_____

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

(1) _____ You are allowed to turn only when the green arrow is on.
(2) _____ You are allowed to turn when the green ball is on if it is safe to do so.
(3) _____ 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) _____ Not Sure.
(5) _____

_____

35. What does this sign mean?

(1) _____ Be prepared for firetrucks entering or crossing the roadway in this area.
(2) _____ This is a warning that this road is heavily used by large trucks.
(3) _____ Be prepared for trucks entering or crossing the roadway in this area.
(4) _____ Not Sure.
(5) _____

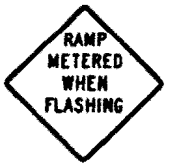
_____

36. What does the sign on the right mean?

(1) _____ Do not change lanes or turn across the double white lines.
(2) _____ Do not pass. Two-way traffic.
(3) _____ Do not change lanes.
(4) _____ Not Sure.
(5) _____

_____

37. What does this sign mean?



(1) _____ When the yellow lights are flashing, a traffic signal at the entrance to the freeway is in use.
(2) _____ Only a certain number of cars are allowed on the ramp when the yellow light are flashing.
(3) _____ You must pay a toll to use the freeway entrance ramp.
(4) _____ Not Sure.
(5) _____

_____

38. What is the purpose of this sign?

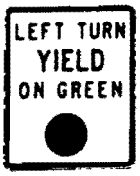
(1) _____ To let motorcyclists know they should use caution.
(2) _____ To let motorists know the road will be noisier ahead.
(3) _____ To let motorists know the pavement is in poor condition.
(4) _____ Not Sure.
(5) _____

_____

39. **Which is the most correct statement about this sign?**

(1) _____ **To go straight, you must be in the lane on the right.**
(2) _____ **You may go straight or turn left in the left lane.**
(3) _____ **You must go straight if you are in the lane on the right.**
(4) _____ **Not Sure.**
(5) _____

_____



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

(1) _____ **Stop and wait for a gap in traffic. Then turn left.**
(2) _____ **Wait for a green arrow. Then turn left.**
(3) _____ **Turn left. Oncoming traffic will have a red light.**
(4) _____ **Not Sure.**
(5) _____

_____

Preferential Lane Marking (Diamond)

41. **Why is the white diamond painted on the pavement?**

(1) _____ **This is a symbol used for aircraft speed control.**
(2) _____ **This lane is to be used only by certain vehicles.**
(3) _____ **This is a two-way road.**
(4) _____ **Not Sure.**
(5) _____

_____

Yellow Arrow - Traffic Signal

42. **What does it mean when the yellow arrow is on?**

(1) _____ **You should not enter the intersection.**
(2) _____ **Your time to turn is about to begin.**
(3) _____ **Your time to turn is about to end.**
(4) _____ **Not Sure.**
(5) _____

_____

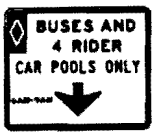
Steady Red X - LCS

43. **What does the red "X" signal mean?**

(1) _____ **Stop here.**
(2) _____ **Do not drive in this lane.**
(3) _____ **This is a signal for buses.**
(4) _____ **Not Sure.**
(5) _____

_____

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



(1) _____ Carpools with 2 or more people.
(2) _____ Carpools with 3 or more people.
(3) _____ Carpools with more than 3 people.
(4) _____ Not Sure.
(5) _____

_____

45. What does a sign this color and shape mean?

Warning Sign

Shape and Color

(1) _____ Warning.
(2) _____ Directions or Guidance.
(3) _____ Construction Area.
(4) _____ Not Sure.
(5) _____

_____

46. What is a sign with a green background used for?

Guide Sign Color

(1) _____ To provide directions or guidance.
(2) _____ To provide general warnings to drivers.
(3) _____ To provide warning for construction areas.
(4) _____ Not Sure.
(5) _____

_____

APPENDIX H

MOTORIST SURVEY ADMINISTRATION

The SetUp

In the Driver License (DL) stations, the following equipment will be used:

Videotape player (1 or 2 depending on the size and layout of the DL station)

Folding table and chairs

Identifying TTI logo sign or backdrop

Survey tapes

Lap top computer

Extension cord

Answer sheets

Comment sheets

Pens

Maps

The survey area should be set up in the DL station in a location that is least apt to be disruptive. Be aware of where written DL tests are being given, so that our survey doesn't interfere with test-taking. Also, be aware of where the waiting lines and heavy traffic areas are and stay out of the way. There are two ways our survey can interfere with DL station business-- from noise and from physically taking up space. Try to minimize these conflicts.

If space allows, set up two videotape players at sufficient distance from each other such that the audio doesn't compete. Position your chair close enough to the respondent's chair to hear well. The videotape player should be the only thing in front of the respondent while they are taking the survey.

The Approach

When approaching potential respondents, begin by asking them if they would be willing to participate in a driver survey. Explain that the survey will only take about 20 minutes, that it's for the Highway Department, and it has to do with understanding signs, signals, and pavement markings.

In the DL stations, good candidates for the survey are people who are **accompanying** those doing business at the DL station; for example, parents of teenagers who are taking a driving test, and spouses, relatives, or friends of people getting renewals or taking written tests. Anyone sitting in a waiting area that appears to be of driving age should be approached. Anyone standing in line **with** someone else should be approached. If a waiting time for a line is 20 minutes or more, ask people in the back of the line to take the survey, and ask the next person in line to hold their place in line.

Do not discriminate among potential respondents initially. You will have a quota based on gender, age, and race, that will affect your sample selection at some point in the survey. However, as you approach potential respondents, you should disregard such things as how they are dressed, what nationality they are, how pleasant (or unpleasant) they look, how busy they look, how capable they look, etc. The only criterion for inclusion in the survey, initially, is that they be a driver. They do not have to be a licensed driver. They do not have to drive very often or very far. And they may be a new driver.

Once they have agreed to do the survey, immediately ask them if they drive. If they don't, explain that the survey is only for drivers, we can't use them, and thank them for their willingness to participate anyway.

The Survey

If they are a driver, ask them to have a seat in front of a monitor. Then say:

"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."

Start the tape and adjust the volume so that it is just loud enough for the respondent to hear. As the respondent tells you their answers, make sure you hear them clearly. That is, be sure to distinguish between "B" and "D". They should give you only one answer for each question. If they give you two answers, an answer that is not provided, or something extraneous, ask them to tell you one of the four letters. Do not put words in their mouths. For example, if they say in response to a question, "I've never seen that sign before," you would not automatically say "not sure," but instead should ask, "which letter do you choose?"

Keep your interaction with them during the survey at a minimum. Don't stop the tape, fast forward, or rewind unless it is necessary. It is necessary when the survey is interrupted (for example, by DL station activity or a power outage). It is not necessary when the

respondent thinks they didn't see the picture long enough or missed something about the question.

You should have a comment sheet available for comments during and after the survey for each respondent. If, while taking the survey they note something they want to go back to discuss or question, mark it during the survey on the comment sheet. At the very end of the survey (after the demographic questions), ask them if they have any general comments they would like you to record for the study. At times, drivers may wish to take the opportunity to note their personal peeves or to compliment the Highway Department. This would be the time and place for such comments, no matter how general or specific. Write their comments down on the comments sheet as near to verbatim as you can, then read them back to them. If they would like a response from the Highway Department, or if they ask for the results of the study, take down their name and address on the comments sheet also.

The demographic questions are very important to this study. If someone terminates the survey early, go to the demographic questions and record their sex, age, and ethnicity, as best as you can estimate them. Do not fill in any other responses, as these would be assumptions on your part (unless the respondent has given you information that would answer these questions). Don't forget to do all the background questions. The objective of this study is not simply to determine the percentage of correct answers to questions (as in a test), but to study the responses based on driver characteristics. You may need to explain this to anyone who is resistant to providing personal information.

The Debriefing

We would like to obtain more detailed information from a subset of the sample of respondents as a means of determining why confusion exists. Therefore, for each 10th respondent we will conduct a debriefing session. Every respondent whose ID number ends with "0" should be given a debriefing. If the "0" respondent is not cooperative, then ask the

next respondent and continue until a respondent cooperates.

During the de-briefing, go back to every question where the respondent gave "Not Sure" as their response, and discuss with them why they were not sure. Use the answer sheet for reference. For these questions, try to find out:

A. Were they not sure about which of the answers provided was the right answer?
B. Did they think none of the answers were the right answer?
C. Were they not sure what the question was?
D. Did they run out of time to make a decision?
E. Were they not able to tell enough about the TCD from the information provided in the slide (in or out of context)?
F. Did they think there was more than one right answer?
G. Were they simply unfamiliar with the TCD?

Record their responses on the comments sheet. Next, offer to go over the questions they answered incorrectly. Tell them the "preferred" response, and try to find out why they thought their answer was correct.

As stated previously, this de-briefing should be conducted routinely with every 10th respondent. However, any respondent should be allowed to go over their responses or ask questions at the end of the survey. **This should be at their request, not yours,** for those who are not selected for the de-briefing. Go back to specific items that they have questions or comments on and provide "preferred" responses using the answer sheet. Going over the entire survey with them is not necessary and takes too much valuable time. Try to avoid this activity.

Be willing to provide correct or appropriate information to the respondents. However, remember that your role as a surveyor is to elicit information from the respondent. You are not an educator, but a researcher. You are not a spokesperson for the Highway Department. In the surveyor role, you are also not a student from Texas A&M University.

You are a researcher.

Questions you may be asked:

Who's paying for this? Your answer: The State Highway Department.

How much of my tax dollars are going for this? Your answer: This study is quite involved and has several different aspects to it. I'm not sure what the total budget is myself.

Why are you doing this? Answer: The State wants to make sure that drivers understand traffic control devices and how they are used. They want to make sure they are presenting the information drivers need in the best way possible.

What are you going to do with the results? Everybody's answers will be computerized and analyzed as a group. The results will be written in a report that will be turned into the Highway Department. The report will show the Highway Department what areas of driver information need to be improved.

May I get a copy of the results? If you would put your name and address at the end of your questionnaire, we will send you the results of the study when it is complete. However, the study is just getting started and the results may not be available until next Fall.

Why don't they...? (all sorts of comments or suggestions as to things that are wrong and how they should change them) Tell them you don't know or you're not sure, but you will make a note of their comment and pass it along. (Again, you are not a spokesperson for the Highway Department and your interaction should focus on getting information, not giving it.)

<u>The Closure</u>

When the interview is complete, don't forget to thank the respondent and give them a Texas Highway map.

APPENDIX I.
SURVEY RESULTS

QUESTIONS

1. What does this sign mean?

   A. 24.2 Be prepared for a winding road.
   B. 73.3 Slow down when the pavement is wet.
   C. 1.8 Watch for out of control vehicles.
   D. 0.7 Not Sure

2. What is the purpose of this sign?

   A. 13.3 To let you know you are at a railroad crossing.
   B. 84.8 To let you know you will cross railroad tracks ahead.
   C. 1.8 To let you know there are two railroad tracks ahead.
   D. 0.1 Not Sure.

3. What does this sign mean?

   A. 3.0 The speed limit will be higher ahead.
   B. 18.2 The speed limit ahead will be strictly enforced by the police.
   C. 70.9 The speed limit will be lower ahead.
   D. 7.9 Not sure.

4. What does the yield sign tell you?

   A. 9.7 You must slow down before entering the intersection.
   B. 87.3 You may enter the intersection if it is safe to do so, otherwise, you must stop or slow down until it is safe.
   C. 3.0 You must slow down and stop at the intersection before you enter it.
   D. ___ Not Sure.

5. What does this sign mean?

   A. 7.9 Turn right at the next driveway if you are in this lane.
   B. 90.3 Turn right at the next intersection if you are in this lane.
   C. 1.8 You are not allowed to change lanes after you see this sign.
   D. ___ Not Sure.

6. How do you use this center lane?

   A. 20.6 Get into this lane at the point where you are ready to turn left.
   B. 69.7 Get into this lane when you need to slow down in order to turn left.
   C. 4.2 Get into this lane when you need to speed up in order to move into the traffic lane.
   D. 5.5 Not Sure.

7. When you see this sign, what should you do?

   A. ___ Don't drive on the bridge if there is ice on it.
   B. 6.1 Slow down and gently apply the brakes while you are on the bridge.
   C. 93.3 Slow down, don't brake or make sudden turning movements on the bridge.
   D. 0.6 Not Sure.

8. How should you respond to this sign?

   A. 55.2 The road will curve to the left a short distance ahead and you should slow down before reaching the curve.
   B. 43.6 The road will curve to the left a short distance ahead, but you may drive the curve at the speed limit.
   C. 0.6 The next mile of highway has several curves and you should slow down.
   D. 0.6 Not Sure.

9. What is the appropriate response to this sign?

   A. 1.2 Turn right.
   B. 82.4 Go to the right side of this sign.
   C. 15.8 Stay in the far right lane.
   D. 0.6 Not Sure.

10. What does this sign mean?

   A. 23.0 If you are driving slower than the speed limit, you should be in the lane on the right.
   B. 76.4 If you are driving slower than the other traffic, you should be in the lane on the right.
   C. 0.6 If you have car trouble, you should pull off on the right side of the road.
   D. ___ Not Sure

11. What type of light would the intersecting cross road traffic see?

A. 49.1 Blinking red.
B. 9.7 Blinking yellow.
C. 37.6 Either red or yellow, depending on the intersection.
D. 3.6 Not Sure

12. What is the purpose of this sign?

A. 29.1 To warn drivers that shadows make it difficult to see cars coming from the other direction.
B. 57.0 To let drivers know they should be prepared to stop with little warning.
C. 4.2 To let drivers with eyesight problems know they should use caution in this area.
D. 9.7 Not Sure

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

A. 6.7 To let you know there is no curb on this road.
B. 7.9 To let you know that you should not cross this line for any reason.
C. 83.0 To let you know where the edge of your driving path is.
D. 2.4 Not Sure

14. What does this marker tell you?

A. 13.3 You should reduce your speed.
B. 73.3 There is something at the edge of the roadway you should avoid hitting.
C. 3.0 You should drive to the right of this post.
D. 10.4 Not Sure

15. What does this sign mean?

A. 0.6 Passing is not allowed on the bridge ahead.
B. 6.1 A one-lane bridge is ahead.
C. 92.7 A narrow bridge is ahead.
D. 0.6 Not Sure

16. What is this sign telling you to do?

A. 0.6 Stop when you see this sign.
B. 93.9 Be prepared for a STOP sign ahead.
C. 2.4 At the next STOP sign you should go straight after you stop.
D. 3.1 Not Sure

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

A. 64.8 It is illegal to change lanes across these lines.
B. 23.0 You may change lanes across these lines with caution, if necessary.
C. 7.9 You may change lanes across these lines from left to right, but not from right to left.
D. 4.3 Not Sure

18. What does this sign mean?

A. 0.6 The speed limit will be higher ahead.
B. 3.0 The speed limit ahead will be strictly enforced by the police.
C. 94.5 The speed limit will be lower ahead.
D. 1.9 Not Sure

19. What does this sign mean?

A. 69.7 There are fewer lanes ahead and traffic on your right will move into you lane.
B. 14.5 There is a one-lane road ahead.
C. 10.3 There are narrow lanes ahead.
D. 5.5 Not Sure

20. Which one of the following statements is true about the center line?

A. 89.1 This is a two-way road where you are allowed to pass.
B. 4.8 This is a two-way road where you are not allowed to pass.
C. 3.6 This is a one-way road where you are allowed to change lanes.
D. 2.5 Not Sure

21. What does this sign mean?

A. 18.2 Winding road ahead.
B. 2.4 You will make a turn to the right, then turn to the left ahead.
C. 78.2 You will make a turn to the left, then turn to the right ahead.
D. 1.2 Not Sure

22. What type of light would the intersecting cross road traffic see?

A. 8.5 Blinking red
B. 48.5 Blinking yellow
C. 38.8 Either red or yellow, depending on the intersection.
D. 4.2 Not Sure

23. What is this sign telling you?

A. 74.5 There is two-way traffic ahead.
B. 1.2 There is one-way traffic ahead.
C. 20.6 There is a divided highway ahead.
D. 3.7 Not Sure

24. Which of the following statements is true about the center line?

A. 2.4 This is a two-way road where you are allowed to pass.
B. 95.2 This is a two-way road where you are not allowed to pass.
C. 0.6 This is a one-way road where you are allowed to change lanes.
D. 1.8 Not Sure

25. What does this sign mean?

A. 0.6 If you turn onto the side road, you will cross a gravel road.
B. 6.1 You will cross a railroad track, then come to an intersection ahead.
C. 90.3 If you turn onto the side road, you will cross a railroad track.
D. 3.0 Not Sure

26. What does this sign mean?

A. 3.0 There is an intersecting road to the right ahead.
B. 38.2 You should drive 30 miles per hour or less to make the next turn.
C. 44.2 You should turn right at the next intersection.
D. 14.6 Not Sure

27. What is the purpose of this sign?

A. 4.8 To let motorists know the road will be slippery when wet.
B. 46.7 To let motorists know the road will be noisier ahead.
C. 30.9 To let motorcyclists know they should use caution.
D. 17.6 Not Sure

28. What should you do in response to this sign?

A. 73.3 Be aware that traffic will be coming into your lane from the right.
B. 12.7 Move to the right lane.
C. 9.1 Prepare to exit on the left.
D. 4.9 Not Sure

29. At what point can you speed up again?

A. 5.5 After you cross the school crosswalk.
B. 9.1 After you go past the block of the school building.
C. 77.0 When you see a Speed Limit sign.
D. 8.4 Not Sure

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

A. 25.5 Yield to oncoming traffic. They will a have a green light also.
B. 41.8 Wait for a green arrow. Then turn left.
C. 30.9 Turn left. Oncoming traffic will have a red light.
D. 1.8 Not Sure

31. Which one of the following statements is true about the solid white line?

A. 57.6 This is a one-way road where you are allowed to change lanes.
B. 5.5 This is a one-way road where you are not allowed to change lanes.
C. 85.5 This is a two-way road where you are allowed to pass.
D. 1.4 Not Sure

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

A. 5.5 Treat the intersection as if it has a STOP sign.
B. 7.3 Stop. Wait for the light to turn green.
C. 85.5 Slow down, and go through the intersection with caution.
D. 1.7 Not Sure

33. Which one of the following statements is true when you see the sign on the right?

A. 37.6 The canter lane is to be used only for making left turns.
B. 12.7 You will be able to make only left turns at the next intersection.
C. 44.2 The center lane is to be used only for making left and right turns.
D. 5.5 Not Sure

34. Which one of the following statements is true in regard to this sign?

A. 20.0 You are allowed to turn only when the green arrow is on.
B. 69.7 You are allowed to turn when the green ball is on if it is safe to do so.
C. 7.9 You are protected from oncoming traffic if you turn from the turn lane when either the green arrow or the green ball is on.
D. 2.4 Not Sure

35. What does this sign mean?

A. 29.1 Be prepared for firetrucks entering or crossing the roadway in this area.
B. 68.5 This is a warning that this road is heavily used by large trucks.
C. 1.2 Be prepared for trucks entering or crossing the roadway in this area.
D. 1.2 Not Sure

36. What does the sign on the right mean?

A. 77.6 Do not change lanes or turn across the double white lines.
B. 6.7 Do not pass. Two-way traffic.
C. 12.1 Do not change lanes.
D. 3.6 Not Sure

37. What does this sign mean?

A. 59.4 When the yellow lights are flashing, a traffic signal at the entrance to the freeway is in use.
B. 24.2 Only a certain number of cars are allowed on the ramp when the yellow light are flashing.
C. 4.2 You must pay a toll to use the freeway entrance ramp.
D. 12.2 Not Sure

38. What is the purpose of this sign?

A. 1.8 To let motorcyclists know they should use caution.
B. 96.4 To let motorists know the road will be noisier ahead.
C. 0.6 To let motorists know the pavement is in poor condition.
D. 1.2 Not Sure

39. Which is the most correct statement about this sign?

A. 76.4 To go straight, you must be in the lane on the right.
B. 12.7 You may go straight or turn left in the left lane.
C. 7.3 You must go straight if you are in the lane on the right.
D. 3.6 Not Sure

40. What should you do to turn?

A. 83.6 Stop and wait for a gap in traffic. Then turn left.
B. 9.1 Wait for a green arrow. Then turn left.
C. 4.8 Turn left. Oncoming traffic will have a red light.
D. 2.5 Not Sure

41. Why is the white diamond painted on the pavement?

A. ___ This is a symbol used for aircraft speed control.
B. 89.7 This lane is to be used only by certain vehicles.
C. 3.0 This is a two-way road.
D. 7.3 Not Sure

42. What does it mean when the yellow arrow is on?

A. 4.2 You should not enter the intersection.
B. 2.4 Your time to turn is about to begin.
C. 88.5 Your time to turn is about to end.
D. 4.9 Not Sure

43. What does the red "X" signal mean?

A. 3.6 Stop here.
B. 78.8 Do not drive in this lane.
C. 5.5 This is a signal for buses.
D. 12.1 Not Sure

44. What vehicles are allowed to enter the HOV lane?

A. 17.6 Carpools with 2 or more people.
B. 63.6 Carpools with 3 or more people.
C. 11.5 Carpools with more than 3 people.
D. 7.3 Not Sure

45. What does a sign this color and shape mean?

A. 67.9 Warning
B. 22.4 Guidance
C. 4.8 Railroad Crossing
D. 4.9 Not Sure

46. What is a sign with a green background used for?

A. 89.1 To provide directions or guidance.
B. 3.0 To provide general warnings to drivers.
C. 1.8 To provide warning for construction areas.
D. 6.1 Not Sure