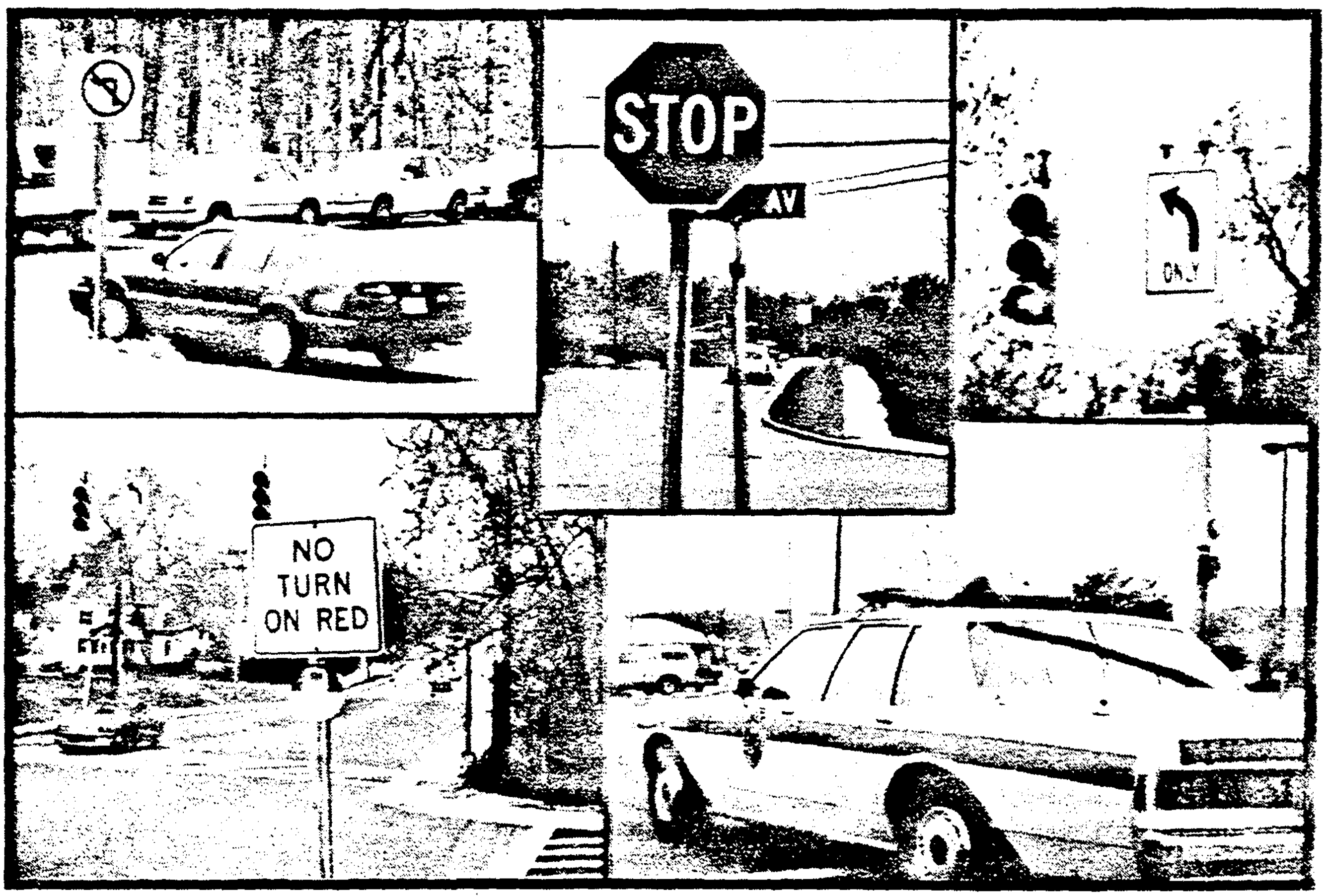
Motorist Compliance With Standard Traffic Control Devices

Publication No. FHWA-RD-89-103

April 1989



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FOREWORD

This research study was initiated as a result of a survey conducted by the American Association of State Highway and Transportation Officials (AASHTO) where State officials indicated their concern about motorists violating traffic control devices. This study was to determine if a problem exists, to quantify the problem if possible, and to recommend solutions to problems which can be corrected.

The research found situations having high violation rates include ignoring speed limit signs, disregarding STOP signs, and not stopping before turning right at red traffic signals. However, the limited data taken over the years did not indicate the violation rates were increasing. Driver interview studies found motorists often violate control devices when they determined "no risk" is involved. It is concluded that traffic control devices should be installed only where they are reasonable, and they should not unduly restrict the motorist. If high violation rates are observed, it is an indication the control device is not being properly applied by the traffic engineer or there is a lack of driver understanding. Heavy enforcement is not usually a practical solution.

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R. J. Betsold
Director, Office of Safety and
Traffic Operations Research
and Development

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-RD-89-103	PB89 194831/AS	

4. Title and Subtitle	5. Report Date
MOTORIST COMPLIANCE WITH STANDARD TRAFFIC CONTROL DEVICES	April 1989
	6. Performing Organization Code
7. Author(s) Martin T. Pietrucha, Kenneth S. Opiela, Richard L. Knoblauch, Kristy L. Crigler	8. Performing Organization Report No.
9. Performing Organization Name and Address Center for Applied Research, Inc. 9617 Beach Mill Road Great Falls, VA 22066	10. Work Unit No. (TRAIS) NCP 3A1c0022 11. Contract or Grant No. DTFH61-86-C-00026
12. Sponsoring Agency Name and Address Office of Safety & Traffic Operations, R&D Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296	13. Type of Report and Period Covered Final Report September 1986- April 1989 14. Sponsoring Agency Code

15. Supplementary Notes
FHWA COTR: Howard H. Bissell (HSR-30)

16. Abstract

This report describes a study of motorist compliance with standard traffic control devices. The research included a comprehensive review of past studies, contacts with traffic, law enforcement, and department of motor vehicles personnel, and an assessment of the viability of other information sources for identifying and quantifying motorist noncompliance. It was concluded that while there is considerable concern about motorist noncompliance, little data existed to determine the frequency of occurrence or consequences of the problem.

To determine the reasons for noncompliance, motorists were interviewed. The interviews included both typical motorists and those having high violation rates. It was found that compliance is generally a function of perceived reasonableness of the traffic controls. Field studies to observe motorist behavior were conducted to establish the extent of noncompliance. Six noncompliance problems were selected and data were gathered at over 900 sites in four States. The results indicate that, although noncompliance is not uncommon (e.g., not making a full stop at a STOP sign), the occurrence of conflicts resulting from the noncompliance was insignificant.

Potential countermeasures for increasing compliance were identified with the assistance of a panel of highway safety experts. Before/after field studies were conducted to evaluate several of the potential countermeasures that involved engineering changes. Limited changes in compliance were observed.

17. Key Words	18. Distribution Statement
Motorist Compliance, Safety, Traffic Control Devices, Human Factors, Motorist Behavior, Traffic Violations	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	156	PC MF

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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I. INTRODUCTION AND BACKGROUND

The growing problem of motorist disregard of traffic control devices (TCDs) has become an increasing concern in the highway safety community. This concern has been highlighted by an American Association of State Highway and Transportation Officials (AASHTO) survey on noncompliance and by two successive annual sessions at the Transportation Research Board (TRB) Human Factors Workshop specifically addressing driver compliance. This report presents the results of a study that investigated motorist compliance in detail.

The purpose of this project was to identify the traffic control devices that have compliance problems, define the scope of the problems, and assess countermeasures to address noncompliance problems. The primary objectives of the effort included:

- Determine if a compliance problem exists.
    - -- Has it been growing over the years?
    - -- Pinpoint specific traffic control devices that are problems.
    - -- Determine the magnitude of the problem to establish baseline conditions.
- Determine if a typical problem driver exists; if so, identify the driver type.
- Identify approaches or countermeasures to combat the problem.

The project tasks included a thorough state-of-the-art review; contacts with various groups of traffic professionals; motorist interviews; the collection and analysis of compliance data; identifying approaches to increase compliance; and the field testing of selected countermeasures.

This report is organized into six parts documenting the various aspects of the study and drawing conclusions from the findings. The remainder of this chapter provides background information derived from the literature review, contacts with various agencies, and reviews of available data sources. Chapter 2 describes the motorist interviews that were conducted and summarizes the results. Chapter 3 summarizes the procedures and results of the behavioral studies that were conducted for six noncompliance problems. In chapter 4, the efforts to identify practical approaches or countermeasures for motorist noncompliance are discussed. The findings of the field testing of selected countermeasures is presented in chapter 5. The conclusions drawn from the study are given in chapter 6 along with some recommendations for improved practices.

A. Literature Review

A comprehensive literature review was conducted covering the following subject areas: motorist behavior, motorist compliance, motorist information processing characteristics, motorist comprehension, police enforcement, countermeasures (other than enforcement), and driver education. A computerized bibliographic search was conducted to identify relevant foreign and domestic published and unpublished documents. Ultimately, over 140 reports, papers, and journal articles were retrieved, reviewed, and abstracted. The literature review identified the specific TCDs studied, the methodology used, and the findings relative to motorist compliance. The relevant items are summarized below and in appendix A.

1. Motorist Behavior

Several studies have attempted to use accident analyses to establish the relative importance of vehicle, road, and human factors as causes in road accidents. The results clearly indicate the human element as the main cause.(1) The common denominator of human errors seems to be lack of adequate information from the road, the road environment, other road users, and the vehicle. The Insurance Information Institute reports that most of the annual 50,000+ highway fatalities are attributable to "driver error"; and analysis indicates that a high proportion of driver errors are caused or compounded by poor (or nonexistent) signing.(2)

On the other hand, a study concluded that experimental results pointing to the relative inefficiency of highway traffic signs are probably due to the "deficient motivation" of drivers to obey them.(3) Subjects were instructed to drive as safely as possible over a highway route 160 miles (257 kilometers) long, naming all the types of traffic signs they saw. Subjects reported approximately 97 percent of the signs on the entire route and committed no traffic violations. Two factors govern why motorists observe or ignore TCDs: the perceived reasonableness of the TCD and the perceived risk of punishment for violations.

In assessing the strategy of driving, two main types of behavior were observed: adapting to traffic needs and expressing psychodynamic needs.(4) Drivers adapt to traffic needs, such as complying with speed limits, to the extent they consider worthwhile and risk-free. Driving behavior is also gauged according to the psychodynamic needs of the moment. Drivers have been studied in a social context as well.(5) Interviews were conducted to determine reactions to common driving situations. The behavior of other drivers was seen as a potential cause of danger in traffic: it appeared to markedly affect psychological reactions of motorists while driving. These results suggest that driving performance is not based solely on the physical environment, but also involves reactions to motives and attitudes that are inferred to exist in other drivers. Thus, it was concluded that driver education for deficient drivers could probably benefit from the application of social psychology theory.

The involvement of personality factors in traffic accidents is supported by findings from psychiatric studies.(6) They suggest that it may be more beneficial to study the relationship between certain personality types (e.g., impulsive, aggressive, hostile) and driver behavior (e.g., violation of TCDs). This sort of approach suggests that drivers who readily become angry are more likely to disregard TCDs, but it was noted that they did not necessarily have more accidents. The British Medical Journal also investigated this theory.(7) The article claimed that overt aggressiveness causes relatively few accidents. "Not paying much attention" was given more often as a reason for driver error. The effectiveness of theoretical and practical driver education as part of the school curriculum has not been established, but predriving courses for all ages emphasizing safety have given promising results.

2. Motorist Compliance

The noncompliance problem appears to be concentrated in specific situations and/or with specific TCDs:

- Exceeding the posted speed limit.
- Not stopping at STOP signs.
- Not stopping at RIGHT TURN ON RED (RTOR) locations.
- Violating the red signal.
- Violating active railroad (RR) grade crossing signals.
- Violating left-turn lane signals.
- Traveling too fast for conditions, i.e., work zones.

Information derived from the literature review on driver compliance with these various TCDs is presented below.

Exceeding the Posted Speed Limit. Most recent studies on the observance of speed limits have concentrated on the 55 mi/h (88 km/h) national speed limit. However, an English study investigated the extent to which drivers knew the speed limit at four sites posted at either 30 mi/h (48 km/h) or 40 mi/h (64 km/h).[8] Overall, 74 percent of drivers gave the correct limit when asked, but 26 percent were unable to do so. The study also showed that drivers who knew the speed limit were generally traveling slower than drivers who did not. What could not be determined, however, was the percentage of drivers who may have known the limit, chose to ignore it, and, when questioned, replied they were not aware of the limit.

A Louisiana survey indicated that while two-thirds of those interviewed now drive slower than before the 55 mi/h (88 km/h) speed limit was imposed, the majority of Louisiana drivers still exceed 55 mi/h (88 km/h) on Interstate highways.[9] When asked why they thought most people speed, they most frequently cited being in a hurry; enjoying the sensation of speed; habit; saving time; and believing that roads and cars were designed for higher speeds. Half of those interviewed thought the State police were enforcing the speed limit; one-third thought they were not; and the remainder believed enforcement was a key factor in increasing compliance. Only one-fifth thought education and advertisement would achieve the same objective.

As early as 1932, studies were undertaken on the "reasonableness or unreasonableness" of speed limits.[10] Vehicle speeds were studied on uncontrolled secondary streets, arterial streets protected by STOP signs, and streets controlled by traffic signals. The data indicated a "reasonable speed" that a large majority of drivers were willing to observe under the different conditions. It was concluded that if speed limits were set on these bases, it might be possible to curb the small number of drivers who exceed them. If the speed limit were unreasonably low, violations would be too numerous for the police to enforce.

Another study recommended a method to establish maximum speed limits based on the 85th percentile of travel speeds.[11] Data indicated that risk increases with deviation from mean speed, and such increase is minimal until approximately the 85th percentile when the slope of the risk curve starts to rise sharply. A British study of motorway traffic control signals also found compliance with speed signals generally unsatisfactory.[12] In addition, it found that advisory limits attracted compliance among less than 15 percent of drivers.

Most of the literature on countermeasures retrieved for this project addressed improving driver compliance with posted speed limits. Before and after speed studies indicated that STOP signs are not effective in controlling speeds.[13] Vehicle speeds and deceleration rates before a sharp curve were reduced at four locations in California after "rumble strips" were installed.[14] Rumble strips were also tested in a Swedish study.[15] The effect was measured in terms of the drivers' choice of speed and acceleration patterns. The rumble strips proved effective in reducing drivers' choices of speeds and the effect was demonstrated to persist over a period of 2 years.

The introduction of speed limits often has only a short-term effect on reducing speeds unless police regularly enforce the speed limits. Posted speed limits alone do not guarantee compliance. The impact of reasonable lane-related speed limits and strict surveillance by police with automatic radar devices can permanently influence driving behavior and reduce accidents.[16]

Vehicle speeds were measured on main roads before and after setting up road signs or positioning a police car.[17] The road signs tested were a reduce speed limit sign 50 percent larger than normal and one of normal size supplemented by the sign "Radar Speed Check." The greatest reduction in speed, and the only one that produced a statistically significant effect, occurred when a police car was present. There was, however, no permanent effect. The sign with the radar warning panel was more effective than the oversize sign alone.

Drivers' observance of speed limits is influenced by different traffic surveillance methods. A TFD report found that drivers who have observed some traffic surveillance activity along a particular road will remember that surveillance the next time they drive along the same road.[18] The memory effect is statistically significant for at least 10 days for traffic surveillance by radar; 17 days for helicopter; and 10 days for marked patrol cars.

The presence of conspicuously marked police units was found to be sufficient to slow 95 percent of speeding drivers.[19] The magnitude of initial speed reduction was the same in response to stationary and moving police units, but the "halo effect" (the tendency to maintain reduced speed after passing the police) was significantly greater for the drivers exposed to moving police units than to stationary units. The results are consistent with the hypothesis that compliance behavior is determined by the perceived risk of apprehension.

Not Stopping at STOP Signs. Drivers' acceptance of a need for a rule or regulation, i.e., "perceived reasonableness," has already been cited as a principal factor governing their observing or ignoring road traffic rules. Several studies conducted on STOP and YIELD signs bear this out.

In a study of STOP, YIELD, and no control, 140 intersections were examined in three regions of the United States.[20] Less than 20 percent of the drivers voluntarily came to a full stop (19 percent for STOP, 8 percent for YIELD, and 9 percent for no control). The study also showed that increasingly restrictive control did not have an effect on accident experience, and sight distance had no effect on safety or operations. In citing other studies of behavior at STOP signs, it was shown that the violation rate for STOP signs has been over 50 percent since 1935.

In 1981, research was conducted to determine whether STOP sign control was fulfilling the requirements for application as specified by the Manual of Uniform Traffic Control Devices.[21,22] The dependent variables of violation and compliance rate, conflicts, and accidents were compared in a factorial design with the independent variables of major-roadway volume, minor-roadway sight distance, rural or urban traffic condition, and type of intersection geometry. The results indicated that the violation rate decreases with increasing major-roadway volume and is significantly low up to the average daily traffic (ADT) level of 2,000 and significantly low above the ADT level of 5,000. The research concluded that the operational effectiveness of low-volume intersections could be enhanced with no detriment to safety by applying no sign control below major-roadway volume of 2,000 ADT, YIELD-sign control at major-roadway volume between 2,000 and 5,000 ADT, and STOP-sign control (or signalization) above 5,000 ADT.

STOP signs were shown to be ineffective (and frequently ignored) as TCDs for reducing vehicular speeds in residential areas.[23] According to the author, placing STOP signs for speed control tends to increase peak speeds. A high noncompliance rate for these signs also was shown.

A 1975 study demonstrated that not more than two traffic signs should be placed on the same spot.[24] Traffic signs placed within a short distance of each other were not studied. It is likely, however, that the intervening distance plays an important role in the perception of traffic signs in a row. Another study showed that STOP sign violations also were significantly reduced after rumble strips were installed.[14]

Not Stopping at Right Turn On Red (RTOR) Locations. By the end of the 1970s, all States had modified their laws to permit drivers to turn right on steady red at signalized intersections after stopping.[25] Overall, it has been noted that RTOR appears to be working well and is supported by the public. The only problem reported was that some drivers turn before coming to a complete stop, which can be attributed to motorists realizing that they need not always stop fully before turning right on red.

In a 1981 study, it was found that 64 percent of the vehicles observed did not come to a full stop before turning right on red; 2% of those did so unsafely.[26] During the 1-year period following the implementation of RTOR in which the study was conducted, the percentage of nonstoppers rose from 47 percent to 70 percent. These results were compared with those found in a Virginia Highway Research Council study using similar procedures. In that study of 15 locations 1 month after the advent of RTOR, the compliance rate was found to be 3 percent. Also, in a study of 13 locations where RTOR had been allowed for a year or more, the rate was found to be 9 percent.

RTOR behavior at 12 intersections in the Washington, D.C. metropolitan area was studied in 1987.[27] For all right-turning vehicles, 7.6 percent were RTOR where the vehicle did not come to a full stop. The results of this study also indicated that this violation occurs more in off-peak traffic periods and the incidence is greater at low-volume approach legs.

Violating the Red Signal. The problem of poor driver compliance with traffic light signals was examined in terms of drivers who "traverse the stop-line after the termination of the yellow signal interval" ("red-runners").[28] The data confirm that "red-running" is a significant motorist compliance problem, and its incidence is increasing because the deterrent effects of accident risk and penalty severity are low. It was concluded that a high level of police surveillance increases the perceived probability of detection, which is an effective deterrent.

Researchers concluded that driver observance of red signals should be improved by appropriate changes to signal timing, particularly the change interval.[29] It was suggested that the most promising long-term countermeasure lies in a change of societal attitudes toward motivation, which is the primary factor influencing drivers' behavior.[28]

In the study regarding RTOR at 12 intersections referenced above, it was found that 0.52 percent of the left-turning and straight-through vehicles observed ran the red signal, more frequently at higher volume intersections and during peak traffic periods.[27] In another study many motorists were observed to violate a traffic signal with red, yellow, and green arrow right-turn controls if no serious "vehicular conflict" was obvious.[30]

In general, studies of driver behavior at signalized intersections have shown that increased enforcement leads to increased compliance. The presence of surveillance reduces the incidence of unsafe driver behavior. Research showed that intensified police surveillance at signalized intersections led to more cautious driving.[31] During periods of police surveillance, average speeds dropped at 115 feet (35 meters) before the stop line for stopping drivers. Traffic signal violations dropped from 23 percent to 9.2 percent of the number of vehicles which were at 131-328 feet (40-100 meters) from the stop line when the signals changed to green-amber.

The main factor in the effectiveness of enforcement to encourage compliance appears to be the frequency of visits, not the strength of the patrol. Also, as long as evidence of surveillance is present, driver behavior is affected; when the surveillance leaves, driver behavior reverts to what it was before the surveillance.[32]

Violating Active Railroad (RR) Grade Crossing Signals. The issue of driver compliance at rail-highway crossings has been a concern since the early 1970's. Driver knowledge of highway-railroad grade-crossing controls and hazards was studied in 1981.[33] Questionnaires were completed by 829 licensed drivers or candidates for licenses. Responses showed that: more than 50 percent of all respondents believed that all grade crossings, except those rarely used by trains, have active warning signals; most drivers have adequate knowledge concerning the hazards of grade crossings; most drivers do not know the required driver response at passive grade crossings; drivers perceive little law enforcement related to driver actions at grade crossings; and driver knowledge of the TCDs used to warn of grade crossings is inadequate.

Another study examined the contributing factors of rail-highway accidents at crossings that have flashing light or crossbuck warning devices.[34] The results suggest that the credibility of warning devices is a more important problem than conspicuity at crossings with flashing light signals. Signals were ignored when there were unnecessarily long warning times before the actual arrival of the train. Approximately 80 percent of the investigated accidents at crossings with crossbucks involved driver recognition errors. The principal contributing factors were lack of adequate sight distance and low driver expectations that a train would appear.

Potential countermeasures to the credibility problem include reducing the length of track circuits to ensure compatibility with existing train operations and installing constant warning time devices where the range in train speeds is wide. Because removing sight obstructions and installing automatic warning devices are often not practical or cost-effective, a reasonable countermeasure for crossings with crossbucks would be to provide more complete information about the hazard and a safe approach speed. Also, driver education activities should emphasize the hazards at grade crossings and how to respond to them.

An investigation of the effective use of STOP signs at grade crossings indicated that rates for STOP sign crossings are lower than rates for crossbuck-only crossings for higher vehicle-train exposure values.[35] Field studies showed that STOP signs, when properly used, result in improved driver behaviors adequate for the detection and avoidance of trains. They suggest that STOP signs should be applied selectively only at hazardous passive grade crossings and should not be used indiscriminately at all passive grade crossings.

Violating Left-Turn Signals. Left-turn accidents increase dramatically when permissive phasing replaces protected-only (exclusive) phasing and when it is used at approaches where the speed limit is over 45 mi/h (72 km/h).[36] No substantial changes in left-turn and total accidents were found when permissive phasing is part of the original signal installation or is the first left-turn signal at an existing signal and where the speed limit is 45 mi/h (72 km/h) or less. When a left-turn signal is warranted, permissive phasing should be used because of the reduced delay compared to exclusive phasing.

Motorists' perceptions of exclusive/permissive signal phasing were studied at 10 intersections in Virginia.[37] The study showed that more than one-third of the 460 motorists questioned were confused the first time they encountered exclusive/permissive signal phasing. Familiarity with this type of signal treatment reduces motorists' confusion. A sign (LEFT TURN YIELD ON GREEN BALL) placed adjacent to the signal head also helped reduce confusion.

A 1982 study focused on whether the use of left-turn red arrows in lieu of red balls can create a safety hazard because of motorists' misinterpretation of the device.[38] For those jurisdictions using the red arrow for the first time, the violation rate was 6.5 percent for the red arrow as opposed to 8.2 percent for the red ball. For jurisdictions which had used the red arrow previously, the violation rates were 5.7 percent and 6.7 percent for the red arrow and red ball, respectively. In both situations, the differences are statistically significant at the 5 percent level.

Traveling Too Fast for Conditions. The concern over moving traffic safely and efficiently through work zones has only recently emerged. In work zone situations traffic is constrained and drivers are expected to negotiate unusual traffic patterns. In addition, factors such as short sight distances, high volumes, poor condition of signs and markings, and driver insensitivity increase the safety risks. Under these circumstances, motorist compliance becomes increasingly important.

The effectiveness of yellow and orange signs at lane closures on interstate highways were compared.[39] Findings imply that signs should always be maintained in good condition because driver obedience improved when new signs of either color were used. Orange signs were slightly more effective than yellow signs in reducing traffic conflicts and merges near the traffic cones. However, approximately 20 percent of the drivers interviewed admitted they deliberately delayed merging.

The effectiveness of advance warning devices at freeway construction lane closures is determined by the risk perceived by approaching drivers.[40] Under low-volume conditions, drivers' merging patterns and travel speeds were not affected by the advance warning devices at the site. Speeds and lane changes were initiated only when the construction activity was actually in sight. At sites with volumes approaching more than 1000 vph, traffic engineering measures to encourage early merging are desirable; changeable message signs were quite successful.

One measure in the study used warning devices in connection with moving work zones.[15] The standard warning sign was compared with a barrier on wheels either towed by the vehicle constituting the road work zone or placed 50 meters behind the vehicle. The barrier placed 50 meters behind the vehicle produced the best effect on driver behavior.

3. Approaches to Improve Compliance

The literature review included the review of documents associated with approaches to improving motorist compliance in general. Typically, approaches are categorized into three categories - engineering, enforcement, and education. These approaches are sometimes referred to as countermeasures to the problem. The discussions above cited efforts to use engineering (i.e., physical changes to the road or road environment) to increase motorist compliance. Some compliance problems may require nonengineering approaches or countermeasures.

Effective police efforts include Selective Traffic Enforcement Programs (STEPs), which focus on speeding and drinking drivers. STEPs consist of enforcement that is proportional to traffic accidents with respect to time and place.[41] Demerit point systems and advisory letters have also been suggested to deter drivers from traffic violations.[42] Incentive systems have been shown to improve compliance with traffic rules and regulations.

Programs to educate drivers can improve driver compliance. The Arizona Traffic Survival School (TSS) program was implemented in 1968 to reduce moving traffic violations and consequent accidents.[43] Arizona drivers with eight points on their driving records are required to attend a 10-hour TSS program. About 68,000 drivers have attended the program since its inception. A before and after study indicated that the TSS program is effective in reducing the number of violators and violations (57 percent to 88 percent reduction) despite the fact that about a quarter of the drivers instructed to attend a TSS program failed to do so.

A three-level driver improvement system was developed in a 1982 study.[44] It incorporates three levels of action: warning, instruction, and sanction. Six experimental 8-hour courses were evaluated to assess the relative benefits of formal instruction and at-home study, and of three instructional methods: classroom only, classroom/audio-visual, and classroom/ home-study. Home-study programs were more effective across methods of instruction. All three methods of instruction were effective in improving knowledge, with the home-study group showing the most improvement. A 1-hour group meeting also was included to acquaint traffic offenders with the consequences of additional violations and to foster attitudes that are more favorable to compliance. Comparison of pre- and post-scores on an attitude measure showed that the meeting was effective.

Renewal applicants with poor prior 3-year accident and conviction records were studied in a California study.[45] Such applicants were required to take a longer written test and to view a film focusing on defensive driving. Results showed no significant effects on subsequent accidents or convictions. Similar results were found for applicants with poor records who were required to take the longer written test and a diagnostic driving test with counseling sessions.

B. Current Research

Contacts were made with organizations that were conducting research on topics related to motorist compliance. The researchers were queried about the extent to which motorist compliance was being investigated, the current status of the project, and the opportunities for obtaining relevant results. The following current research projects were reviewed:

- Guidelines for Converting Stop to Yield Control at Intersections (NCHRP Project 17-7).
- Signal Displays for Left-Turn Controls (FHWA).
- Guidelines for the Use of Permissive Left-Turn Phasing (KY-HPR-85-10).
- Wrong-Way Traffic Control at Intersections (FHWA).
- Driver Risk Perception and Performance (FHWA).
- Speed Zoning and Control in Texas (TX-HPR-334).
- Assessment of Current Speed Zoning Criteria (FHWA).
- Fundamental Studies of Speed Zoning and Control (FHWA).
- Service Vehicle Lighting and Traffic Control for Short-Term and Moving Zones (NCHRP Project 17-6A).
- Traffic Control Stop and Go and Short-Term Maintenance Lane Closures (TX-HPR-2-18-85-377).
- Temporary Pavement Markings for Work Zones (NCHRP Project 3-32).
- Evaluation of Methods for Predicting Rail-Highway Crossing Hazards (VA-HPR).
- Sign Design to Accommodate Aged Drivers (FHWA).
- Stop Signs with Flashing Traffic Signals (FHWA).
- Variable Speed Limit Systems: System Design (FHWA).
- Construction Cost and Safety Impact of Work Zone Traffic Control Strategies (FHWA).
- Traffic Control and Accidents at Rural High-Speed Intersections (KY-HPR-86-114).

While some useful information was gleaned from these efforts, most was not directly germane to the topic of compliance. The studies that included work on traffic control devices were usually accident-based or dependent on operational measures other than compliance. Relevant findings were noted in appendix A.

C. Solicitation of Opinions

The primary impetus behind this research effort was the American Association of State Highway and Transportation Officials (AASHTO) survey on motorist compliance. The survey results indicated that many state highway officials believe that a motorist compliance problem exists and is growing. In an effort to establish a sound understanding of the motorist compliance problem, the AASHTO survey was carefully reviewed. Additional opinions were also solicited from other professionals involved in maintaining highway safety including police, department of motor vehicles personnel, and highway-user advocate groups. The findings of these efforts are presented in the following sections.

1. <u>AASHTO Survey on Motorist Compliance</u>

Early in 1985, the AASHTO Executive Committee made a request to the AASHTO Subcommittee on Traffic Engineering to investigate the problem of motorist non-compliance with TCDs. In April 1985, a survey was sent to the State traffic engineer in all 50 States and the District of Columbia. The survey was analyzed, summarized, and presented to the AASHTO Traffic Engineering Subcommittee in June 1985. Of the 46 agencies responding, an overwhelming majority (74 percent) felt there is an existing problem. A summary of the more significant reasons for compliance problems, as viewed by the respondents, is shown in table 1.

Table 1. Summary of compliance problems and concerns cited in the AASHTO survey.

Compliance Problem/Concern
• 55 NMSL
• TCD Misuse
• Enforcement
• Driver Perception of Need
• Signal Timing
• TCD Comprehension
• Driver Respect
• Societal Changes
• Speed Limits, Except 55
• MUTCD Five Basic TCD Requirements
• Stop Sign Usage
• Driver Education/Public Relations
• Work Zone TCDs
• RTOR/LTOR
• Advisory Speed
• School Bus
• TCD Updating
• RR Crossings

The individual survey returns were analyzed in depth. They were screened for information not included in the survey summary and to clarify the basis for the information given (e.g., Idaho DOT provided estimates of compliance, which were included in the survey summary, but further investigation revealed that those percentages were based on the opinions of the staff, not on field studies). This information has been compiled on a summary form included in appendix A.

In responses to the survey findings, various committees and subcommittees of AASHTO initiated efforts to study the problem in depth. The matter was further reviewed by the Traffic Engineering Subcommittee and information was requested from several States' accident data files concerning situations where violation of a TCD was considered a potential cause of an accident. The Standing Committee on Highway Traffic Safety also initiated plans to examine the problem. AASHTO formed a task force within its Subcommittee on Public Affairs to examine the educational efforts in this area. When these activities were planned, the intent was to look into the entire compliance problem. However, AASHTO's subsequent actions focused on compliance problems associated with work zone safety. A Public Affairs Task Force collected materials used for promoting work zone safety and began developing an information packet for a nationwide media blitz.

2. Police Contacts

The project staff contacted nine geographically dispersed police agencies of varying size, attempting to choose states of different character (e.g., urban/industrial, rural/agrarian). Three groups of State police (or highway patrols), county police, and municipal police agencies were contacted and police officers of different rank were selected within each agency. Contacts were was also established with police officers attending a class at the Traffic Institute at Northwestern University. This group consisted of officers of different rank, from different jurisdictions in several geographic locations.

Each agency contact was sent a data request form that asked for specific information about:

- TCDs most frequently violated.
- Reasons for noncompliance.
- Safety problems caused by violators.
- Existing high violation locations.
- Estimated degree of noncompliance.
- Enforcement:
  - -- Practices.
  - -- Tolerances.
  - -- Specialized selective enforcement programs.
- Prosecution success rate/sanctions.
- Level of cooperation with:
  - -- Department of Motor Vehicles.
  - -- Judiciary.
  - -- Prosecutors.
- Implementation/policy contacts.

The data request form used is provided in appendix D. The results obtained are summarized in appendix C. The findings were also added to the summary provided in appendix A.

As with the AASHTO data, the information derived regarding which TCDls are problem devices and reasons for noncompliance was found to be based on opinion. The survey results indicated that the enforcement practices or tolerances exercised by most agencies are basically a matter of individual officer's discretion. Most jurisdictions reported a prosecution success rate of well over 90 percent, and most of the officials felt their agency had a good working relationship with the motor vehicle department, judges, and prosecutors.

At the 1986 Human Factors Workshop on Motorist Compliance, Major Tom Milldebrandt reported on his survey of the members of the Highway Safety Committee of the International Association of Chiefs of Police (IACP). The results of that survey are reported in appendix B. While much of the information from the survey is interesting, it was not considered germane to this study.

3. Motor Vehicle Administration Contacts

Motor vehicle administration varies by State, but in general these agencies are responsible for the education and licensing of drivers, follow-up on adjudication of traffic offenders, and the registration of motor vehicles. Hence, it was determined important to review the opinions of personnel from these agencies on motorist compliance.

Nine motor vehicle departments were contacted for information on the motorist compliance problem. The three States in which State police agencies patrols were contacted were included as contacts to assess the level of cooperation or problems between the State police and the department. An information request form was developed which covered:

- TCDs most frequently violated.
- Reasons for noncompliance.
- Existing high violation locations.
- Estimated degree of noncompliance.
- Safety problems associated with noncompliance.
- Problems with TCDs contributing to noncompliance:
  - -- Reasonable?
  - -- Restrictive?
  - -- Confusing?
  - -- Not conveying potential risk or hazard?
  - -- Improperly applied?
- Level of cooperation:
  - -- Police.
  - -- Judiciary.
  - -- Prosecutors.
- Implementation/policy contacts.

The data request form is shown in appendix E. The results of the information request are summarized in appendix A. As with the AASHTO and police survey results, much of the information is subjective. In some cases, a blank form was returned because the official(s) believed any response would only be a guess.

In an effort to assess the extent of knowledge of TCDs required of drivers, copies of the State driver's handbook, sample driver examinations, and pertinent excerpts from the State's vehicle code were requested from all the States. It was hoped that a review of these documents would indicate the extent to which TCD comprehension, compliance, and enforcement was promoted through motor vehicle administration agencies.

Information in the driver's handbooks on TCDs and sanctions was compared by state and region of the country. This information is shown in figure 1 and table 2. Figure 1 indicates that some driver's handbooks explain nearly every sign in the MUTCD. Other States give minimal information about TCDs. Table 2 shows that most States have some type of program to monitor the behavior of drivers once they are licensed. While the points per violation and point limit vary, all of the systems take action when a driver has three or more violations in a year.

MUTCD CODE/DEVICE	TOTAL %=49	T	DR	SD	WY*	WI*	WV	WA	VA	VT	UT	TX	TN	SD	SC	RI	PA	OR	OK	OH	ND	NC	NY	NM	NJ	NH	NV	NE	MT	MO	MS	MN	MI	MA	MD	ME	LA	KY	KS	IA	IN	IL	ID	HI	GA	FL	DC	DE	CT	CO	CA	AR	AZ*	AK	AL
R1-1 STOP	100	49	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
R1-2 YIELD	98	48	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●
R1-3 4-WAY	20	10	●	●								●			●											●									●			●	●			●				●									
R1-4 ALL-WAY	6	3		●								●																														●													
R1-1 SPEED LIMIT	77	38	●	●			●		●		●	●	●	●	●		●	●			●	●	●	●	●	●		●	●			●	●	●	●		●	●	●	●	●	●	●	●	●	●		●		●	●			●	●
R-2-2 TRUCK SL	6	3		●									●																													●													
R2-3 NIGHT SL	4	2		●																																															●				
R2-4 MINIMUM SL	14	7	●	●											●																	●	●									●													●
R2-5 SPEED REDUCTION	16	8	●	●				●										●											●						●							●	●	●	●										
R3-1,2,3 TURN RESTRICTIONS	90	44	●	●				●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●	●		●	●	●	●	●		●	●
R3-4 NO U-TURN	82	40		●			●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●	●		●	●	●	●	●	●		●	●	●		●	●	●	●	●			
R3-5,6,7,8 LANE USE CONTROLS	57	28	●	●					●			●	●	●	●	●	●		●						●						●	●	●		●		●	●			●		●	●	●	●		●	●	●	●			●	●
R3-9 TWO-WAY LEFT TURN ONLY	35	17		●			●					●	●			●		●		●	●							●				●	●		●				●			●		●		●								●	
R3-10,11,12,13,14,15 PREFERENTIAL LANE SIGNING	16	8	●						●									●						●									●							●						●					●				
R4-1 DO NOT PASS	41	20		●			●					●							●		●		●		●				●			●	●		●		●	●	●				●	●				●		●	●				●
R4-2 PASS W/CARE	20	10	●	●							●							●											●				●					●	●				●	●											
R4-3 SLOWER TRAFFIC KEEP RIGHT	20	10						●			●	●	●		●			●																				●				●			●					●					
R4-5,6 UPHILL TRAFFIC LANES	8	4											●																									●												●	●				
R4-7 KEEP RIGHT	69	34		●					●		●	●	●		●	●		●	●			●	●		●			●	●		●	●	●	●			●	●	●	●	●	●	●	●	●	●		●		●	●	●		●	●
R4-8 KEEP LEFT	8	4		●														●													●							●																	
R5-1 DO NOT ENTER	90	44	●	●				●	●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●
R5-1A WRONG WAY	61	30	●	●			●	●	●			●	●	●	●		●			●	●					●		●				●	●	●			●	●	●	●	●	●	●		●	●			●		●				●
R5-2 TO 10 SELECTIVE EXCLUSION	63	31	●	●				●			●	●	●		●	●	●	●	●		●		●	●	●	●	●	●		●	●		●	●				●	●		●			●	●					●	●	●		●	
R6-1,2 ONE WAY	65	32	●	●					●		●	●	●					●			●	●	●			●	●	●				●		●	●		●	●	●	●	●	●	●	●	●	●		●		●	●	●		●	●
R6-3 DIVIDED HWY X SIGN	12	6		●											●																	●							●			●													●
R-7/R-8 PARKING SIGNS	49	24	●	●				●	●		●		●			●	●	●				●			●			●				●			●	●	●	●					●	●					●		●	●		●	●
R-9 PEDESTRIAN SIGNS	4	2		●																		●																																	
R10-1 TO 11 TRAFFIC SIGNAL SIGNS	45	22		●					●						●		●				●	●	●		●	●						●	●		●	●	●					●	●		●	●		●			●			●	●
R11-1 KEEP OFF MEDIAN	2	1																																				●																	
R11-2 ROAD CLOSED	8	4										●																											●											●				●	
R11-3,4 LOCAL TRAFFIC ONLY SIGNS	0	0																																																					
R12-1 TO 5 WEIGHT LIMIT SIGNS	4	2											●																																									●	
R13 WEIGH STATION SIGNS	0	0																																																					
R14 TRUCK ROUTE SIGNS	0	0																																																					
TOTAL=34			15	25			7	10	13		12	17	17	6	15	10	11	16	9	7	12	10	11	8	12	10	6	12	10	6	9	16	15	10	14	4	13	19	17	8	11	18	14	15	14	14	1	11	8	14	17	9		14	14

*COULD NOT OBTAIN DRIVERS' MANUAL

Figure 1. Summary of traffic control devices cited in driver handbooks.

STATE

TOTAL %=49	T	DR	SD	WY*	WI*	WV	WA	VA	VT*	UT	TX	TN	SD	SC	RI	PA	OR	OK	OH	ND	NC	NY	NM	NJ	NH	NV	NE	MT	MO	MS	MN	MI	MA	MD	ME	LA	KY	KS	IA	IN	IL	ID	HI	GA	FL	DC	DE	CT	CO	CA	AR	AZ*	AK	AL	MUTCD CODE/DEVICE
59	29					●	●	●			●	●		●		●	●		●	●							●	●			●	●	●	●		●	●	●	●	●	●			●	●		●	●	●	●				●	W1-1 TURN
59	29	●	●				●	●			●	●			●	●			●					●			●	●			●			●		●	●	●	●	●	●	●		●	●		●	●	●		●		●	●	W1-2 CURVE
45	22					●	●	●				●			●				●	●							●	●			●	●		●		●	●	●	●	●	●			●			●		●					●	W1-3 REVERSE TURN
45	20		●				●	●			●			●		●	●		●	●							●	●			●					●	●	●	●	●	●				●				●					●	W1-4 REVERSE CURVE
63	31		●			●	●	●			●	●			●	●			●	●		●		●		●	●	●			●	●	●	●			●	●	●	●	●	●		●	●		●		●				●	●	W1-5 WINDING
16	8		●												●																●			●											●				●				●	●	W1-6,7 LARGE ARROW
16	8		●												●		●																					●	●		●								●					●	W1-8 CHEVRON
59	29	●	●			●	●	●			●		●	●	●	●	●		●	●							●	●			●	●		●		●	●		●	●	●	●		●	●		●		●	●				●	W2-1 X-ROAD
59	29	●	●			●	●	●			●	●		●	●	●	●		●	●							●	●			●	●		●		●	●		●	●	●	●		●	●		●		●		●			●	W2-2TO5 JUCTION SIGNS
35	17	●										●		●	●			●			●						●	●			●	●	●	●			●			●	●			●			●							●	W3-1 STOP AHEAD
22	11											●		●	●												●				●		●	●			●				●			●			●							●	W3-2 YIELD AHEAD
65	32	●	●			●	●	●		●	●		●	●	●										●	●	●		●	●	●	●	●	●		●	●		●	●		●		●	●		●	●	●	●	●		●	●	W3-3 SIGNAL AHEAD
84	41	●				●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●		●	●	●	●		●	●		●	●	●	●	●		●	●	W4-1 MERGE
6	3		●												●																●																								W4-3 ADDED LANE
78	38	●	●			●	●	●		●	●	●			●	●	●	●	●	●		●			●		●			●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●			●	●	W4-2,9-1/2LANE RED TRANSISTION
8	4										●																				●										●													●	W5-1 ROAD NARROWS
39	19										●	●			●			●			●	●						●			●		●	●			●		●		●			●	●		●		●		●			●	W5-2 NARROW BRIDGE
14	7																		●												●			●											●		●						●	●	W5-3 ONE LANE BRIDGE
94	46	●	●			●	●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●	W6-1/2 DIVIDED HWY (E/B)
76	37	●	●			●	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●		●				●	●	●	●			●	●	●	●	●	●	●	●		●				●	●	●	●		●	●	W6-3 TWO WAY TRAFFIC
80	39	●	●			●	●	●		●	●		●	●		●	●	●	●		●	●		●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●			●		●		●		●	●	W7-1TO4 HILL SIGNS
16	8		●								●									●											●													●	●		●							●	W8-1/2 BUMP/DIP
14	7										●																				●		●	●			●										●							●	W8-3 PAVEMENT ENDS
20	10										●										●										●	●					●			●				●	●		●							●	W8-4 SOFT SHOULDER
94	46	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●		●	●	W8-5 SLIPPERY WHEN WET
73	36	●	●				●	●		●		●		●	●	●	●	●	●	●	●			●	●	●	●	●	●		●	●	●	●			●	●	●	●		●		●	●		●	●	●				●	●	W-11 ADVANCE CROSSING
73	36	●	●			●	●	●		●	●			●	●	●	●	●	●	●	●					●	●	●	●		●	●	●			●	●	●	●	●	●		●	●	●			●	●	●	●			●	W-11A CROSSING
10	5										●																				●	●					●																	●	W12-1 DOUBLE ARROW SIGN
61	30	●	●			●	●	●		●	●	●		●		●		●	●						●		●	●			●	●	●	●	●	●	●	●		●				●	●				●		●		●	●	W12-2 CLEARANCE
35	17	●					●	●			●			●		●												●			●	●									●	●			●		●		●		●		●	●	W13-1 ADVISORY SPEED PLATE
27	13		●					●			●			●			●									●	●					●							●		●				●				●				●		W13-2/3 ADVISORY EXIT SPEEDS
4	2																														●																							●	W14-1/2DEAD END/NO OUTLET
73	36	●	●			●	●	●			●	●	●		●	●		●	●	●		●	●		●		●	●		●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●		●					●	W14-3 NO PASSING PENNANT
0	0																																																						W14-4 LIMITED SIGHT DISTANCE
10	5													●	●																●		●								●														W15-1 PLAYGROUND
43	21		●			●				●	●			●	●	●	●			●		●						●			●			●		●		●			●			●			●		●				●	●	W20-7 ADVANCE FLAGGER
22	11		●							●		●		●	●							●						●						●				●			●													●	W21-1 WORKER SIGN
		16	22			16	19	19		12	25	16	7	20	23	18	15	12	18	16	10	11	5	7	10	7	19	20	6	7	33	21	17	23	7	17	24	17	20	20	25	13	6	23	22	0	23	10	24	8	12		16	33	TOTAL = 37

*COULD NOT OBTAIN DRIVERS' MANUAL

Figure 1. Summary of traffic control devices cited in driver handbooks. (Cont.)

STATE

TOTAL %=49	T	DR	SD	WY*	WI*	WV	WA	VA	VT*	UT	TX	TN	SD	SC	RI	PA	OR	OK	OH	ND	NC	NY	NM	NJ	NH	NV	NE	MT	MO	MS	MN	MI	MA	MD	ME	LA	KY	KS	IA	IN	IL	ID	HI	GA	FL	DC	DE	CT	CO	CA	AR	AZ*	AK	AL	MUTCD CODE/DEVICE
92	45	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	3B-1 CENTER LINES
69	34	●	●			●		●		●	●	●	●	●	●	●	●				●	●	●	●	●		●		●	●	●	●			●	●		●	●		●		●	●	●		●		●				●	●	3B-2 LANE LINES
94	46	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	3B-3 NO PASSING ZONES
51	25		●			●	●	●		●	●				●	●	●				●	●		●	●				●		●	●				●		●			●		●	●			●		●				●	●	3B-6 PAVEMENT EDGE LINES
43	21	●	●					●		●	●	●	●				●			●							●		●							●		●	●				●	●	●				●	●			●	●	3B-9 CHANNELIZATION LINES
14	7	●	●							●	●																														●		●						●						3B-10 PAVEMENT MEDIANS
6	3		●								●																																						●						3B-11 INTERCHANGE RAMP MRKS.
51	25	●	●			●		●		●	●	●					●			●		●		●	●		●				●	●			●	●					●		●	●			●	●	●		●		●		3B-14 STOP LINES
59	29	●	●			●	●	●		●	●	●					●			●		●		●	●		●	●		●	●	●			●	●			●		●		●	●		●			●		●		●	●	3B-15 CROSSWALKS
2	1	●																																																					3B-16 PARKING SPACES
38	19	●	●				●	●						●			●					●		●	●			●		●	●	●				●			●				●		●					●				●	3B-17 WORDS & SYMBOLS
6	3	●						●																																	●														3B-18 CURB MARKING
8	4	●				●																																												●			●		3B-19 PREFERENTIAL LANE MRKS.
61	30		●			●	●	●		●	●	●		●		●	●		●	●	●		●				●				●	●			●	●		●			●	●	●	●	●		●		●	●			●	●	TWO-WAY LEFT TURN LINES
98	48	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	CIRCULAR GREEN
92	45	●	●			●	●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●		●	●	GREEN ARROW
96	47	●	●			●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	CIRCULAR YELLOW
61	30	●	●			●		●				●	●	●		●		●	●		●	●	●		●				●	●	●			●	●		●			●	●		●	●	●		●			●	●		●	●	YELLOW ARROW
96	47	●	●			●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	CIRCULAR RED
31	15	●	●										●			●		●				●			●						●				●								●		●		●		●	●			●		RED ARROW
98	48	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	FLASHING CIRCULAR RED
98	48	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	FLASHING CIRCULAR YELLOW
53	26	●	●											●		●	●	●	●				●	●	●	●		●		●	●		●	●		●				●		●	●	●		●			●		●		●	●	STEADY WALK
16	8		●													●								●									●	●		●							●						●						FLASHING WALK
53	26	●	●											●		●	●	●	●				●	●	●	●		●		●	●		●	●		●				●		●	●	●		●			●		●		●	●	STEADY DON'T WALK
39	19	●	●													●		●	●					●		●				●	●		●	●		●						●	●	●					●		●		●	●	FLASHING DON'T WALK
37	18	●	●			●	●	●				●		●		●		●	●								●				●										●		●	●	●								●	●	STEADY GREEN DOWNWARD ARROW
33	16	●	●			●		●				●				●		●	●								●				●										●		●	●	●								●	●	STEADY YELLOW X
24	12		●					●				●				●		●	●												●										●		●	●									●	●	FLASHING YELLOW X
37	18	●	●			●	●	●				●		●		●		●	●								●				●										●		●	●	●								●	●	STEADY RED X
0	0																																																						FREEWAY ENTERANCE RAMP CONTROLS
		25	27			18	14	21		15	16	18	12	16	9	21	17	15	17	12	12	15	13	17	17	9	16	12	12	15	23	14	4	13	14	19	9	12	12	11	20	12	26	22	17	9	14	6	21	14	14		24	22	TOTAL = 30

*COULD NOT OBTAIN DRIVERS' MANUAL

Figure 1. Summary of traffic control devices cited in driver handbooks. (Cont.)

TOTAL %=49	T	DR	SD	WY*	WI*	WV	WA	VA	VT*	UT	TX	TN	SD	SC	RI	PA	OR	OK	OH	ND	NC	NY	NM	NJ	NH	NV	NE	MT	MO	MS	MN	MI	MA	MD	ME	LA	KY	KS	IA	IN	IL	ID	HI	GA	FL	DC	DE	CT	CO	CA	AR	AZ*	AK	AL	MUTCD CODE/DEVICE
86	42	●	●			●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●		●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●		●		S1-1 SCHOOL ADVANCE
88	43	●	●			●	●	●		●			●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●		●	●	S2-2 SCHOOL CROSSING
4	2																									●		●																											S3-1 SCHOOL BUS STOP AHEAD
20	10	●	●				●				●	●							●																								●			●									●	●	S4-1TO4 SCHOOL SL SIGNS
73	36	●	●				●	●		●	●	●				●	●	●	●	●	●	●			●	●	●		●	●	●	●	●	●		●	●	●	●			●		●	●		●	●	●	●			●	●	R15-1,2 CROSSBUCK
90	44	●	●			●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		●		●	●	●		●	●	W10-1 RAILROAD ADVANCE
4	2													●																														●													W10-2,3,4 RAILROAD ADVANCE
39	19	●	●				●							●			●		●	●							●		●	●	●					●	●				●	●	●	●									●	●	RR CROSSING/CROSSBUCK PVMNT MRKS.
		6	6			3	6	4		4	5	5	2	5	3	4	6	4	6	5	4	4	3	0	4	3	5	4	4	5	5	3	4	4	3	5	5	4	4	3	5	6	3	6	3	0	4	2	4	4	3		6	5	TOTAL = 8
		62	80			44	49	57		43	63	56	27	56	45	54	54	40	48	45	36	41	29	36	41	25	52	46	28	36	77	53	35	54	28	54	57	50	44	45	68	45	50	65	56	10	52	26	63	43	38		60	74	GRAND TOTAL = 109
		57	73			40	45	52		39	58	51	25	51	41	50	50	37	44	41	33	38	27	33	38	23	48	42	26	33	71	49	32	50	26	50	52	46	40	41	62	41	46	60	51	9	48	24	58	39	35		55	68	% OF GRAND TOTAL

*COULD NOT OBTAIN DRIVERS' MANUAL

Figure 1. Summary of traffic control devices cited in driver handbooks. (Cont.)

Table 2. Point system/driver improvement programs summary by State.

State	Point System	Points Allowed Per Year*	Speeding >55	Speeding <55	Other TCDs	Driver Improvements	Required After X Points*
AL	Yes	6	2	2	3	No	---
AK	Yes	12	2-6	2-6	4-6	Yes	Varies
AZ							
AR	Yes	9	3-6	3-6	3	Yes	9
CA	Yes	4	1	1	1	No	---
CO	Yes	12	3-6	3-6	3-4	No	---
CT	Yes	11	4	4	1-3	Yes	10
DE	Yes	8	2-5	2-5	2-3	Yes	8
DC	Yes	8	4	4	2	Yes	4
FL	Yes	12	3-4	3-4	3	Yes	12
GA	Yes	8	2-6	2-6	3	Yes	---
HI	Yes	12	1-6	1-6	0-3	No	---
ID	Yes	12	3-4	3-4	1-4	No	---
IL	Yes	15	5-50	5-50	5-20	Yes	---
IN	Yes	9	2-6	2-6	2-4	Yes	---
IA	Yes	4	1	1	1	Yes	3
KS	Yes	3	1	1	1	Yes	3
KY	Yes	6	0-5	3-5	3-5	Yes	6
LA	No	---	---	---	---	No	---
ME	Yes	10	2-10	2-10	0	Yes	---
MD	Yes	8	0-5	0-5	1	Yes	---
MA	No	---	---	---	---	No	---
MI	Yes	Varies	1-4	2-4	2-3	Yes	Varies
MN	Yes	Varies	1	1	1	Yes	Varies
MS	Yes	3	1	1	1	Yes	2
MO	Yes	6	3	2-3	1-2	Yes	---
MT	Yes	5	3	3	2	Yes	4
NE	Yes	6	0-3	1-3	1	Yes	6
NV	Yes	12	0-4	1-4	2-4	No	---
NH	No	---	---	---	---	No	---
NJ	Yes	6	2-5	2-5	2-4	Yes	6
NM	Yes	12	0-6	2-6	2	Yes	12
NY	Yes	8	3-5	3-5	2	Yes	5
NC	Yes	12	2-3	2-3	2-3	Yes	7
ND	Yes	12	1-12	1-12	2	Yes	---
OH	Yes	6	2	2	2	Yes	5
OK	Yes	2	2-3	2-3	1-2	Yes	2
OR	Yes	2	1	1	1	Yes	2
PA	Yes	11	0-5	0-5	3	Yes	6
RI							
SC	Yes	12	2-4	2-4	4	Yes	12
SD	Yes	15	2	2	2-4	Yes	15
TN	Yes	12	1-8	1-8	3-4	Yes	12
TX	Yes	4	1	1	1	No	---
UT	Yes	67	35-75	35-75	40-60	Yes	67
VT							
VA	Yes	12	3-4	3-4	3-4	Yes	12
WA	Yes	4	1	1	1	Yes	4
WV	Yes	6	3-6	3	2-3	Yes	3
WI							
WY							

*Some of the values have been converted to one year totals for comparison purposes.

Each sample driver examination gathered in this effort was analyzed to determine how well applicants are tested about their knowledge of TCDs. The results are summarized in table 3. In most cases, less than one-third of the questions on the examinations refer to TCDs, and most of those deal with well-known signs (e.g., STOP, red, yellow, green (RYG) signals).

4. User-Group Contacts

A data request form similar to that sent to the motor vehicle administrators was sent to the following user groups to solicit their opinions on motorist noncompliance:

- American Automobile Association.
- American Trucking Association.
- The Automobile Club of Chicago.
- The Automobile Club of Southern California.
- The Bicycle Federation.
- The Highway Users Federation.
- National Committee on Uniform Traffic Control Devices.
- National Committee on Uniform Traffic Laws and Ordinances.
- American Association of Motor Vehicle Administrators.

While all of the groups recognized the problem of motorist compliance, only the Automobile Club of Southern California and the Bicycle Federation believed they had enough information to complete the data request form. The responses from these two organizations were incorporated into the summary in appendix A.

D. Review of Other Information Sources

In an effort to find a means to assess the extent of motorist noncompliance and to gauge the degree of change in compliance over time, the viability of various databases was investigated. Reviews were conducted of various national accident databases, a state accident/citations database, and the traffic speeds database created to monitor compliance to the National Maximum Speed Limit (NMSL). The results of these investigations are provided below.

1. Accident Data

Three national accident databases were examined for information about trends in compliance behavior: National Safety Council (NSC), National Accident Sampling System (NASS), and Fatal Accident Reporting System (FARS).

The National Safety Council (NSC) information is compiled from accident summaries provided by a varying set of jurisdictions each year. The NSC data are gathered and reported in urban and rural categories. Before 1981, rural data were taken from State agencies reporting to the NSC and urban data were taken from municipal sources. Since 1981, State agencies report both the urban and rural data. This change in reporting practices between rural and urban jurisdictions, the varying set of agencies reporting each year, and the differing data available on noncompliance from each of the sources, render the NSC database inappropriate for the purposes of this project.

Since NASS and FARS are primarily accident data bases, a significant amount of file manipulation was necessary even before the project team began looking for useful compliance information. Elements in categories that are useful in

Table 3. Driver examination features summary by State.

State	Number of Questions	Number of Questions Relating to TCDs	Percentage	Special Sign Examination/ Section	Number of Questions
AL	---	---	---	---	---
AK	---	---	---	---	---
AZ	---	---	---	---	---
AR	---	---	---	Yes	---
CA	10	4	40	No	---
CO	---	---	---	---	---
CT	20	3	15	No	---
DE	---	---	---	Yes	---
DC	20	---	13*	No	---
FL	20	4	20	Yes	20
GA	20	---	---	Yes	20
HI	171*	56	33	No	---
ID	38	8	21	Yes	12
IL	40	7	18	Yes	15
IN	18	---	---	Yes	10
IA	---	---	---	---	---
KS	22	9	41	No	---
KY	30	---	---	Yes	10
LA	25	---	---	Yes	---
ME	---	---	---	---	---
MD	20	---	---	No	---
MA	10	2	20	No	---
MI	---	---	---	Yes	---
MN	---	---	---	---	---
MS	59*	9	15	No	---
MO	20	---	---	Yes	---
MT	---	---	---	Yes	---
NE	20	---	---	---	---
NV	50	9	18	No	---
NH	20	---	20*	No	---
NJ	30	---	20*	No	---
NM	20	6	30	No	---
NY	---	---	---	---	---
NC	---	---	---	Yes	---
ND	---	---	---	---	---
OH	---	---	---	---	---
OK	---	---	---	---	---
OR	26*	2	8	No	---
PA	10	1	10	Yes	8
RI	---	---	---	---	---
SC	---	---	---	Yes	---
SD	---	---	---	---	---
TN	20-30	---	---	No	---
TX	20	1	5	No	---
UT	20	4	20	No	---
VT	---	---	---	---	---
VA	20	5	25	No	---
WA	---	---	---	Yes	---
WV	25	---	---	No	---
WI	---	---	---	---	---
WY	---	---	---	---	---

accident analysis had to be collapsed and reevaluated before any meaningful work in cross tabulating and statistical analysis could begin. It became apparent that reformatting 15 years of accident data into compliance data would be a massive task. Initially, it was anticipated that NHTSA would reconfigure much of the data; however, NHTSA was unable to commit the necessary resources to the task. FHWA also declined to do the entire job, but offered access to the NASS and FARS files.

2. MCTARS Accident/Citation Database

The State of Maryland utilizes the MCTARS system to track accident and violation data for individual municipalities. This system was believed to be representative of a State system capable of providing information on the number and locations of cited violations and accidents. However, MCTARS is a demonstration project, currently functioning in two cities for two years. During this period the database is being built and uses investigated. The ultimate value of this system for the analyses of motorist compliance will depend upon the accuracy of information entered and the support software which is developed.

3. FHWA Monitoring of 55 NMSL Compliance

Since 1974, a Federal mandate has required the States to certify that they are enforcing the 55 National Maximum Speed Limit (NMSL) and report to FHWA the percentages of vehicles exceeding the 55 NMSL. It was hoped that this database, which is maintained by the FHWA Office of Traffic Operations, Traffic Regulation Branch, would provide information about trends and actual compliance levels relative to the 55 NMSL. It was discovered that much of the data collected before 1982 is suspect due to inconsistent sampling plans and the use of detectable radar as the principal speed measuring device. Consequently, it could not provide a reliable measure of motorist compliance for the purposes of this study.

E. Summary

A large number of documents, both domestic and foreign, were reviewed at the outset of this research project. In the review of topics associated with motorist compliance and behavior, traffic control devices, highway safety and related topics, it was noted that:

- A considerable amount of research has been conducted in the areas of highway safety, driver behavior, and traffic control device effectiveness, but only limited effort has been devoted to quantifying motorist compliance.
- It has been determined that driver behavior is a function of the need to adapt to traffic conditions and meet the psychodynamic requirements of the driver. There seems to be agreement that certain personality traits may lead to noncompliance with traffic controls, but these driver groups do not necessarily have more accidents.
- Various studies have indicated that drivers observe or ignore traffic controls on the basis of "perceived reasonableness" of the control and the "perceived chance" of being caught violating the control.
- Compliance to speed limits has been studied most extensively over the years. The "reasonableness" concept seems to be widely accepted by drivers. Enforcement has been shown to significantly increase compliance, but the "halo effect" is short lived.
- Studies as far back as the 1930s have indicated that over 50 percent of

motorists fail to voluntarily come to a complete stop at STOP signs. The data from various studies on this issue are not sufficiently consistent to determine the degree of change that has taken place over the years.

- The relatively recent implementation of RTOR has led to several studies of compliance to the requirement to stop before making a right turn. These studies have found consistent levels of noncompliance, but also noted that the occurrence of conflicts as a result of the failure to comply is rare.
- Similarly, violations of the red signal indication have been quantified, but associated conflicts were noted to be rare.
- A considerable amount of research has been focused on motorist compliance at railroad-highway grade crossings. These studies have noted that the credibility of the controls are often questioned by motorists.
- Studies of controls such as protected-permissive left turn signalization, have noted good compliance when the controls are understood by motorists.
- The literature indicated that selective enforcement, remedial driver training, and driver points systems are effective in enhancing motorist compliance.

The literature provided very little information relative to the extent of noncompliance and whether it has been changing over time.

Various current research projects were reviewed to determine the nature of other efforts relative to motorist compliance to traffic control devices. It was noted that:

- Various research projects currently underway could not provide information useful to this project due to the scope or status.
- Some of the studies related to speed limits, railroad crossings, and work zones are ultimately expected to offer new insights on motorist compliance.

While information useful for this study was not obtained, other efforts which would address motorist compliance were identified.

Contacts were made with a number of agencies associated with highway safety, traffic enforcement, and driver licensing in an effort to determine whether a motorist compliance problem exists. The many contacts led to the following conclusions:

- Much of the impetus for research into motorist compliance results from the survey conducted by AASHTO in which 74 percent of the States indicated that a problem exists.
- A detailed review of the AASHTO survey responses indicated that virtually all of the States perceive a problem, but only a few have done anything to quantify it.
- Contacts with police agencies revealed a similar belief that a motorist compliance problem exists. Police agencies use enforcement to improve compliance, but the application is generally on a discretionary basis.
- Contacts with motor vehicle administration personnel revealed similar beliefs, but even less quantification of the problem. These agencies were noted to have various programs aimed at the frequent violator.
- An assessment of driver handbooks and licensing exams indicated a wide disparity in the treatment of standard traffic control devices and their importance. This suggests that stronger emphasis is possible to assure that motorists are fully aware of the need to understand and comply with traffic control devices.
- Only two highway user groups responded to the request for information. They indicated that they thought a motorist compliance problem exists.

While there was a consensus that a problem exists, few agencies had attempted to quantify the extent or correlate noncompliance to safety problems.

Various databases were also reviewed in an effort to determine the extent of the problem and to measure changes in noncompliance over time. These reviews indicated that:

- National accident databases do not represent a convenient nor effective means to determine the extent of motorist noncompliance.
- State accident and citation databases are rare, but offer future potential to assess the extent of the problem.
- Data inconsistencies in the 55 NMSL database render it unreliable at present. It is also of limited usefulness due to its scope.

It was concluded that current databases would not provide the quantitative information desired.

While the work effort relative to the first part of this research was extensive, the results were somewhat disappointing. Much of the literature reviewed was factually based, but few of the items were directly applicable to the motorist compliance problem. Almost all of the information received from various police agencies, motor vehicle administrations, State highway departments, and user groups was subjective or anecdotal in nature. There was a consensus, however, regarding which TCDs are violated most frequently. Table 4 summarizes the frequency with which some TCDs were cited as problems by all groups that were contacted. Table 5 shows the results of a police agency rating of the devices with the largest compliance problems.

The efforts of the first phase of the research failed to identify a specific set of TCDs or laws that were a problem. Little information was available in general on motorist noncompliance. It was therefore necessary to define those traffic control devices or laws that could be analyzed within the scope of the project. The decision was made to use the ordering of the concerns indicated in tables 4 and 5 while avoiding those areas where other research was being conducted. Therefore, traffic signals and STOP signs were selected. While speed limits were cited as major problems, speed compliance was not considered in this study. Illegal turns also were cited as a problem, but since specific turn move-ments were not noted a subjective decision was made to focus on left turns. Recent or current research led to the decision not to consider railroad crossing, passing zone, and pedestrian crossing noncompliance. Advisory speeds and school bus operations were selected from the remainder of items on the lists since it was felt that they could be effectively studied.

The traffic control devices/laws and associated compliance problems noted in table 6 were subsequently selected for study. In each case, a particular noncompliance problem was identified as the focus of the research.

Table 4. Frequency TCDs or laws were mentioned as compliance problems in contacts with various groups.

Traffic Control Device or Law	Frequency
Signals	24 %
STOP Signs	20 %
55 MPH Speed Limit Signs	17 %
Other Speed Limit Signs	16 %
Right Turn on Red Rules	9 %
No Turn (Right or Left) Signs	8 %
No Passing Signs/Markings	6 %
Railroad-Highway Grade Crossing Devices	6 %
Advisory Speed Plates	6 %
YIELD Signs	5 %
Wrong Way Driving	4 %
Yielding Right of Way to Pedestrians	4 %
School Bus Stops & Related Operations	4 %
Lane Markings	3 %
Pedestrian Signals	3 %
No Turn on Red Signs	3 %
Total Number of Agencies Reporting = 76.	

Table 5. Police agency ranking of traffic control devices/laws that are most frequently violated.

Order	Traffic Control Device or Law
1	STOP Signs
2	Traffic Signals (Running the Red)
3	Speed Limits
4	Turn Prohibitions
5	Right Turn on Red
6	No Passing Zones
7	Lane Markings
8	YIELD Signs
9	Yield Right of Way at Signalized Intersections
10	Railroad Crossing Controls
11	No Turn on Red Signs
12	Crosswalks
13	Parking Regulations
14	Advisory Speeds
15	Median Crossover Controls
16	Warning Signs
17	One-way Operations
18	Stopping for School Buses
19	Traffic Signals (Failure to Yield on Permissive Turns)
Total Police Agencies Reporting = 13.	

Table 6. Summary of traffic control devices/laws and noncompliance actions selected for investigation

Traffic Control Device/Law (MUTCD Reference Code)	Noncompliance Action
Traffic Signals	• Running the red • Right turn on red without full stop
STOP Signs (MUTCD R1-1)	• Failure to come to a complete stop
No Left Turn Signs (MUTCD R3-2)	• Left turns where prohibited or restricted
Advisory Speed Plate (MUTCD W13-1)	• Exceeding the advised speed
School Bus Operations	• Passing stopped school buses displaying flashing lights

II. ATTITUDINAL STUDIES

Attitudinal studies were conducted to develop insights into the reasons for traffic violations by "high violator" and "typical" motorists. Drivers in these groups were asked to respond to a survey designed to determine if and how often they violate traffic control devices. "Typical" motorists were selected at random from persons renewing licenses or registering vehicles. "High Violators" were categorized as those motorists who accumulated a sufficient number of violation points to require special processing by the motor vehicle administration in their State.

The following sections describe the procedures used in this aspect of the research, provide a profile of subjects, and summarize the information gathered on motorist compliance.

A. Study Procedures

The attitudinal surveys were designed to solicit information from drivers on their motoring habits. A survey questionnaire was designed to query drivers about their compliance with specific traffic control devices. It included questions about violations, frequency of violation, reasons for noncompliance, and potential countermeasures using a nondirective interview technique. Typical and high violator motorists were selected at random from persons at department of motor vehicle (DMV) offices in four States. All subjects were assured that the responses would not be seen by the DMV and were paid for their participation.

A log was developed to record subject responses for both of these subject groups (figure 2). The experimenter recorded personal data about the subject, then asked each subject a series of questions about his or her compliance for each of the TCDs listed. The answers to these questions were recorded on the response log.

Typical drivers were selected from persons waiting to be served at the department of motor vehicle offices. The high violators were identified in these offices as those who required special processing for licensing. It was necessary to get the assistance of DMV staff in identifying candidates in the high violator categories. These candidates were identified using the driver point system.

In many States, a point system is used to monitor the frequency of violations by individual motorists. When drivers exceed a certain number of points in a given time period, they are often required to complete refresher courses in lieu of having driving privileges suspended or revoked. Driver improvement centers were visited to conduct interviews with a sample of chronic offenders.

B. Subject Profile

The study planned to gather approximately equal samples of subjects within each group in the States of California, New York, Texas, and Virginia. The target samples were achieved for the typical drivers, but administrative problems hampered efforts to get equal samples in the high/chronic violator category. Difficulties were encountered in achieving the target sample in Texas in a reasonable time. California officials reversed an initial decision to help identify chronic

INTERVIEW LOG

Interviewer: ____________
Date: ____________

Device/Law	V-Y/N	f	T-Y/N	Reason	Countermeasure	R	C
a. Signals (Run Red)							
b. Signals (RTORAS)							
c. Signals (NTOR)							
d. Signals (Pedestrian)							
e. Pedestrian Ops							
f. Stop							
g. Yield							
h. Speed Limit (55)							
i. Speed Limit (School)							
j. Speed Limit (Other)							
k. No Right Turn							
l. No Left Turn							
m. No U Turn							
n. Lane Use Controls							
o. Do Not Pass							
p. Wrong Way Driving							
q. Advisory Speeds							
r. C&M Areas							
s. School Bus Ops							
t. RR Grade Crossings							
u.							
v.							

Figure 2. Attitudinal study interview log form.

violators making it impossible to get any subjects. Therefore, the sample of chronic offenders consists principally of New York and Virginia drivers.

The target sample of 240 subjects is subdivided by State, violator, and nonviolator types, sex, and age as shown in table 7. The actual breakdown is shown in the lower portion of the table. It was very difficult to get a uniform distribution across various age and sex categories in the chronic violator samples because certain demographic types (e.g., older women) are almost nonexistent at driver improvement clinics or in courts. Efforts were made to secure subjects from these underrepresented groups (older males and females in general) whenever possible. Consequently, it is doubtful that the resulting sample is representative of chronic violators nationwide. The chronic violator sample is also not necessarily directly comparable to the sample of typical drivers selected. The characteristics of this sample must be recognized in the review of results.

The responses of both subject groups were coded and reduced to yield frequency and cross-tabulation data. A chi-square analysis was used to determine the statistical significance of the cross tabulations.

C. Noncompliance Levels and Reasons

Tables 8 and 9 provide a summary of the percentage of violations, frequency of violation, and ticketing of the typical drivers and chronic offenders, respectively. The first column shows the number of drivers who answered that they had violated the device in question. The second column gives the associated percentage of the total number of subjects questioned. Columns 3 through 7 give the frequency (i.e., daily, weekly) of violation. The percentages are based on the total number of subjects who answered that they did violate a particular device. The last column gives the percentage of violators who noted that they have been ticketed for violating a specific device or law.

Speed-related devices are among the most frequently violated, and while 39 percent of typical drivers and 43 percent of the violators admitted to driving in the wrong direction, it should be noted that this is a rather infrequent occurrence. One should also note that many of the more frequently violated devices, excluding those already mentioned, were chosen for in-depth study in this research.

Tables 10 and 11 list the principal reasons for committing a violation for each device/law. While drivers gave very specific reasons for each category, low frequencies for some necessitated collapsing the responses into five basic categories. The Device Fault category is representative of answers such as, "defective device," and "yellow is too short." The Safe-No Risk category is characterized by answers such as, "low cross street traffic," or "I could see that there was no train coming." Personal Reasons consisted of answers such as, "I'm impatient," "I'm in a hurry," or "It's a habit." The Enforcement category includes answers like, "I check for the police first," and "I do it in areas where enforcement is light." The perception of no risk is often cited as a reason for violating a device or law, and the threat of enforcement or lack of that threat seldom influences a driver's decision to violate. Therefore, it seems that increased education rather than more enforcement should be considered to address the compliance problem.

Table 12 gives the reasons motorists violate traffic signals by running the red indication. Here, 36 percent of the typical drivers cited impatience or being in a hurry as a reason for not complying. Interestingly, 24 percent of these motorists believed it was safer to run the red than risk being rear-ended when stopping for a yellow indication. For the chronic violators, impatience or being in a hurry makes up the largest category of response (59 percent), while 9 percent of the respondents feel that only when they encounter signals with excessively long cycle lengths do they "selectively" run red.

Table 13 provides a similar summary of the reasons cited for not coming to a complete stop at RTOR locations. Of the typical drivers, 77 percent said they did not come to a full stop making a right turn on red at intersections where the cross-street traffic volume is low and/or there are no sight line obstructions. Likewise, a high number of the chronic offenders (82 percent) also cited good sight lines and low cross-street volumes as reasons for not coming to a full stop.

Table 14 lists the reasons motorists fail to come to a complete stop at STOP signs. Of the typical drivers, 51 percent said that they do not come to a full stop at a stop-controlled intersection because the cross-street traffic volume is low and/or there are no sight line obstructions. Of the chronic violators, 62 percent said they do not stop at STOP signs because of good sight lines or low cross-street traffic or a combination of the two. This would confirm some of the results of a 1981 study which was discussed in the literature review.(21) Impatience or being in a hurry was cited as the reason for not complying by 18 percent of the typical drivers. It was noted that 11 percent of the violators said they were "in a hurry" when they did/do not fully stop.

The analysis of the interview results related to violations of left turn prohibitions is provided in Table 15. It was noted that 35 percent of the typical drivers who admitted to violating no left turn restrictions said they do so as a matter of convenience. Of these drivers, 29 percent cited being lost or confused about directions as their reason for noncompliance. Of the chronic violators, 40 percent claimed that they make a prohibited left turn for the sake of convenience, 20 percent of this group mentioning being lost or confused as the reason for violating.

Table 16 shows the reasons cited by motorists relative to "exceeding" advisory speeds. Of the typical drivers responding, 19 percent felt the advisory speeds are set too low to be meaningful. Of the violators, 18 percent feel the same way. It was noted that 16 percent of the typical drivers said they slow down, but not to the posted speed and 35 percent admitted to paying closer attention to advisory speed warnings in certain situations (e.g., at an unfamiliar curve, in the rain, at night, driving an oversize vehicle). Of the chronic violators, 40 percent also cited these reasons.

All of the reasons given for violating specific devices center around perceived risk and personal reasons, which target education and engineering improvements (e.g., exceeding advisory speeds - purpose not fully understood by motorists and/or advisory speeds not appropriate) as the primary countermeasure areas. Enforcement or the perceived risk of being caught is seldom, if ever, mentioned as a deterent to noncompliance. This hierarchy of approaches to reducing noncompliance derived from the motorist interviews is consistent with the approaches reflected in the literature.

Tables 17 through 20 provide a series of cross-tabulations of age, sex, and violation behavior for running red signals and STOP signs for the typical drivers. All of the tables point out that the 17-29 age category contains a statistically significant higher frequency of violators than the 30-49 and 50-74 age ranges. This is especially true of the male drivers questioned. This trend has been shown in previous studies.

Table 7. Distribution of driver sample for attitudinal study.

	Driver Type Sample by State, Age, and Sex - Planned												Total by Type
	New York			Virginia			Texas			California			
	<30	30-50	>50	<30	30-50	>50	<30	30-50	>50	<30	30-50	>50	
Violators													
Male	5	5	5	5	5	5	5	5	5	5	5	5	
Female	5	5	5	5	5	5	5	5	5	5	5	5	120
Typical													
Male	5	5	5	5	5	5	5	5	5	5	5	5	
Female	5	5	5	5	5	5	5	5	5	5	5	5	120
State Totals			60			60			60			60	240

	Driver Type Sample by State, Age, and Sex - Actual												Total by Type
	New York			Virginia			Texas			California			
	<30	30-50	>50	<30	30-50	>50	<30	30-50	>50	<30	30-50	>50	
Violators													
Male	16	7	1	14	9	0	3	2	0	0	0	0	
Female	3	1	0	7	1	0	1	0	0	0	0	0	65
Typical													
Male	6	6	4	5	5	5	5	5	4	6	6	5	
Female	3	7	4	6	5	5	5	5	5	3	5	5	120
State Totals			58			62			35			30	185

Table 8. Percentage of typical driver violations, frequency of violation, and ticketing by device/law (total N=120).

Device/Law	Percentage That Has Ever Violated	Frequency of Violation: Daily	Weekly	Monthly	Yearly	>Yearly	Percentage That Was Ever Ticketed
Speed Limit (55)	71	52	32	13	2	0	28
Signals (Pedestrian)	64	24	24	33	19	0	1
*Advisory Speeds	54	51	28	18	2	2	0
Speed Limit (Other)	43	78	14	2	0	6	12
Wrong-Way Driving	39	2	2	4	2	89	3
*Signals (Run Red)	38	4	18	44	20	13	7
*STOP	38	25	43	21	2	9	7
RR Grade Crossings	30	0	6	11	39	44	0
*Signals (RTORAS)	26	29	42	16	7	7	1
Do Not Pass	21	4	4	12	32	48	1
No U-Turn	16	5	16	37	21	21	2
*No Left Turn	14	18	6	41	6	30	3
Signals (NTOR)	14	0	19	44	38	0	0
Speed Limit (School)	8	0	63	13	13	13	1
Lane Use Controls	4	0	20	20	20	40	0
*School Bus Operations	3	0	0	0	33	67	0
No Right Turn	2	0	0	100	0	0	0
Pedestrian Movements	2	0	0	50	50	0	0
Yield	2	0	50	0	0	50	0
Work Zone Areas	0	--	--	--	--	--	0

*Device/Law included in behavioral study.

Table 9. Percentage of chronic violators' violations, frequency of violation, and ticketing by device/law (total N=65).

Device/Law	Percentage That Has Ever Violated	Frequency of Violation					Percentage That Has Been Ticketed
		Daily	Weekly	Monthly	Yearly	>Yearly	
Speed Limit (55)	92	68	27	3	2	0	62
*Advisory Speeds	74	56	21	21	2	0	0
Signals (Pedestrian)	65	29	39	22	10	0	0
*STOP	60	43	30	16	5	5	32
Speed Limit (Other)	60	68	29	0	3	0	35
*Signals (Run Red)	54	24	24	35	3	15	29
*Signals (RTORAS)	43	26	56	15	4	0	5
Wrong-Way Driving	43	0	3	3	3	90	3
*No Left Turn	35	13	25	25	25	13	6
No U-Turn	34	4	17	22	9	17	3
Do Not Pass	34	9	9	14	32	36	0
Signals (NTOR)	23	13	33	27	2	7	0
RR Grade Crossings	29	0	0	0	73	27	0
No Right Turn	12	11	44	22	0	22	0
*School Bus Operations	11	17	17	0	0	67	3
Speed Limit (School)	11	14	57	14	0	14	3
Yield	8	60	40	0	0	0	0
Lane Use Controls	5	33	67	0	0	0	0
Work Zone Areas	2	--	--	--	--	--	0
Pedestrian Operations	2	0	0	100	0	0	0

*Device/Law included in behavioral study.

Table 10. Typical drivers principal reason for violating by device type.

		Principal Reason for Violating (percent)				
Device/Law	N	Device Fault	Safe No Risk	Personal Reasons	Enforcement	Other
*Signals (Run Red)	37	35	8	46	0	11
*Signals (RTORAS)	30	0	80	20	0	0
Signals (NTOR)	16	6	38	44	0	13
Signals (Pedestrian)	77	4	88	6	0	1
Pedestrian Movements	2	0	50	50	0	0
*STOP	42	5	71	17	0	7
Yield	1	0	100	0	0	0
Speed Limit (55)	82	23	18	54	1	4
Speed Limit (School)	9	22	68	0	0	11
Speed Limit (Other)	48	8	52	29	8	2
No Right Turn	2	0	0	100	0	0
*No Left Turn	17	0	18	53	0	29
No U-Turn	19	0	5	63	0	32
Lane Use Controls	5	20	20	0	0	60
Do Not Pass	24	0	92	0	0	8
Wrong-Way Driving	47	0	0	11	0	89
*Advisory Speeds	63	21	75	3	0	2
Work Zone Areas	0	--	--	--	--	--
*School Bus Operations	2	0	0	100	0	0
RR Grade Crossings	35	57	23	17	0	3

*Device/Law included in behavioral study.

Table 11. Chronic violators' principal reason for violating by device type.

Device/Law	N	Principal Reason for Violating (percent)				
		Device Fault	Safe No Risk	Personal Reasons	Enforcement	Other
*Signals (Run Red)	32	19	9	63	3	6
*Signals (RTORAS)	27	0	82	15	0	4
Signals (NTOR)	14	14	57	29	0	0
Signals (Pedestrian)	41	7	93	6	0	1
Pedestrian Ops	0	--	--	--	--	--
*STOP	35	14	71	9	0	6
Yield	5	0	46	60	0	0
Speed Limit (55)	57	25	19	49	2	5
Speed Limit (School)	7	0	71	29	0	0
Speed Limit (Other)	33	21	36	33	9	0
No Right Turn	8	--	--	88	0	13
*No Left Turn	20	5	15	60	0	20
No U-Turn	20	--	5	55	0	40
Lane Use Controls	2	--	--	50	--	50
Do Not Pass	20	0	90	10	0	0
Wrong-Way Driving	27	0	0	11	0	85
*Advisory Speeds	45	20	73	0	0	7
C&M Areas	1	100	0	0	0	0
*School Bus Ops	6	0	67	0	0	33
RR Grade Crossings	12	58	25	8	0	8

*Device/Law included in behavioral study.

Table 12. Reasons motorists violate traffic signals (run red).

Group	Reason	Frequency	Percentage
Typical Drivers (N=42)	In a Hurry	13	31
	Don't Want To Be Rear-Ended	10	24
	Yellow Is Too Short	2	5
	Lost/Confused	2	5
	Habit	2	5
	Impatient	2	5
	Cross-Street Volume Is Low	1	2
	Only Late at Night	1	2
	Wet/Dry Pavement Sensitive	1	2
	Going Too Fast to Stop	1	2
	Vehicle Sensitive	1	2
	Cycle Is Too Long	1	2
	Mistake	1	2
	Hill	1	2
Chronic Violators (N=32)	In a Hurry	1	53
	Cycle Is Too Long	3	9
	Don't Want To Be Rear-Ended	2	6
	Impatient	2	6
	Going Too Fast to Stop	2	6
	Vehicle Sensitive	2	6
	Cross-Street Volume Is Low	1	3
	Yellow Is Too Short	1	3
	Check If It Is Clear, Then Go	1	3
	Mistake	1	3
	Aggressive	1	3
	Not Caught Yet	1	3

Table 13. Reasons motorists violate RTOR.

Group	Reason	Frequency	Percentage
Typical Driver (N=30)	Cross-Street Volume Is Low	11	37
	Good Sight Lines	6	20
	Good Sight and Low Volume	6	20
	In a Hurry	5	17
	Check If It Is Clear, Then Go	3	10
	Only Late at Night	2	7
	Check for Police First	1	3
	Bad Attitude	1	3
Chronic Violators (N=27)	Low Cross-Street Volumes	12	44
	Good Sight Lines	5	19
	Good Sight and Low Volume	5	19
	In a Hurry	4	15
	Going Too Fast to Stop	1	4

Table 14. Reasons motorists violate STOP signs.

Group	Reason	Frequency	Percentage
Typical Drivers (N=43)	Cross-Street Volume Is Low	18	42
	In a Hurry	7	16
	Check If It Is Clear, Then Go	5	12
	Good Sight and Low Volume	4	9
	Good Sight Lines	2	5
	Only Late at Night	2	5
	Too Many	2	5
	At Intersection I Know	2	5
	Right Turning Only	2	5
	Impatient	1	2
	Unaware of the Sign	1	2
	Habit	1	2
	Vehicle Sensitive	1	2
	Check for Police First	1	2
	Mistake	1	2
	Attitude	1	2
Chronic Violators (N=35)	Cross-Street Volume Is Low	12	34
	Good Sight and Low Volume	6	17
	Good Sight Lines	4	11
	In a Hurry	4	11
	Too Many	2	6
	At Intersection I Know	2	6
	Check If It Is Clear, Then Go	2	6
	Four-Way Stops Only	2	6
	Right Turns Only	2	6
	Two One-Way Streets Only	1	3
	When It Is Safe To Do So	1	3
	STOP Should Be a Yield	1	3
	Bad Sign Placement	1	3

Table 15. Reasons motorists violate No Left Turn signs.

Group	Reason	Frequency	Percentage
Typical Drivers (N=17)	Convenience	6	35
	Lost/Confused	5	29
	In a Hurry	3	18
	Check If It Is Clear, Then Go	3	18
	Don't See Sign	1	6
	When It's Safe To Do So	1	6
Chronic Violators (N=20)	Convenience	8	40
	Lost/Confused	4	20
	In a Hurry	4	20
	Low Opposing Traffic	2	10
	Sign Is Not Necessary	1	5
	Temporal Signs Only	1	5

Table 16. Reasons motorists "violate" advisory speeds.

Group	Reason	Frequency	Percentage
Typical Drivers (N=64)	Set Too Low	12	19
	I Slow but not to Speed Posted	10	16
	At Curves I Know	9	14
	Wet/Dry Sensitive	8	13
	Vehicle Can Handle Higher Speeds	8	13
	Judge Each One Myself	6	9
	Only 5-10 mi/h Over	6	9
	Wet/Dry Curves I Know	2	3
	Used as an Advisory	2	3
	In a Hurry	1	2
	Heightens My Caution	1	2
	Vehicle Sensitive	3	5
	I Can Go Faster Without Problem	1	2
	Deltas are Too Large	1	2
	I Like to Drive Fast	1	2
Chronic Violators (N=45)	At Curves I Know	11	24
	Set Too Low	8	18
	Only 5-10 mi/h Over	8	18
	Vehicle Can Handle Higher Speed	5	11
	Wet/Dry Sensitive	4	9
	Judge Each One Myself	4	9
	I Slow, But Not to Speed Posted	4	9
	Vehicle Sensitive	3	7
	Unaware of Sign/Law	2	4
	Used as an Advisory	1	2
	Deltas are Too Large	1	2
	Slow for Big Deltas Only	1	2

Table 17. Cross tabulation of run red violation and driver age groups.

Compliance	Age Groups 17-29	30-49	50-74	Row Totals
Do Not Violate	20 26.7% 51.3%	24 32.0% 55.8%	31 41.3% 81.6%	75 62.5%
Violate	19 42.2% 48.7%	19 42.2% 44.2%	7 15.6% 18.4%	45 37.5%
Column Totals	39 32.5%	43 35.8%	38 31.7%	120 100%

Significance Analyses

Chi Square Statistic:	8.81593
Degrees of Freedom:	2.0
Significance:	0.0122

Note: The total, row percent, and column percent are given for each cell.

Table 18. Cross tabulation of run red violations by driver age and sex.

Compliance	Sex	Age Groups 17-29	30-49	50-74	Row Totals	
Do Not Violate	Males	9 24.3% 23.1%	13 35.1% 30.2%	15 40.5% 39.5%	37 30.8%	75 62.5%
	Females	11 28.9% 28.2%	11 28.9% 25.6%	16 42.1% 42.1%	38 31.7%	
Violate	Males	13 52.0% 33.3%	8 32.0% 18.6%	4 16.0% 10.5%	25 20.8%	45 37.5%
	Females	6 30.0% 15.4%	11 55.0% 25.6%	3 15.0% 7.8%	20 16.7%	
Column Totals		39 32.5%	43 35.8%	38 31.7%	120 100%	120 100%

Significance Analyses	For Males	For Females
Chi Square Statistic:	6.19568	NA
Degrees of Freedom:	2	NA
Significance:	0.0451	NA

Note: The total, row percent, and column percent are given for each cell.

Table 19. Cross tabulation of stop violations and driver age groups.

Compliance	Age Groups 17-29	 30-49	 50-74	Row Totals
Do Not Violate	16 21.3% 41.0%	31 41.3% 72.1%	28 37.3% 73.7%	75 62.5%
Violate	23 51.1% 59.0%	12 26.7% 27.9%	10 22.2% 26.3%	45 37.5%
Column Totals	39 32.5%	43 35.8%	38 31.7%	120 100%

Significance Analysis

Chi Square Statistic:	11.38994
Degrees of Freedom:	2
Significance:	0.0034

Note: The total, row percent, and column percent are given for each cell.

Table 20. Cross tabulations of stop violations by driver age groups and sex.

Compliance	Sex	Age Groups 17-29	 30-49	 50-74	Row Totals	
Do Not Violate	Males	10 27.8% 45.5%	14 38.9% 66.7%	12 33.3% 63.2%	36 58.1%	75 62.5%
	Females	6 15.4% 35.3%	17 43.6% 77.3%	16 41.0% 84.2%	39 67.2%	
Violate	Males	12 46.2% 54.5%	7 26.9% 33.3%	7 26.9% 36.8%	26 41.9%	45 37.5%
	Females	11 57.9% 64.7%	5 26.3% 22.7%	3 15.8% 15.8%	19 32.8%	
Column Totals		39 32.5%	43 35.8%	38 31.7%	120 100%	120 100%

Significance Analyses	For Males	For Females
Chi Square Statistic:	2.27728	11.36567
Degrees of Freedom:	2	2
Significance:	0.3203	0.0034

Note: The totals, row percent, and column percent are given for each cell.

III. BEHAVIORAL STUDIES

Studies of motorist behavior on the road were conducted to determine the level and seriousness of noncompliance. Field studies were necessary to verify the perceptions of the various professionals contacted in the first phase of this effort and to ascertain the impacts of the propensity to violate traffic controls noted in the attitudinal surveys. Field studies were designed to address motorist compliance for each of the problems noted in table 6. These included:

- Traffic Control Signals (Running Red Indications).
- Traffic Control Signals (Right Turn on Red Operations).
- Stop Signs (Failing to come to a Complete Stop).
- No Left Turn Signs (Left Turns where Restricted or Prohibited)
- Advisory Speed Plate (Exceeding the Advised Speed).
- School Bus Operations (Passing a Stopped Bus Displaying Flashing Lights).

A special field study procedure was developed to record motorist compliance for each of these situations as described below. The results of the field studies are provided in the subsequent sections.

A. Study Design and Analysis Procedures

The major objective of this phase of the research was to determine if there is a compliance problem. A special procedure was defined for each situation using a basic study design which involved comparing the violation rates of experimental and control locations. Study sites were selected in New York, Virginia, Texas, and California. Experimental sites were defined as those with known high violation locations as identified in contacts with local traffic engineers and police officials. Control sites with similar geometric and operating characteristics were selected at locations near the experimental test sites. Since it was difficult for local personnel to identify high violation locations for the advisory speeds and school bus operations studies, a random sample of curve/turn locations and school bus routes was used.

Originally, 960 sites were to be studied, as shown in table 21. However, while many contacts were sure they had a compliance problem with one or more of the devices being studied, they had trouble citing a specific location for the problem. So even though they responded enthusiastically to the request for help, they often could not provide even one site. Ultimately, 906 sites were studied with the distributions of experimental and control sites as noted in the lower half of the table. While the target numbers were not met in some cases, the overall credibility of the study is still very strong.

A specific study procedure was designed for each of the six devices selected. Each study procedure was based on the principles in the Institute of Transportation Engineers' Manual of Traffic Engineering Studies.[46] A procedure and data form specifically tailored to the expected behavior of violators and nonviolators relative to the device/law was developed. The factors considered in the individual studies are given in table 22. Data collectors completed a site evaluation form for each study location which contained information about the physical and operational characteristics of the site prior to the behavioral observations. This information was used to stratify the sample to determine if certain intersection characteristics affect compliance behavior. A complete set

Table 21. Distribution of field study sites.

Planned									
Compliance Problem	Geographic Area: Northeast Exp	Cntrl	South Exp	Cntrl	Central Exp	Cntrl	West Exp	Cntrl	Total
Device #1	20	20	20	20	20	20	20	20	160
Device #2	20	20	20	20	20	20	20	20	160
Device #3	20	20	20	20	20	20	20	20	160
Device #4	20	20	20	20	20	20	20	20	160
Device #5	20	20	20	20	20	20	20	20	160
Device #6	20	20	20	20	20	20	20	20	160
TOTAL	240		240		240		240		960

Actual									
Compliance Problem	Geographic Area: New York Exp	Cntrl	Virginia Exp	Cntrl	Texas Exp	Cntrl	California Exp	Cntrl	Total
Run Red	19	19	20	20	29	29	20	20	156
RTOR	20	20	17	17	20	20	16	16	146
Stop	15	15	20	20	20	20	16	16	142
No Left Turn	20	20	13	13	7	6	18	18	115
Advisory Speed	20	--	30	--	30	--	33	--	113
School Bus Ops	60	--	67	--	60	--	47	--	234
TOTAL	228		237		221		220		906

Table 22. Variables analyzed for each device/law.

Traffic Signals (Running the Red Indication)

- turning movement
- driver action
- conflict causation
- vehicle type
- cycle length
- speed limit
- approach volume
- peak hour
- location (i.e., State)

No Left Turn Signs (Violations of Left Turn Restrictions)

- turning movement
- type of control
- conflict causation by direction
- vehicle type
- temporal restrictions
- approach volume
- location (i.e., State)

Traffic Signals (Improper Right Turn on Red)

- queuing conditions
- type of stop
- conflict causation
- vehicle type
- cross street volume
- approach volume
- pedestrian paths
- pedestrian signals
- location (i.e., State)

Advisory Speed Signs (Exceeding Advised Speeds)

- change in speed
  - operational
  - actual
- pavement condition
- curve/turn type
- vehicle type
- location (i.e., State)

STOP Signs (Failing to Fully Stop at Stop Signs)

- turning movement
- queuing conditions
- conflict causation
- type of stop
- vehicle type
- cross street volume
- approach volume
- pedestrian paths
- location (i.e., State)

School Bus Operations (Passing Stopped School Buses)

- flasher mode
- auxiliary equipment
- vehicle passing by direction
- operating mode
  - boarding
  - alighting
- roadway type
- land use
- stop location
- terrain by direction
- location (i.e., State)

of instructions for filling out the site form and compliance forms along with samples of the individual forms are included in appendix F.

The data gathered in the various field studies were checked for consistency and completeness and summaries of the totals and percentages by category were prepared. Analysis of variance techniques were used to analyze the significance of the data under a variety of hypotheses. Using analysis of variance, orthogonal contrast procedures were used to identify those factors which were significant and their interactions with other variables. The discussions in the following sections report the significant findings derived from the analyses. In all cases the 95 percent confidence level was utilized as the criterion for significance.

B. Field Studies of Running the Red Indication at Traffic Signals

Procedures. The data collectors counted the number of vehicles entering the intersection on green, subdivided by the number of left-turning, straight-through, and right-turning vehicles. They also counted the number of vehicles entering the intersection on yellow, by turning movement; the number of vehicles entering the intersection on red without causing a conflict, by turning movement (conflict being defined here as any action by a study vehicle that caused a change in the speed or the travel path of another vehicle or pedestrian); the number of vehicles entering the intersection on red that cause a conflict, by turning movement (noting whether the vehicles were cars or trucks); and the number of vehicles that enter the intersection by "jumping the green" (entering the intersection on red just before the signal turns green) by conflict causation and turning movement. RTOR vehicles were counted in the right-turn-on-green category.

Observers recorded the behavior of every vehicle that passed through the intersection from the study leg. Data were collected until 400 vehicles had been observed or two hours had elapsed. A site evaluation form was also completed to record pertinent location features.

Results. Data collectors spent 135 hours at 156 study sites observing 77,157 vehicles commit 622 violations. Table 23 provides a summary of the observations by category. The percentages of each observed behavior category relative to the total number of observations are provided in the parentheses. The overall summary indicates a very low percentage of vehicles run the red and only a fraction of these caused a traffic conflict. While motorist compliance was the dependent variable in the analysis, the site characteristics and traffic operations data enabled the study team to analyze the data with a large number of independent variables.

Initially, the data were stratified into subgroups by how the vehicle entered the intersection (e.g., green, red, jumping the green and causing a conflict), how the vehicle moved through the intersection (e.g., left, straight, right), and what type of vehicle was involved (e.g., car, truck). The raw frequency values were not used in any of the analyses, but they are provided for informational purposes. The frequency values of these individual cells (e.g., Trucks/Turning on Left/On Green) were compared to the total number of vehicles observed for each study site to yield a proportion that would allow a comparison of these stratified subgroups between sites. The mean value of this proportion for all experimental and control sites was calculated. These experimental and

Table 23. Summary of field observations of signal compliance and conflicts.

Driver Approach Action	Vehicles Observed by Movement Turn Left	Straight	Turn Right	Row Totals
Enter on Green	11,047 (14.0 %)	54,114 (68.4 %)	10,087 (12.8 %)	75,608 (95.6 %)
Enter on Yellow	639 (0.8 %)	1,870 (2.4 %)	250 (0.3 %)	2,759 (3.5 %)
Enter on Red w/o Conflict				
- Cars	160 (0.2 %)	295 (0.4 %)	93 (0.1 %)	548 (0.7 %)
- Truck	10 (0.01 %)	27 (0.03 %)	5 (0.06 %)	42 (0.05 %)
Enter on Red w/ Conflict				
- Cars	19 (0.02 %)	25 (0.03 %)	16 (0.02 %)	60 (0.07 %)
- Truck	1 (0.001%)	4 (0.005%)	0 (0.00 %)	5 (0.006%)
Jumped Signal w/o Conflict	12 (0.02 %)	12 (0.02 %)	0 (0.00 %)	24 (0.03 %)
Jumped Signal w/ Conflict	8 (0.01 %)	1 (0.001%)	0 (0.00 %)	9 (0.01 %)
			Total Vehicles	79,055

Note: The percentage relative to all observations is given in parentheses.

control means were compared using a t-test. The initial analysis using this approach showed no significant difference between the experimental and control populations in any category.

In succeeding analyses, the cells were collapsed (e.g., conflict was combined with no conflict; left turns were combined with straight throughs and right turns) to see if other data configurations would yield interesting results. The only cells nearing a significant difference in the succeeding groupings of data were the experimental and control groups of drivers running red collapsed by turning movement, presence or absence of conflict, and vehicle type. This means the drivers running red, regardless of vehicle, turning movement, or likelihood of causing a conflict, did so more frequently at the experimental locations than at the control locations. The experimental group had a mean value of 0.0097 incidents per vehicle (i/v) entering the intersection compared to a mean of 0.0062 i/v for the control group. The dimension, incidents per vehicle, represents the numbers of vehicles (cars, trucks, or both if specified) that behaved in a certain way (e.g., enter on red and turn left) divided by the total number of vehicles entering the intersection. This measure is equivalent to a percentage when multiplied by 100. However, it should be noted that these results were not significant and that this behavior represents a small percentage of drivers. While there was also no significant difference between running red while causing a conflict and running red without causing a conflict, the conflict-causing drivers accounted for approximately 10 percent of the run red drivers (0.0009 i/v for the experimental and 0.0006 i/v for the control).

Since the attitudinal data showed that some chronic offenders cite signals with known long cycle lengths as ones they tend to violate, a two-way analysis of variance was conducted using entering the intersection on red as the dependent variable, and site type (experimental or control) and cycle length as factors. The results of the analysis showed no significant main effect for site type and no main effects for cycle length or the interaction between site type and cycle length.

A previously cited study suggested that improvements in signal compliance rate might occur if the change interval (yellow signal phase) is adjusted.[40] Since yellow phase timing is a function of speed, and there seems to be a speed compliance problem especially at higher speeds, a two-way analysis of variance was conducted using entering the intersection on red as the dependent variable, and site type and speed limit as independent variables. No significant main effect for site type resulted, and there was no main effect for speed limit or the interaction between site type and speed limit.

Another study of red signal violations has shown that there was some difference in violation rate when compared to changes in volume at the study site.[21] There was also found to be a relationship between violation rate and peak hour traffic periods. A two-way analysis of variance was conducted with each of these variables as a factor in separate analyses. Using entering the intersection on red as the dependent variable, and site type and volume entering the intersection from the study leg as factors, the analysis showed no significant main effects or interactions for any of the factors. Likewise, using entering the intersection on red as the dependent variable and site type and p.m. peak hour as factors, no significant main effects or interactions for any of the factors were shown.

The study team decided to test the popular idea that people in different parts of the country drive differently. A two-way analysis of variance was performed using entering the intersection on red as the dependent variable and site type and State as factors. The results showed a significant main effect for State. There was no effect for site type and no interaction between the factors. The mean values of incidents per vehicle by site type by State are noted in table 24. The variation within a site type, either experimental or control, causes the main effect for State. Here it can be seen that violations occur more frequently in Virginia at both experimental and control sites than in other States. Again, it must be pointed out that these violation rates are small.

Table 24. Differences in incidents per vehicle by site type and State.

State	Site Type	
	Experimental	Control
New York	0.005	0.007
Virginia	0.019	0.010
Texas	0.006	0.001
California	0.009	0.007

C. Field Studies of Improper Right Turns On Red at Signals

Procedure. The data collectors first completed a site inventory using the site evaluation form. For the behavioral data, they counted the number of study vehicles that: turned on green or yellow; stopped on red, waited for and turned on green; stopped on red, because the vehicle in front had stopped, and turned on green; turned on red with or without stopping, and attempted to turn on red, but turned on green as the signal changed.

When the signal was red, the data collectors determined if the study vehicle arrived as a single vehicle or was part of a queue (line) of vehicles waiting at the signal. Next, they decided if the study vehicle made a voluntary full stop (a stop being defined as a complete cessation of movement, however brief), was stopped by vehicular or pedestrian cross traffic, or did not stop at all before entering the intersection. Then they determined if the action caused a conflict with any vehicular or pedestrian traffic. They also noted whether the study vehicle was a car or a truck. Observers recorded the behavior of every right-turning vehicle that passed through the intersection from the study leg.

After observing the behavior of 200 vehicles, they took a 5-minute count of the number of vehicles passing through the intersection from the near side cross-street approach. When this 5-minute volume count was completed, they continued observing behavior on the study leg. Data were collected until 400 vehicles were observed or until 4 hours had passed.

Results. In conducting the RTOR study, data collectors spent 440 hours at 146 study sites observing 51,056 right-turning vehicles (21,434 turned right on red); 13,142 failed to make a full stop before turning right on red. The distribution of observations is provided in table 25. In this case the noncompliance was more obvious (61.3 percent of the vehicles did not properly stop), but only 1.4 percent were involved in a conflict as a result. As with the run-red study, the individual value in each cell of the data collection form was compared to the total number of vehicles observed at the study site to yield a proportion that would allow a comparison between sites. The mean values of the proportion for the experimental and control means were compared using a t-test. The results of this analysis show that there was a significant difference between the experimental and control sites in the Red/No Queue/No Stop With Conflict for Cars category (0.0051 i/v for experimental and 0.0029 i/v for control). This means that the scenario of a car making a RTOR, not stopping, and causing a conflict was more likely to occur at an experimental site than at a control site.

As the categories were collapsed, other significant results were noted. The Red/No Queue/No Stop with Conflict for All Vehicles category showed a difference of 0.0053 i/v for the experimental locations and 0.0030 for the controls. While there was no significant difference between the collapsed category Red/No Stop With and Without Conflict for All Vehicles, approximately 61.3 percent of the vehicles summing over all locations did not come to a full stop (62.0 percent at the experimental sites and 58.0 percent for the control sites) as compared to values found in other studies (table 26).

Since both the literature and the attitudinal data suggest that there is a relation between stop compliance (RTOR or STOP sign) and major and minor street volumes, two-way analyses of variance were conducted using the Red/No Queue/No Stop with Conflict for All Vehicles category as the dependent variable, with site type and major street traffic volume as the factors for one analysis, and site type and minor street volume for another. The analysis for the major street showed no significant main effect for site type, and no main effects for cross-street volume or the interaction between site type and cross-street volumes. Thus, vehicles making a RTOR without stopping and causing a conflict did so regardless of the traffic volume on the cross street. In the other analysis, the results showed no significant main effects or interactions for site type and minor street volume.

These analyses were expanded to check the effects of major and minor street volumes on the behavior of all RTOR violator drivers. A two-way analysis of variance was conducted using the Red/No Stop category as the dependent variable and site and cross-street volume as factors. The analysis showed no significant main effects or interactions. The same analysis was performed replacing cross-street volume with approach volume as a factor. This analysis showed a significant main effect for approach volume. The mean values of incidents per vehicle by site type by volume are given in table 27. While there is an effect by volume, it is contrary to expectations. Incidence of violations goes up as the approach volume goes up. This might be a function of congestion and its influence on motorist behavior.

Based on these research findings, a two-way analysis of variance was performed using Red/No Queue/No Stop with Conflict for All Vehicles category as the dependent variable, and site type and pedestrian accommodations along the study leg (presence or absence of sidewalks). The results of this analysis showed no significant main effects or interactions. The analysis was expanded to include all RTOR violations as part of the dependent variable. It also showed no significant main effects or interactions.

Table 25. Summary of right turn on red compliance and conflict data.

Signal Display	Driver Action	Cars	Trucks
Green	Turned on green or yellow	26,323 (51.56 %)	1,167 (2.29 %)
	Stopped on red, waited for green, turned on green	532 (1.00 %)	40 (0.08 %)
	Queued behind a waiter, turned on green	332 (0.65 %)	7 (0.02 %)
	Attempted to turn on red, turned on green	1,188 (2.32 %)	33 (0.06 %)
Red - No Queue on Arrival			
	Came to full stop, turned with conflict	37 (0.06 %)	3 (0.01 %)
	Came to full stop, turned w/o conflict	1,081 (2.10 %)	52 (0.10 %)
	Stopped for cross traffic, turned with conflict	207 (0.41 %)	7 (0.02 %)
	Stopped for cross traffic, turned w/o conflict	4,550 (8.91 %)	174 (0.34 %)
	Stopped for pedestrian, turned with conflict	46 (0.09 %)	0 (0.00 %)
	Stopped for pedestrian, turned w/o conflict	292 (0.57 %)	9 (0.02 %)
	Did not stop completely, turned with conflict	218 (0.41 %)	8 (0.02 %)
	Did not stop completely, turned w/o conflict	7,614 (14.90 %)	262 (0.51 %)
Red - Traffic Queue on Arrival			
	Came to full stop, turned with conflict	7 (0.01 %)	0 (0.00 %)
	Came to full stop, turned w/o conflict	445 (0.90 %)	4 (0.02 %)
	Stopped for cross traffic, turned with conflict	50 (0.10 %)	1 (0.00 %)
	Stopped for cross traffic, turned w/o conflict	1,230 (2.41 %)	25 (0.05 %)
	Stopped for pedestrian, turned with conflict	9 (0.02 %)	0 (0.00 %)
	Stopped for pedestrian, turned w/o conflict	55 (0.11 %)	1 (0.00 %)
	Did not stop completely, turned with conflict	76 (0.15 %)	1 (0.00 %)
	Did ot stop completely, turned w/o conflict	4,891 (9.58 %)	72 (0.14 %)

Note: The percentage relative to all observations is given in the parentheses.

Table 26. Comparison of RTOR compliance results to previous studies.

Study	Year	RTOR Vehicles Not Coming to a to a Full Stop, %		RTOR Vehicles Not Coming to a Full Stop Causing a Conflict, %		Right-Turning Vehicles Not Coming to a Full Stop Causing a Conflict, %	
CAR/FHWA	1988	Test Group	62.0	All	2.3	All	34.6
		Control Group	58.0				
		All	61.3				
Gordon	1987		---		---		7.6
Baumgaertner	1977		64.4		1.9		---
Virginia Highway Research Council[1]	1975		3.0		---		---
Virginia Highway Research Council[2]	1975		9.3		---		---

[1] Study done 1 month after implementation of RTOR in Virginia.

[2] Study done 1 year after implementation of RTOR in Virginia.

Table 27. Mean number of incidents per vehicle by site type and approach volume level.

Approach Volume (Vehicles/ Hour)	Site Type Experimental	Control
0 - 100	0.231	0.254
101 - 200	0.222	0.244
201+	0.296	0.322

Since presence or absence of sidewalks is only a surrogate measure of pedestrian activity, the analysis was repeated, replacing sidewalks with presence or absence of pedestrian signals as the surrogate measure. The results of both dependent variable categories (Red/No Queue/No Stop with Conflict for all Vehicles and Red/No Stop) showed no significant main effects or interactions.

Regional behavior differences were also checked. A two-way analysis of variance was conducted using the Red/No Queue/No Stop with Conflict for All Vehicles category as the dependent variable, and site type and State as the factors. The analysis showed a significant main effect for State and the interaction between State and site type. The mean values of incidents per vehicle by site type by State are given in table 28.

Table 28. Summary of incidents per vehicle by site type and State for observations involving conflicts.

State	Site Type Experimental	Control
New York	0.011	0.004
Virginia	0.003	0.004
Texas	0.001	0.001
California	0.005	0.003

Table 28 shows a large difference between the violation rate of experimental and control sites in New York, perhaps because all the experimental sites were in Rochester, a city that has a well-known RTOR compliance problem. The analysis was expanded to include all RTOR violators as part of the dependent variable measure. The results of this analysis showed a significant main effect for State but no significant interactions. The mean values of incidents per vehicle by site type by State are given in table 29. Here a greater variation among the States is seen rather than between the experimental and control sites within a State.

D. Field Studies of Failure to Come to a Full Stop at Stop Signs

Procedures. After completing a site inventory, the data collectors first determined if the study vehicle arrived alone or as part of a queue of vehicles waiting at the STOP sign. Next, they decided if the vehicle made a voluntary full stop, was stopped by vehicular or pedestrian cross traffic, or did not stop at all before entering the intersection, and assessed whether the action caused a conflict with any vehicular or pedestrian traffic. They then recorded whether the study vehicle turned left or right, or proceeded straight through the intersection and categorized the vehicle as a car or a truck. Observers noted the behavior of every vehicle that passed through the intersection on the study leg.

Table 29. Summary of incidents per vehicle by site type and State for RTOR violators.

State	Site Type: Experimental	Site Type: Control
New York	0.180	0.212
Virginia	0.301	0.325
Texas	0.231	0.264
California	0.293	0.253

After observing 200 vehicles (or after 2 hours of data collection), a five minute count was taken of the number of vehicles entering the intersection from the cross street; then observing behavior resumed on the study leg. Data were collected until 400 vehicles were observed or until 4 hours had passed.

Results. Data collectors spent 528 hours at 142 sites observing 31,212 vehicles, of which 21,110 failed to stop at a STOP sign. A summary of the observational totals and relative percentages is given in table 30. It can be noted that noncompliance occurs often, but the occurrence of conflicts is rare. It can be noted that 67.6 percent of the motorists fail to comply, but only 1.3 percent of these result in a traffic conflict.

As before, a mean of the proportion of data form cell frequencies to vehicles observed by site was calculated. A t-test was used as a measure of statistical significance. The results were significant for the Queue/No Stop with Conflict/Right Turning Car category (0.0017 i/v for the experimental and 0.0005 i/v for the control). As the categories were collapsed, the Queue/No Stop with Conflict/Right Turning/All Vehicles category was also significant (0.0020 i/v for the experimental and 0.0006 for the control) along with the Queue/No Stop with Conflict/All Turning Movements/All Vehicles category (0.0040 i/v for the experimental and 0.0017 i/v for the control). For this device, the problem occurs with vehicles that had already stopped once (in the queue) not stopping before entering the intersection. There was no significant difference between the collapsed category No Stop With and Without Conflict for all vehicles.

A series of two-way analyses of variance was run with the Queue/No Stop with Conflict/All Turning Movements/All Vehicles category and site type held constant as the dependent variable. Different independent variables were used as the second factor in the analyses including: approach volume (minor street), cross-street volume (major street), pedestrian accommodations (presence of sidewalks), and State. In the analysis using cross-street volume as the second factor, there was a significant main effect for site type and cross-street volume with no significant interaction. The mean values of incidents per vehicle by site type by cross-street volume are summarized in table 31. These results show an increase in violations as cross street volumes increase up to 900 vehicles per hour. This is opposite the findings derived from the attitudinal studies. The difference might be explained by the low cell numbers for this type of behavior.

Table 30. Summary of STOP sign compliance and conflicts data.

Driver Action	Vehicles by Movement: Turn Left Cars	Turn Left Trucks	Go Straight Cars	Go Straight Trucks	Turn Right Cars	Turn Right Trucks
No Queue on Arrival						
Came to full stop, proceeded with conflict	5 (0.01%)	0 (0.00%)	6 (0.01%)	1 (0.00%)	8 (0.03%)	4 (0.01%)
Came to full stop, proceeded w/o conflict	368 (1.18%)	9 (0.03%)	640 (2.05%)	52 (0.16%)	394 (1.26%)	25 (0.08%)
Stopped for cross traffic, proceeded with conflict	90 (0.28%)	14 (0.05%)	78 (0.24%)	5 (0.01%)	36 (0.11%)	5 (0.01%)
Stopped for cross traffic, proceeded w/o conflict	1894 (6.07%)	188 (0.60%)	1949 (6.24%)	109 (0.32%)	1495 (4.79%)	107 (0.29%)
Did not stop completely, proceeded with conflict	75 (0.24%)	21 (0.08%)	92 (0.29%)	3 (0.01%)	71 (0.24%)	21 (0.08%)
Did not stop completely, proceeded w/o conflict	2977 (9.54%)	197 (0.63%)	5251 (16.8%)	231 (0.74%)	5481 (12.6%)	334 (1.07%)
Traffic Queue on Arrival						
Came to full stop, proceeded with conflict	0 (0.00%)	0 (0.00%)	3 (0.01%)	0 (0.00%)	1 (0.00%)	0 (0.00%)
Came to full stop, proceeded w/o conflict	81 (0.26%)	0 (0.00%)	180 (0.58%)	11 (0.03%)	77 (0.24%)	1 (0.00%)
Stopped for cross traffic, proceeded with conflict	34 (0.11%)	1 (0.00%)	21 (0.07%)	1 (0.00%)	12 (0.03%)	2 (0.00%)
Stopped for cross traffic, proceeded w/o conflict	785 (2.52%)	38 (0.12%)	730 (2.34%)	35 (0.11%)	574 (1.84%)	33 (0.11%)
Did not stop completely, proceeded with conflict	24 (0.08%)	8 (0.03%)	41 (0.12%)	0 (0.00%)	44 (0.14%)	7 (0.03%)
Did not stop completely, proceeded w/o conflict	1376 (4.41%)	72 (0.24%)	2254 (7.22%)	81 (0.24%)	2377 (7.62%)	72 (0.24%)
	Total Vehicles 31,212					

Note: The percentages relative to all observations are given in parentheses.

Table 31. Mean values of incidents per vehicle by site type and cross-street traffic volume.

Cross Street Volume (Vehicles Per Hour)	Site Type: Experimental	Control
0 - 300	0.002	0.001
301 - 600	0.005	0.001
601 - 900	0.010	0.005
901+	0.005	0.002

A significant main effect was exhibited for the site type factor in the analysis using pedestrian accommodations as the second factor. There were no other effects or interactions. The mean values of incidents per vehicle by site type by pedestrian accommodations are given in table 32. These results indicate no effect due to pedestrian accommodations.

Table 32. Mean values of incidents per vehicle by site type and pedestrian accommodations.

Pedestrian Accommodations	Site Type Experimental	Control
Sidewalk	0.004	0.002
No Sidewalk	0.004	0.002

In conducting a two-way analysis of variance using the Queue/No Stop with Conflict/Right Turning/All Vehicles category as the dependent variable and site type and the number of lanes from the left approach of the cross-street as factors, a significant main effect was shown for site type, number of lanes, and the interaction between them. The mean values of incidents per vehicle by site type by number of lanes are provided in table 33.

Table 33. Mean value of incidents per vehicle by site type and number of lanes.

Number of Lanes Left Side Cross-Street Approach	Site Type Experimental	Control
1	0.001	0.000
2	0.006	0.001

The results in table 33 bear out the reports of the field data collectors that motorists were more likely to violate the stop when the curb lane of a two lane approach was open to them. It was also observed that much of the cross-street traffic would travel in the lane closer to the center lane when approaching the intersection.

An expanded series of two-way analyses of variance was run with the No Stop/All Turning Movements/All Vehicles category and site type held constant as the dependent variable and first factor, respectively. A group of different variables was used as the second factor. The other factors were: approach volume, cross-street volume, pedestrian accommodations, and State. The results of the analysis using approach volume as the second factor showed a significant main effect for this factor. There were no other main effects or interactions.

The mean values of incidents per vehicle by site type by approach volume are indicated in table 34. It can be seen that as the approach volume went up, the violation rates came down for approach volumes of 0 to 300 vehicles per hour. However, the violations went up again for approach volumes above 300 vehicles per hour. There is no apparent explanation for this trend.

Table 34. Mean values of incidents per vehicle by site type and approach traffic volume level.

Approach Volume (Vehicles Per Hour)	Site Type	
	Experimental	Control
0 - 100	0.759	0.715
101 - 200	0.653	0.654
201 - 300	0.638	0.649
301+	0.693	0.707

Another analysis with cross-street volume as the second factor showed a significant main effect for this variable, but no main effects for site type or the interaction between site type and cross-street volume. The mean values of incidents per vehicle by site type and cross-street volume are indicated in table 35. These results show a decrease in the violations as the cross-street volumes go up. This is consistent with the findings of the attitudinal study. There were no other notable results from these analyses.

Table 35. Mean values of incidents per vehicle by site type and cross-street traffic volume level.

Cross Street Volume (Vehicles Per Hour)	Site Type	
	Experimental	Control
0 - 300	0.734	0.739
301 - 600	0.620	0.604
601 - 900	0.615	0.597
901+	0.557	0.503

A two-way analysis of variance was conducted using the No Stop/Right Turning/All Vehicles category as the dependent variable, and site type and the number of lanes from the left approach of the cross-street as factors. The results of this analysis showed a significant main effect for number of lanes, but no other effects or interactions. The mean values of incidents per vehicle by site type by number of lanes are provided in table 36. The data confirm the observations of the field data collectors cited earlier.

Table 36. Mean values of incidents per vehicle by site type and number of lanes.

Number of Lanes Left Side Cross-Street Approach	Site Type	
	Experimental	Control
1	0.572	0.425
2	0.923	0.735

E. Field Studies of No Left Turn Sign Violations

Procedures. Data collectors first completed a site inventory form and then counted the number of vehicles passing the site by movement including illegal left turns. Movements included left turn, through, and right turn, as possible at four-legged or T intersections. Separate counts were made of trucks. A differentiation was made between left turns that caused conflicts with other vehicle and those that did not. Observers also noted whether each conflict was with a vehicle traveling in the same direction as the study vehicle or in the opposite direction. Observers recorded the behavior of every vehicle that passed through the study leg. Data collection continued until 400 vehicles had been observed.

Results. Data collectors spent 152 hours at 115 study sites observing 53,165 vehicles (classified as cars or trucks) make 881 illegal left turns. Table 37 summarizes the totals and percentages in the various obervational categories.

Table 37. Summary of no left turn compliance and conflict data.

Driver Action	Vehicles Cars	Vehicles Trucks
Turned left w/o conflict	713 (1.34 %)	31 (0.06 %)
Turned left with conflict in same direction	94 (0.18 %)	8 (0.01 %)
Turned left with conflict in opposite direction	34 (0.06 %)	1 (0.00 %)
Other movement	50,184 (94.39 %)	2,100 (3.95 %)
Total Vehicles	53,165	

Again, a mean of the proportion of data form cell frequency to vehicles observed by site was calculated. A t-test was used to gauge statistical significance. The results showed that only the collapsed category of Left Turn Without Conflict for All Vehicles had any significant difference between the experimental and control populations (0.0299 i/v for experimental and 0.0107 for control).

A series of analyses of variance was run with the Left Turn Without Conflict for All Vehicles category and site type held constant as the dependent variable and first factor, respectively. A series of variables was used as the second factor. These factors were: approach volume, time-based restrictions, type of intersection control (e.g., stop), and State. An analysis using approach volume as the second factor showed a significant main effect for this variable but no other main effects or interactions. The mean values of incidents per vehicle by site type by approach volume are provided in table 38. It can be seen that as the likelihood of blocking a vehicle from behind by a violator increased (i.e., approach volume), the violation rate went down. This series of analyses was expanded to include all left-turn violations as the dependent variable. The results of these analyses, however, also failed to show significant results.

Table 38. Mean values of incidents per vehicle by site type and volume levels.

Approach Volume (Vehicles Per Hour)	Site Type	
	Experimental	Control
0 - 300	0.071	0.018
301 - 600	0.011	0.009
601 - 900	0.008	0.009
901+	0.004	0.002

F. Field Studies of Exceeding Advisory Curve Speeds

Procedure. After completing an abridged site evaluation form, a set of radar speed readings were taken. Even though the study sites were chosen at random, an attempt was made to control for isolation (no intersecting roads or major traffic control devices in either direction for 500 feet); two lane highways (one lane in each direction); and a single curve or the first curve in a series (no upstream curve within 500 feet) marked by a single curve/turn warning sign with an advisory speed plate. Additionally, flat and level sites were used where possible.

At the study site, the data collectors positioned themselves off the road opposite the warning sign with the advisory speed plate. The radar was aimed at the farthest visible point up the road (tangent section). The observers recorded the maximum speed of the vehicle approaching the position. The radar unit was cleared and aimed at the beginning of the curved section of the road, in the opposite direction to monitor the speed of the target vehicle as it departed. The team recorded the lowest speed the unit detected for the target vehicle, noticing whether the vehicle's brake lights came on. If the centerline of the road was visible, they recorded whether the vehicle crossed it. Observers recorded the behavior of only single vehicles or the lead vehicle in a platoon. Data collection continued until 50 vehicles had been observed.

Results. Observers went to 113 locations and observed 5,573 vehicles. In an overwhelming majority of the observations, the vehicle speeds in the curve were above the posted advisory speed. Speeds were checked at curves with posted advisory speeds ranging from 10 mi/h (16 km/h) to 40 mi/h (64 km/h).

The mean advisory speed across all observations was 31.3 mi/h (50.4 km/h), while the mean curve speed was 37.6 mi/h (60.5 km/h). These mean speeds were compared using a t-test. The results showed a significant difference between these speeds. Part of the analysis focused on whether drivers adjust their speed at all when encountering an advisory speed plate. To check this, the difference between the speed limit and advisory speed was compared to the difference between the tangent speeds and curve speeds of the vehicles. Results showed the mean difference between the speed limit and advisory speed (the suggested speed drop) was 14.4 mi/h (23.2 km/h), and the mean difference between the tangent and advisory speed (the actual speed drop) was 9.0 mi/h (14.5 km/h). Therefore, it would appear that most advisory speed warnings are exceeded by an average of 5 to 6 mi/h (8 to 10 km/h).

A series of analyses of variance was run taking the suggested and actual speed drops together as the dependent variable. This dependent variable along with speed drop type (suggested vs. actual) as a factor was held constant throughout the analyses. A series of variables was used as a second factor which included pavement condition, vehicle type, use of curve vs. turn signs, horizontal curvature estimate, pedestrian accommodations, and State. In the analysis using curve vs. turn signs, there was a significant main effect for speed drop type and the use of curve vs. turn signs and a significant interaction between them. The mean values of the speed drops by type and by the use of curve vs. turn signs are provided in table 39. The data in this table indicate that motorists were more likely to drive near the suggested advisory speed at turn sign locations than at curve sign locations.

Table 39. Mean values of speed drops by site type and sign types.

Sign Used	Speed Drop (mi/h)	
	Suggested	Actual
Turn	17.1	12.9
Curve	12.7	6.6

Note: Km/h = 1.609 x mi/hr.

A significant main effect was evident for speed drop type and horizontal curvature element, as was a significant interaction between these factors. The mean values of the speed drops by type by the estimate of horizontal curvature are provided in table 40. The data indicate that the sharper the curve, the greater the actual speed drop.

Table 40. Mean values of speed drops by site type and estimate of horizontal curvature.

Horizontal Curvature Estimate (Degrees Right or Left)	Speed Drop (mi/h)	
	Suggested	Actual
60-90+ left	16.4	12.7
5-60 left	12.1	4.9
5-60 right	10.4	4.8
60-90+ right	15.8	9.8

Note: Km/h = 1.609 x mi/h.

In the analysis where the presence or absence of pedestrian accommodations was used as the second factor, the results showed a significant main effect for the factors speed drop and pedestrian accommodations and a significant interaction between the two. The mean values of the speed drops by type by pedestrian accommodations are provided in table 41. The results show that the motorists were closer to the advisory speed in built-up areas rather than remote locations.

Table 41. Mean values of speed drops by site type and pedestrian accommodations.

Pedestrian Accommodations	Speed Drop (mi/h) Suggested	Actual
Unimproved	15.3	9.3
All Other	12.9	8.6

Note: Km/h = 1.609 x mi/h.

Some regional differences were noted. A significant main effect was evident for the factors speed drop type and State, as was a significant interaction between them. The mean values of the speed drops by type by State are provided in table 42. There were no other notable findings from this analysis.

Table 42. Mean values of speed drops by site type and State.

State	Speed Drop (mi/h) Suggested	Actual
New York	14.8	7.0
Virginia	14.8	9.2
Texas	15.2	12.3
California	13.2	7.4

Note: Km/h = 1.609 x mi/h

G. Field Studies of Stopped School Bus Violations

Procedure. The school bus procedure was different from the other studies in that no site evaluations were completed for the runs.

Data collectors sat on the left side of the bus behind the driver. Each time the bus stopped to drop off or pick up school children, they noted whether the driver turned on the bus's flashing red lights before or after coming to a complete stop, if at all. They noted if any auxiliary warning equipment was used with or in lieu of the red flashers. They checked whether vehicles in the area had stopped because of the school bus and noted whether the vehicles were behind the bus (same category), facing the bus from the opposite direction (opposite category), or approaching the bus from a side street (turning category). It was also noted whether any vehicles passed the bus, and from what direction. They noted whether children were getting on (boarding) or off (discharging) at this stop location. They noted whether the children had to cross directly in front of the bus. They classified the roadway where the stop was made, and noted the adjacent land uses. They noted if the stop location was at an intersection or in the middle of a block, and whether the terrain behind and in front of the bus was flat and straight, or curvy and hilly. This information was recorded for each stop the bus made along the route.

Results. The data collection team rode 234 school bus route runs, noting the activity at 2,615 bus stops and observing 184 violations.

Even though the procedure was pilot-tested in the field, it was extremely difficult for the data collectors to keep an accurate tally of the total number of vehicles in the vicinity of the bus. This makes the computation of rate data (the number of violators expressed as a percentage of potential violators) somewhat suspect. Thus, in analyzing the school bus operation data, the number of violator vehicles at each stop was considered the dependent variable. Several contingency tables were used to see if there was any relationship between the dependent and independent variable(s). The chi-square statistic was analyzed at the 0.05 level of significance.

Dealing with a straight frequency count, no vehicles passed the school bus in 94 percent of the stops studied. At 4 percent of the stops, one vehicle passed the bus; at 2 percent, two or more vehicles passed the bus. In examining the relationship between the incidence of passing and several independent variables, only a few tables had significant results. In table 43, a significant difference can be seen between States, which may be due partly to the larger number of urban routes studied in California. However, we cannot explain why the Texas numbers are also relatively high.

Table 44 compares the violations when school children were getting on or off the bus at the stop. It appears that drivers are more likely to pass a bus when children are getting off the bus. This may show that drivers are more patient during morning school bus runs, but less patient in the afternoon, or that drivers are less willing to pass when they see a child approaching or in the vicinity of the bus.

Location of the bus at either a midblock or intersection stop was checked for significant differences. Table 45 shows that buses stopped at intersections rather than midblock locations are more likely to be passed. This may be the result of confusion about the stopping law at intersection situations.

There were no significant findings from the analysis of flasher mode, bus auxiliary equipment, vehicle passing direction, roadway type, land use, or terrain.

While conducting this study, the study team discovered a report by the Henrico County (Virginia) public schools.[47] This internal study showed that for the 1986-87 school year, each bus in the fleet was passed by a vehicle an average of 1.25 times per day. This was based on 2 weeks of observations by system school bus drivers. By comparison, the results from the four States covered in this study show that the buses observed were passed by a vehicle an average of 1.8 times per day.

Table 43. Summary of school bus stopping compliance data by State.

Number Passing	State				Row Totals
	New York	Virginia	Texas	California	
None	999 56.9% 98.4 %	337 19.2 % 92.1 %	371 21.1 % 89.2 %	49 2.8 % 76.6 %	1756 94.4 %
One Vehicle	14 19.4 % 1.4 %	23 31.9 % 6.3 %	24 33.3 % 5.8 %	11 15.3 % 17.2 %	72 3.9 %
Two or more vehicles	2 6.1 % 0.2 %	6 18.2 % 1.6 %	21 63.6 % 5.0 %	4 12.1 % 6.3 %	33 1.8 %
Column Totals	1015 54.5 %	366 19.7 %	416 22.4 %	64 3.4 %	1861 100.0 %

Significance Analysis
- Chi Square Statistic: 106.96484
- Degrees of Freedom 6
- Significance 0.0000

Table 44. Summary of school bus stopping compliance data by passenger actions.

Number Passing	Bus Passenger Actions		Row Totals
	Loading	Unloading	
None	813 46.3 % 96.6 %	943 53.7 % 92.5 %	1756 94.4 %
One Vehicle	22 30.6 % 2.6 %	50 69.4 % 4.9 %	72 3.9 %
Two or more vehicles	7 21.2 % 0.8 %	26 78.8 % 2.6 %	33 1.8 %
Column Totals	842 45.2 %	1019 54.8 %	1861 100.0 %

Significance Analysis
- Chi Square Statistic: 14.75137
- Degrees of Freedom 2
- Significance 0.0006

Table 45. Summary of school bus stopping compliance data by stopping location.

Number Passing	Bus Stopping Location Intersection	Midblock	Row Totals
None	445 25.4 % 90.3 %	1310 74.6 % 95.8 %	1755 94.4 %
One Vehicle	36 50.0 % 7.3 %	36 50.0 % 2.6 %	72 3.9 %
Two or more vehicles	12 36.4 % 2.4 %	21 63.6 % 1.5 %	33 1.8 %
Column Totals	493 26.5 %	1367 73.5 %	1860 100.0 %

Significance Analysis

Chi Square Statistic:	23.23861
Degrees of Freedom	2
Significance	0.0000

IV. DEVELOPMENT OF PRACTICAL COUNTERMEASURES

The behavioral studies indicated that motorist noncompliance exists, but that the associated safety risk, as indicated by traffic conflicts appears to be low. While the safety risk associated with noncompliance appears to be low, concern still exists relative to motorist compliance to traffic control devices. Accidents can occur even if the rate of conflict incidents per vehicle is low, particularly in highway situations where design or terrain features make risks greater. Motorists accustomed to not complying may compromise their safety to a greater degree in such situations. The need also exists to better understand motorist behavior with regard to traffic controls. Therefore, the last phase of this research was devoted to identifying approaches or countermeasures to reduce motorist noncompliance. The emphasis in this effort was to define practical approaches. This aspect of the research involved convening a panel of experts and conducting further investigations relative to the selected noncompliance problems. These efforts and the findings are documented in this chapter.

A. Experts Panel

A two-day workshop was held at the FHWA Turner-Fairbank Highway Research Center (TFHRC) in McLean, Virginia, with a group of experts in the fields of:

- Traffic Engineering.
- Human Factors.
- Law Enforcement.
- Motor Vehicle Administration.

The workshop was held to "brainstorm" for potential countermeasures to be used to increase motorist compliance with the previously identified problem devices and laws. Invited participants were asked to review project working papers before the meeting to update their knowledge on current levels of compliance for the problem TCDs, relationships between the different aspects (i.e., driver attitudes and driver behavior), and past research into why violations occur. At the workshop, each problem device/law was discussed in detail. The discussions centered around understanding why each problem exists and developing countermeasures that would address the problems.

1. General Considerations

The workshop was initiated with general discussions on the subject of motorist compliance. A common concern of the panel was that, in general, the relationship between violations and accidents is not well understood. Most panelists felt that violation data need to be correlated with accident data. Such correlations could help establish baseline violation rates (e.g., mean, percentile) which would allow traffic and police personnel to analyze device/law compliance in their jurisdictions and determine if they have a compliance problem.

It was also suggested that traffic engineers need to constantly monitor the systems under their authority. Changing traffic patterns sometimes demand modifications in the type of traffic control. It was also noted that signs, markings and signals must be maintained to command respect.

The enforcement community expressed a desire to go back to the "old days" when they enforced traffic laws specifically at high accident locations and had better interaction with engineering officials. There was a constant call for better communication between the engineering, enforcement, and education disciplines relative to traffic controls. It was felt that there is a strong need to educate each other, as well as the public, about the contributions of each discipline to traffic safety.

The following actions were suggested as general countermeasures to address compliance problems, grouped by category:

- Engineering.
  - -- Determine if compliance problems and accident problems correlate; i.e., do places with high noncompliance have more accidents.
  - -- Establish baseline violation rates so local engineers will know if they have a compliance problem.
  - -- Be cognizant of the changing traffic system, regarding traffic volumes and characteristics, and condition of TCDs.
- Enforcement.
  - -- Target enforcement to high accident locations.
  - -- Strive to have uniform enforcement policies (e.g., tolerances).
- Education.
  - -- Educate drivers about how and why the traffic system functions as it does.
  - -- Be cognizant of the need to educate motorists to new or different traffic control devices.

These actions should be undertaken as a matter of standard practice. The following sections summarize the discussions and the countermeasures suggested by the panel of experts relative to the selected compliance problems.

2. Assesment of Running the Red at Traffic Signals

Discussion. Since the attitudinal data showed that many "red runners" said they do so because of long cycle times, discussion initially focused on cycle time. Questions were asked about motorists' maximum tolerance for cycle time. It was hypothesized that this would depend on time of day and traffic conditions. The issue of defective loop detectors causing controllers to go to longer background cycles was raised.

When discussing enforcement, several interesting points were raised. Violators are thought to be making a decision to violate based on the consequences they will have to face. The safety consequences of running a red light appear to be unrecognized by the violator. Their perception of the probability of apprehension is apparently relatively low and should be raised. Therefore, it was reasoned that countermeasures which increase the consequences of apprehension might be most effective. Suggested countermeasures included immediately confiscating the violator's license or mandating large automobile insurance surcharges, as is done to driving while under the influence (DUI) offenders in some States.

The use of automated surveillance/detection systems was also discussed, but many of the session participants expressed doubts about the effectiveness of such devices given the costs and legal implications. Several of the enforcement officials felt they spend too much time trying to enforce the 55 NMSL. Their preference would be to enforce heavily at high accident locations rather than high violation locations.

Officials involved with educating drivers, particularly repeat offenders, said it is difficult to tailor their efforts to particular traffic control devices. They find it more effective, in the limited time they have with their driver improvement classes, to impress upon students their need for a driver's license.

Suggested Countermesures. The following were the suggested countermeasures to address "red running," grouped by category:

- Engineering.
  - -- Improve loop surveillance and maintenance for all actuated and semiactuated signals.
  - -- Convert low volume intersection controllers from fixed time to semiactuated.
  - -- Reduce cycle lengths.
  - -- Interconnect signals.
  - -- Improve network through green band.
  - -- Install large cross-street name signs with block numbers.
  - -- Adjust yellow times and consider use of an all-red phase.
  - -- Remove unwarranted signals.
  - -- Check and improve signal visibility.
- Enforcement.
  - -- Consider the use of photographic surveillance systems, if current pilot programs show them to be effective.
- Education.
  - -- Educate drivers about the meaning of traffic signal displays such as protected/permissive indications.

Many of the engineering countermeasures discussed were noted to be expensive or difficult to implement. Finding a local jurisdiction willing to implement them for evaluation purposes was judged to be difficult. On the other hand, reducing cycle lengths and adjusting phasing (i.e., yellow and all red) were considered inexpensive, easily implemented countermeasures. These two strategies were judged to hold the most promise for reducing red violations for project purposes and general application.

The assessment of enforcement or educational approaches to reducing running the red violations indicated that they would take more time than was available for this project. Technical approaches such as photographic surveillance were also considered impractical. Once current demonstration projects determine if such systems are technically feasible and publicly acceptable, additional data on the long-term effect of photographic surveillance on motorist compliance will be needed.

3. Assessment of Improper Right Turns on Red at Traffic Signals

Discussion. Background research and field data have shown that strict compliance with this law is low. Many panelists felt, however, that it may not be a real safety problem. There were strong feelings expressed about the interpretation of the law. The need for a strict interpretation may not be necessary since so many people violate the full stop caveat with limited occurrence of conflicts. Perhaps the law should be changed to Right Turn On Red After Yield (RTORAY) to better reflect motorist behaviors. It was noted that the major risk from vehicles turning right on red is to pedestrians and bicyclists. Rather than prohibit RTOR at high violation locations, increased utilization of placards to No Turn On Red signs that would selectively exclude right turns on red when children, pedestrians, or school crossing guards are present was proposed.

It was suggested that since so many of the violations are rolling stops rather than outright running through the light, perhaps the drivers think they are stopping. If this is true, it was felt that educational approaches should be used to address this problem.

Suggested Countermeasures. As a result of the discussions, the following actions represented the primary countermeasures to address RTOR violations, grouped by category:

- Engineering.
  - -- Convert the law from RTORAS (stop) to RTORAY (yield).
- Education.
  - -- Educate new drivers about the entire RTOR concept, especially the danger to pedestrians and bicyclists.
  - -- Educate pedestrians and bicyclists about the dangers of vehicles turning right on red.

While these countermeasures are feasible, they were not considered equally practical for short term application. It was determined that in the time available for the project is was not possible to implement, allow for a motorist acclimatization period, and assess the effectiveness of these countermeasures. Actually, if the enforcement countermeasures were selected, there might be a change in accident rates or profiles (e.g., an increase in pedestrian accidents) at study locations but a corresponding change in "violations" may not be apparent, since the basic definition of a violation would change (i.e., RTOR vs. RTORAY). It is possible to hypothesize a renewed respect for traffic laws in general resulting from the change because drivers are no longer flagrantly violating the "stop" part of RTOR and getting away with it. Testing either of these hypotheses was not considered a realistic project activity. Therefore, no further effort regarding RTOR noncompliance was undertaken during the project.

4. Assessment of Failing to Come to a Full Stop at STOP Signs

Discussion. Since behavioral studies showed a definite relationship between the violation rates and the volumes of the major and minor streets, much of the discussion centered on the development of volume-based STOP sign warrants. It was suggested that these warrants be tied into the sight triangle formulas used in the AASHTO publication, A Policy On Geometric Design of Highways and Streets.[48] It was thought that once these warrants are developed, they should be applied to remove all unwarranted STOP signs (or at least replace them with YIELD signs). It was agreed that accident measures, except on a rate basis, should not be included as part of the warrants, since these measures would not represent the same relative hazard for low-volume intersections.

Since development of new STOP sign warrants could lead to the removal of many STOP signs, it was felt that an educational campaign would have to be mounted to explain why the signs were being removed or replaced. These campaigns would need to emphasize the safety, energy, and environmental benefits of STOP sign removal.

Suggested Countermeasures: The following were suggested as feasible countermeasures to address STOP sign violations:

- Engineering.
  - -- Develop and apply a volume- and sight-line-based set of warrants for the placement of STOP signs.
- Education.
  - -- Develop information regarding the safety, energy and environmental benefits of STOP sign removal to counter adverse community reaction.

Since several studies have looked at developing warrants or guidelines for the placement and/or removal of STOP signs, it was felt that there was no point in further attempting to find ways to increase compliance. However, since previous studies have shown that STOP violations continue to be relatively high, it was decided that an accident/violation correlation study was needed to determine whether the existing noncompliance problem is a safety problem as well.

5. Assessment of No Left Turn Sign Violations

Discussion. The discussions of violations of No Left Turn restrictions and prohibitions centered around the fact that it is most often used as a traffic operations measure rather than a safety measure. The lack of motorist understanding of operational needs may be why many drivers disregard left-turn restrictions when a safety risk is not apparent. Panelists also questioned why, if No Left Turn devices are predominantly used as a means to enhance traffic operations, so many of these restrictions are in force all the time rather than only during peak periods. While many of the participants endorsed greater use of supplemental signing to give left-turn restrictions a time base, some cautioned that drivers who violate on the cusps of the time period often claim ignorance of the time. Changeable message signs were suggested to remedy this concern. In the behavioral study, a close relationship between violation rate and approach volume was shown. This prompted some discussion about the possible need for minimum volume warrants for left turn controls.

At one point, several participants mentioned that drivers are seldom aware of operational measures in the traffic system. While driver education emphasizes safety, drivers receive little or no information about actions taken to make the roadway system function more efficiently. It was suggested that motorists be made aware of how, in their own haste, they may be inconveniencing or delaying many other drivers.

Suggested Countermeasures. The following were the suggested countermeasures to address left-turn violations:

- Engineering.
  - -- Educate engineers to eliminate or reduce unnecessary left-turn restrictions.
  - -- Develop warrants to give guidance in the elimination or reduction

of left-turn restrictions.
  -- Reassess sign size and placement at problem locations.
- Education.
  -- Educate drivers about operational, not just safety, issues in training courses and handbooks.
  -- Emphasize better pre-trip planning to eliminate confusion while driving.

While each of these suggestions has potential, most could not be readily implemented and evaluated during the course of this project. One of the most promising countermeasures is the development of warrants or guidelines for the elimination of left-turn restrictions and/or for the placement of time placards on left-turn signs. It is not known, however, whether compliance (especially during critical peak time periods) is different at full-time no left turns versus time-restricted no left turn locations. Since it was determined that compliance is dependent on traffic volumes, it would be necessary to observe compliance at intersections with a range of traffic volumes. This information is needed before realistic warrants/guidelines can be generated.

6. Assessment of Exceeding Advisory Curve Speeds

Discussion. Initially, the panel discussed whether advisory curve speed signs could actually be violated. Since advisory curve speed signs are classified as warning signs,it is not a regulatory sign and hence the police cannot legally enforce an advisory speed. Police involvement with this sign only occurs when an accident happens, but then violation of the advisory speed is never specifically cited.

Many of the participants felt that there is a problem with uniformity in setting advisory speeds. The Traffic Control Device Handbook specifies three different methods of determining curve speeds.[49] Other research has suggested other means of setting advisory speeds for curves. Most of the panelists thought that criteria need to be applied consistently. Many felt, however, that the system functions reasonably well as is (i.e., "if it ain't broke, don't fix it").

Since many of the attitudinal study responses had to do with weather and vehicle sensitivity to curve speeds, many panelists thought it would be useful to make sure all motorists are sensitive to the issues related to negotiating curves and driving in general.

Suggested Countermeasures. The following were the suggested countermeasures to address advisory speed "violations":

- Engineering.
  -- Develop criteria for uniformity of application.
  -- Check applicability of posted speeds to existing geometric conditions at problem (i.e., high accident) locations.
- Education.
  -- Educate drivers about how curve speeds are set, and how appropriate speeds may change under different conditions (e.g., wet/dry; car/truck/motorcycle).
  -- Educate drivers about the curve/turn family of warning signs (W1-1 to 5 in the MUTCD).

As with many of the other devices/laws, the educational countermeasures appeared to be most promising. However, they could not be implemented and effectively tested within the scope of this project. The engineering approaches require additional work, such as an accident-based study of the applicability of posted advisory speeds to establish a sound basis for uniformity criteria.

7. Assessment of Stopped School Bus Violations

Discussion. From the behavioral data, it was apparent that some drivers are confused about what to do when a school bus is stopped at an intersection, e.g., can vehicles from the side street pass a bus in certain situations? The panel was also confused. The behavioral data showed that when red flashers were used prior to stopping the bus, the compliance rate was higher. This prompted a lot of discussion about uniform practices related to school bus safety devices (e.g., red flashers, amber flashers, no.flashers, etc.).

Some of the results of the behavioral study showed that the buses are more likely to be passed during afternoon runs. Therefore, it would be more effective for enforcement to take place in the afternoon.

Since the experts were confused about operational practices, greater education of the public was suggested as a countermeasure.

Suggested Countermeasures. The following were the countermeasures to address school bus violations recommended by the panel:

- Engineering.
  -- Cooperate with enforcement and pupil transportation officials in locating bus routes and stops, including location of off-road stops, signing, etc.
  -- Develop warrants/guidelines for standard safety equipment and operational practices.
- Enforcement.
  -- Target afternoon periods for enforcement.
- Education.
  -- Educate the public about the equipment and operating practices of school buses.

In the background studies related to school bus operations, more variability (between States and between school districts) was found in school bus safety equipment and operational procedures than we had expected. For example, some districts use flashing red lights only when the bus is fully stopped and others use flashing red lights when the bus is preparing to stop. It is not known if specific procedures or specific equipment have an effect on accidents. It was suggested that an analysis be performed of school bus-related accident rates (for specific "types" of accidents) in States/school districts with different kinds of operational practices.

8. Epilogue

The discussions and suggestions of the panel were used to formulate plans to conduct more detailed investigations of selected noncompliance problems. These detailed investigations involved a series of smaller-scale experimental procedures specifically designed to address issues or the effectiveness of countermeasures related to the selected noncompliance problems. Data gathered earlier in the research were used to maximize the extent of the detailed investigations. Consequently, it was possible to undertake the following investigations:

- Analysis of signal timing changes to reduce running the red.
- Analysis of the factors associated with STOP sign compliance.
- Analysis of countermeasures to increase No Left Turn compliance.
- Analysis of advisory curve speed compliance.
- Analysis of stopped school bus violations.

Each of these analyses is documented in the following sections.

B. Analysis of Signal Timing Changes to Reduce Running the Red

From the panel, it was determined that the most appropriate run-red countermeasure to test was signal timing changes. A before/after with controls procedure was used to see if changes in cycle length had an effect on run-red compliance. Study sites used in the behavioral studies became the candidates for signal cycle length changes. The public agencies responsible for signal maintenance were contacted to assess their willingness to alter their signal timing for the purposes of this study. For various reasons the agencies which had previously cooperated in this study were unwilling to make the signal timing changes needed. After some contacts with other agencies, three counties in Maryland agreed to help.

The Maryland agencies each provided a list of sites where it would be possible to change the signal timing. It was necessary to find locations with isolated controllers since most of the networks in these areas were under computer control. Ultimately, "before" experimental data were collected at 16 intersections. An equal number of intersections where a signal timing change was not made were identified as "before" control locations.

The data collectors followed the same procedures used in the behavioral studies. Information was gathered on compliance behavior as well as salient physical/operational features of the site. They completed a site evaluation form (appendix F) and counted the number of vehicles entering the intersection on green, by number of left-turning, straight-through, and right-turning vehicles. They also counted the number of vehicles entering the intersection on yellow, by turning movement; the number of vehicles entering the intersection on red without causing a conflict, by turning movement; the number of vehicles entering the intersection on red that cause a conflict, by turning movement (noting whether the vehicles entering the intersection on red were cars or trucks); and the number of vehicles that enter the intersection by "jumping the green," entering the intersection on red just before the signal turns green, by conflict causation and turning movement. RTOR vehicles were counted in the right-turn-green category. Observers recorded the behavior of every vehicle that passed through the intersection from the study leg. Data were collected for two hours.

"After" data were gathered at all experimental and control sites after the signal cycle lengths had been reduced. Generally, cycles were reduced by 25 percent, but this varied by location. The after data were collected using the same procedures as for the before data. These data were subsequently coded, keyed and checked.

Ultimately, before and after data for 48 intersection approaches were available for analysis. Three-quarters of the approaches were located at four-legged intersections with the remainder at T intersections. The approaches were equally divided into major and minor leg categories. Speed limits on these approaches varied from 25 mi/h (40 km/h) to 40 mi/h (64 km/h) with more than half having a speed limit of 35 mi/h (56 km/h). The analysis was complicated by the fact that red runners were relatively rare (as had been noted in the behavioral studies). It was determined appropriate to group red runners with and without conflicts for the analysis.

The incidents per vehicle measure used previously was utilized for the before and after analysis. It was noted that the mean number of incidents per vehicle was 0.00971 for the before condition and 0.00492 for the after condition. The experimental sites had a mean number of incidents per vehicle of 0.00677 while the control sites had a rate of 0.00785 incidents per vehicle. Table 46 summarizes the relative difference in the rates of incidents per vehicle categorized by experimental or control, before or after, major or minor intersection leg, and peak or offpeak time periods. In most cases, the number of red runners decreased from the before to the after periods. The exceptions are the rates for the experimental sites on a major intersection leg during offpeak periods, and the experimental sites on minor intersection legs during peak periods.

Table 46. Summary of the relative rate of run the red incidents per vehicle for before and after periods.

Intersection Type	Approach Category	Time Period	Analysis Period Before	After
Experimental	Major	Peak	0.01100	0.00640
		Offpeak	0.00429	0.00786
	Minor	Peak	0.00540	0.00700
		Offpeak	0.01057	0.00243
Control	Major	Peak	0.01760	0.00520
		Offpeak	0.00971	0.00343
	Minor	Peak	0.01240	0.00640
		Offpeak	0.00886	0.00214

The significance of the trends represented in table 46 were subjected to an analysis of variance. The peak and offpeak hours data were analyzed separately under the assumption that volume levels would vary between these times affecting the behavior of drivers. The analysis of the peak hour data indicated that the difference between the before and after periods was significant. No significant interactions between the controlling factors were noted. The analysis of the offpeak data indicated that the difference between the number of red runners was almost significant. For the offpeak period it was further noted that the number of red runners was significantly less for traffic on the minor leg, but the differences were insignificant for traffic on the major legs.

The statistical analyses verify the contention that reducing the cycle lengths increases motorist compliance. This was clearly true for peak hours when volumes are likely to be the greatest since traffic on all approaches experiences lower average delays. During the offpeak periods, the differences were sufficiently close to be considered significant. The analysis of the interaction effects indicated that the greatest reduction in red runners occurs on those approach legs categorized as minor. This would be consistent with the knowledge that the minor leg traffic is least favored by longer cycles. Reduced cycles decrease the tendency to "hurry" through an intersection when traffic volumes are light.

C. Analysis of Factors Associated with Stop Sign Compliance

The experts panel indicated that an accident/violation correlation study should be conducted to determine whether the noncompliance problem is a safety problem as well. Accident and compliance data were collected for 75 stop-controlled intersections stratified into equal sized groups of low, medium, and high accident histories. Data related to the features of the locations, traffic conditions, compliance rates, and accidents were examined to determine if relationships between the factors exists. The sample intersections underwent the same compliance analysis used in the behavioral studies.

After completing a site inventory, the data collectors determined if the study vehicle arrived as a single vehicle or was part of a queue of vehicles waiting at the STOP sign. They assessed whether the study vehicle made a voluntary full stop, was stopped by vehicular or pedestrian cross traffic, or did not stop at all before entering the intersection, determining if the action caused a conflict with any vehicular or pedestrian traffic. It was recorded whether the study vehicle turned left or right, or continued straight through the intersection, and whether the vehicle was a car or a truck. Observers recorded the behavior of every vehicle passing through the intersection from the study leg.

After they had observed the behavior of 200 vehicles (or after 2 hours of data collection), they took a 5-minute count of the number of vehicles entering the intersection from the cross street. After completing this 5-minute volume count, observing behavior resumed on the study leg. Data were collected until 400 vehicles were observed or until 4 hours had passed.

Accident data covering a three-year period for the selected sites was obtained from the responsible jurisdictions. These data were reviewed, coded, keyed, checked and appended to the features and compliance rates database.

In the subsequent analysis of the data, some important characteristics of the site types were identified. An analysis of variance using site type as the dependent variable and speed limit on the study leg as a factor showed a distinct relationship between these elements. The approach leg speed limits were significantly higher for the medium and high accident sites compared to the low accident locations. Likewise, the high accident site speed limits were significantly higher than the medium accident locations as shown in table 47.

There was also a relationship noted between the site type and the approach traffic volume on the study leg. An analysis of variance showed significant differences between these groups. There was a progression in approach volume that directly correlated to accident levels as provided in table 48.

Table 47. Relative mean speed limits for locations having different accident levels.

Accident Levels	Speed Limit (Mean Value for All Sites)
Low (0 accidents)	25.0
Medium (2-6 accidents)	28.2
High (7-13 accidents)	31.0

Table 48. Mean approach volume levels associated with differing accident levels.

Accident Levels	Volume (Vehicles Per Hour)
Low (0 accidents)	16
Medium (2-6 accidents)	69
High (7-13 accidents)	123

Several compliance-related measures also showed a relationship with the type of site studied. Motorist compliance behavior at each location was shown to be distinctly different relative to the amount of accident activity at each location as indicated in table 49.

Table 49. Mean percentage of vehicles exhibiting certain compliance behaviors by accident levels.

Behavior	Accident Levels Low	Medium	High
No Stop	73	47	47
Stopped by Cross Traffic	21	53	53
Full Stop	6	<1	<1
Total	100	100	100

There also seemed to be a relationship between variations in the "no stop" behavior relative to the site accident levels as noted in table 50.

D. Analysis of Countermeasures to Increase No Left Turn Compliance

The original plans for the detailed investigations included conducting a before/after study of the effect of time restrictions on left-turn violation rates. The list of study sites used in the behavioral studies was reviewed and the jurisdictions contacted to assess their willingness to alter the period when left turn restrictions are in effect (i.e., 24 hours vs. peak periods only). The agencies contacted indicated that there were few opportunities to effect a change from 24-hour left turn restrictions to peak hour restrictions. In some cases, the locations previously used had been redesigned or were scheduled for redesign. In other instances, sign placement was "politically" motivated, and therefore the operating agencies had little actual control over changing the restrictions. Some agencies had the policy of minimizing such restrictions and therefore sufficient numbers of control sites could not be identified. Consequently, plans to analyze less restrictive no left turn controls had to be abandoned.

Table 50. Mean percentage of vehicles exhibiting certain compliance by behavior by site accident levels.

Behavior	Accident Levels		
	Low	Medium	High
No Queue, No Stop	69	33	21
Queue, No Stop	4	14	26
All No Stop	73	47	47

E. Analysis of Advisory Curve Speed Compliance

For this analysis, an accident-based study of the adequacy of advisory speeds was conducted. This study correlated posted speeds, curve advisory speed, actual vehicle speeds, accidents, and site features data. The experimental plan called for a comparison of compliance data at curve sites having low, medium, and high numbers of accidents. The basic hypothesis was that noncompliance is hazardous, therefore it would be higher at curve locations with higher numbers of accidents. A sample of 2,795 accidents occurring at curve locations in Fairfax County, Virginia between 1984 and 1988 served as the basis for the analysis. It was determined that very few of these accidents occurred at locations with curve/turn signs and advisory speed plates. Of the 2,795 accidents initially identified, only 14 occurred at isolated locations with advisory curve speed signing. Only isolated locations were used to avoid biases due to other traffic controls or cross traffic.

At each study site, the data collectors completed an abridged site evaluation form. They then positioned themselves off the road opposite the warning sign with the advisory speed plate. The radar was aimed at the farthest visible point up the road (tangent section). The data collectors monitored the speed and recorded the maximum speed of the approaching vehicle. The radar unit was cleared and aimed at the curved section of the road to monitor the speed of the target vehicle as it departed. The observers recorded the lowest speed detected for the target vehicle, and noted whether the vehicle's brake lights came on. If the centerline of the road was visible, they recorded whether the vehicle crossed the centerline. Observers recorded the behavior of only single vehicles or the lead vehicle in a platoon. Data collection continued until 50 vehicles had been observed.

Table 51 provides a summary of the mean speed changes and mean accident experience for the various posted speed and advisory speed situations. It can be noted from the data in the table that a complete cross section was not established and that the number of sites by cell was low. The actual mean speed changes were consistently lower than advised (e.g., moving diagonally across the matrix from upper left to lower right) for equivalent differences between posted and advisory speeds.

Table 51. Summary of data gathered for various curve locations categorized by approach speed limit and advisory curve speed.

Posted Speed Limit	Factor	Advisory Curve Speed 10	15	20	25	30
30	Number of sites	0	0	2	0	0
	Mean actual speed change	---	---	7.60	---	---
	Mean number of accidents	0	0	4.5	0	0
35	Number of sites	1	3	2	4	0
	Mean actual speed change	6.14	14.22	8.88	7.19	---
	Mean number of accidents	2	8	6.5	1.75	0
40	Number of sites	0	0	0	1	1
	Mean actual speed change	---	---	---	4.62	3.28
	Mean number of accidents	0	0	0	0	0

Note: Km/h = 1.609 x mi/h.

The compliance levels at the sites with at least one accident (experimental sites) during the three-year period were compared to the sites with no accident history (control site). The results are shown in table 52. The data indicate that there is no difference between the suggested speed drop and the actual observed speed reduction. This suggests that accident sites are not necessarily sharper, or signed lower than are control sites. It also suggest that the level of noncompliance is not much different at sites which have an accident history and those that do not.

Table 52. Compliance levels at sites with and without accident histories.

Site Type	Speed Drop (mi/h) Suggested	Actual
Accident History (experimental)	14.8	9.2
No Accident History (control)	14.3	8.5

Note: Km/h = 1.609 x mi/h.

Data on curve sharpness was gathered using a ball bank indicator and a G-Analyst (Electronic device capable of recording changes in inertia in two planes; marketed by Valentine Research, Inc. Cincinnati, OH). Readings were taken at the posted advisory speed, the advisory speed plus 5 mi/h (8 km/h), the advisory speed plus 10 mi/h (16 km/h), and the mean observed speed with each instrument. It was found that the traditional ball bank indicator correlates quite highly with the electronic G-Analyst. Table 53 provides a summary of the correlations. It can be noted that the correlations are somewhat larger at higher speeds.

Table 53. Correlation coefficients between ball bank indicator and G - Analyst readings over a range of speeds.

Correlation Coefficients	Advisory Speed	Advisory Speed +5 mi/h	Advisory Speed +10 mi/h	Mean Curve Speed
Advisory Speed	0.81	0.64	0.55	0.48
Advisory Speed +5 mi/h	0.81	0.76	0.84	0.72
Advisory Speed +10 mi/h	0.51	0.68	0.90	0.73
Mean Curve Speed	0.47	0.47	0.68	0.87

Note: Km/h = 1.609 x mi/h.

The ball bank readings for each curve are compared with the ball bank criterion for each advisory speed in table 54. From this information, it is apparent that most of the curves studied were appropriately signed, but some of the curves, particularly those with 10 mi/hr (16 km/h) or 15 mi/h (24 km/h) advisory speeds were overly conservative. This may have resulted from accident experience or political pressures. This lack of consistency in the application of advisory curve speeds is possibly one of the reasons for the relatively high levels of noncompliance. When a curve has an accident problem and the advisory speed is appropriate, it may not be desirable to change it. Other treatments, such as the use of a large arrow sign (W1-6), chevron alignment signs (W1-8), raised pavement markers, and/or post-mounted delineators should be considered.

Table 54. Ball bank indicator readings and criterion categorized by advisory speeds.

Advisory Speed (mi/h)	Ball Bank Criterion	Ball Bank Readings	
		At Advisory Speed	At Observed Mean Speed
10	14	4	8
15	14	5, 8, 13	17, 19, 20
20	12	6, 11, 12, 13	11, 21, 22, 23
25	12	9, 10, 11, 12, 14	13, 15, 16, 16, 17
30	12	9	13
35+	10	-	-

Note: Ball bank readings/criterion given in degrees. Km/h = 1.609 x mi/h.

Table 54 also shows the ball bank reading associated with the observed mean speed of traffic at each curve. These data suggest that the driving public is comfortable with much higher ball bank readings than the those specified by the criterion. At only two curves (including the one posted at 10 mi/h (16 km/h)) was the average motorist driving slowly enough to meet the ball bank criterion. At the remaining twelve locations the ball bank readings associated with the mean observed speeds were higher than the criterion. Perhaps the ball bank criterion should be examined relative to changes in vehicle characteristics resulting from advances in technology and design.

F. Analysis of Stopped School Bus Violations

During the behavioral studies, it was found that motorists noncompliance to school bus signals was relatively infrequent. In 4 percent of the 2,615 bus stops observed one vehicle passed the bus and in another 2 percent of the stops two or more vehicles passed the bus. It was also found that drivers were more likely to pass a bus when children were getting off the bus (55 percent) than when they were boarding the bus (45 percent). Drivers were also more likely to pass a bus stopped at an intersection (10 percent) than a bus stopped midblock (4 percent).

During panel discussions, participants were unable to identify specific countermeasures because it was not known which of the driver behaviors were especially hazardous; i.e., resulted in accidents. It was decided that it would be appropriate to examine a sample of school bus accident reports to identify the hazardous motorist behaviors that should be targeted.

Police officials in the study States (California, New York, Texas and Virginia) were asked to provide hard-copy accident reports of school bus accidents that involved a motorist's failure to comply to the school bus signals. California was unable to sort out accidents that specifically involved noncompliance. They provided a total of 345 school bus accident reports, representing all school bus injury accidents occurring in 1987. A review of these reports identified only eight accidents that involved motorist noncompliance.

New York provided 14 school bus accidents that involved motorist noncompliance from November 1987 through April 1988. Additional reports were not available. Texas was able to provide a total of 66 hard-copy accident reports, 20 from 1987, 24 from 1986 and 22 from 1985. Virginia was unable to identify the reports of interest in their computerized file.

The hard-copy accident reports were reviewed and the following data items were coded:

- State
- Accident Number
- Date
- Time
- Day of Week
- Number of Pedestrians Injured
- Driver's Age
- Driver's Sex
- Pedestrian Age
- Pedestrian Sex

- Injury Severity
- Light Conditions
- Roadway Conditions
- Type of Roadway
- Number of Lanes
- Traffic Control
  - -- School bus flashers - on
  - -- School bus flashers - off
  - -- School crossing guard, bus patrol
  - -- Marked crosswalk
- Striking Vehicle Type
- Striking Vehicle Action
  - -- Proceeding straight - approaching bus from rear
  - -- Proceeding straight - approaching bus from front
  - -- Turning right
  - -- Turning left
  - -- Other
- Accident Occurred
  - -- At an intersection
  - -- Not at an intersection
- Pedestrian Was Struck
  - -- As he stepped onto bus (loading)
  - -- As he crossed in front of bus (loading)
  - -- As he crossed behind bus (loading)
  - -- As he stepped off of bus (discharging)
  - -- As he crossed in front of bus (discharging)
  - -- As he crossed behind bus (discharging)
  - -- Other
- Driver's Vision Was Blocked By
  - -- Standing traffic
  - -- A parked vehicle
  - -- School bus
  - -- Sun
  - -- Other
  - -- Not blocked
  - -- Unknown
- Driver Behavior
  - -- Ignored school bus flashers
  - -- Attempted evasive action, swerved or braked to avoid pedestrian
  - -- Was under the influence of alcohol or drugs
  - -- Was exceeding safe speed for conditions
  - -- Was engaged in a turning or merging maneuver
  - -- Passed a school bus loading/discharging passengers
  - -- Combination of above factors
  - -- Other/Unknown
- Accident Type
  - -- Vehicle following bus passes on left, strikes pedestrian (loading)
  - -- Vehicle following bus passes on left, strikes pedestrian (discharging)
  - -- Vehicle following bus passes on right, strikes pedestrian
  - -- Vehicle following bus strikes bus, which then strikes pedestrian
  - -- Vehicle approaching bus strikes pedestrian crossing in front of bus (loading)

-- Vehicle approaching bus strikes pedestrian crossing in front of bus (discharging)
-- Vehicle approaching bus strikes pedestrian crossing behind bus
-- Turning vehicle strikes pedestrian crossing behind school bus
-- Vehicle following bus attempts evasive action, loses control, and strikes pedestrian while out of control

Although it is not possible to draw precise conclusions from the available data, several interesting trends are apparent. The behavioral data indicated that motorist noncompliance to school bus signals is relatively widespread yet accidents occur relatively infrequently, less than 25 annually in each of three of the largest States.

When the accidents do occur, they involve serious injury or a fatality about one-quarter of the time, half involve moderate injury while another quarter involve slight or no injury. Virtually all of the accidents occur during daylight on a dry two-lane roadway. The majority of the noncomplying motorists approached the school bus from the rear; only about a fourth were found to be approaching from the front of the bus.

The behavior study found that motorists were more likely to pass a stopped bus in an intersection. Nearly one-half of the illegal passing behavior occurred at intersections which represent only one-quarter of the school bus stops. Since about one-third of the accidents occur at intersections, it appears that intersection bus stops are slightly more hazardous than midblock bus stops, based on the frequency of occurrence. It is believed that many of the intersection school bus accidents could be prevented by moving the bus stop to the far side of the intersection.

The final data element that showed some interesting trends was the accident topology. The accidents were divided into accident types or groups that were defined by the direction of approach of the vehicle (from the front or from the rear of the school bus) and by the direction of travel of the school bus passenger (getting on the bus or getting off the bus). More than half of the accidents involved the striking vehicle approaching the bus from the rear, passing on the left and striking the pedestrian as he/she leaves the bus and crosses in front of it. Another 15 percent of the accidents also involve a passenger leaving the bus and crossing in front of it, but these pedestrians are struck by a vehicle approaching from the front of the bus. Only about 10 percent of the accidents involve pedestrians who are in the process of getting on the bus.

The accident-based analysis of the school bus signal compliance problem suggests that two potential problem areas should be addressed:

- To increase pedestrian safety at school bus stops located at intersections, consideration should be given to locating the bus stop at the far side of the intersection; i.e., the bus would stop after it has passed through the intersection.
- The majority of the accidents happen when passengers are leaving the bus. Bus drivers should not discharge passengers until they are certain that all approaching vehicles are stopping.

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the project and presents the conclusions that have been reached. Some general conclusions about motorist compliance as well as some specific conclusions about each traffic device or law that was studied are reported.

A. Summary and Conclusions

Is there a motorist compliance problem? The answer to this question depends on one's perspective.

The literature review and contacts made during the first phase of this project indicated the common opinion from public officials and practitioners that increasingly drivers are failing to obey traffic signals and signs. The collective memory seems to recall a past when there was more respect for traffic control devices. There is, however, little historical information regarding violation rates for different TCDs and therefore few ways to determine if violation rates have been increasing. The absence of quantitative information seems to contradict the notion that motorist noncompliance is a serious and growing problem.

A review of previous research on driver behavior at STOP signs (table 55), shows a progressive rise in the level of motorist violations up to 1977 with a drop found as a result of this research.[20] The apparent progressive rise in noncompliance can in part be attributed to changes in automotive technology (i.e., synchromesh transmissions). It is also likely that differences in study procedures contributed to the increasing trend. These factors would suggest that there has not been a dramatic change in "driving morality."

More confidence can be expressed in the more recent studies summarized in table 26 (Chapter III), which show 64.4 percent of the drivers making a right turn on red without stopping.[26] In this study it was found that 61.3 percent of the motorists making a right turn on red did not stop. Since this study utilized procedures from the previous major study, the results of these studies can be compared with much more confidence. In the intervening 10 years between the data collection periods of these two studies cited in table 26, there is no significant difference in the levels of motorist noncompliance.

Attitudinal surveys conducted as part of this research clearly indicate that noncompliance occurs and in some cases it occurs frequently. The survey also indicated that some motorists, the so-called chronic violator, are less inclined to comply to traffic control devices and laws. The survey asked motorists for the reasons they do not comply. A major reason was found to be the motorists assessment of the "reasonableness" of a traffic control device. Reasonableness is doubted when the traffic control appears to be overly restrictive, not functioning, or poorly placed. Motorists assess the safety risks while in the process of deciding whether or not to comply. The chance of being caught by the police is also considered, but this seems to be a secondary concern to the perceived reasonableness of the traffic control.

Table 55. Summary of previous STOP sign compliance study findings.

Researcher	Year	Percent of Vehicles Making Full Stop	Violation
Morrison	1931	47	53
Fisher	1935	45	55
Elliot	1935	38	62
Hanson	1960	20	80
Leisch	1963	17	83
Beaubein	1976	22	78
Dyer	1977	12	88
CAR/FHWA	1988	33	67

The selection of the devices to be studied in this research was done subjectively. An objective decision could not be made because of a lack of compliance measurements. A futile attempt was also made to use accident and summons information as surrogates for measuring noncompliance. The available national, State, and local databases reviewed were not set up to yield conclusive categorizations (e.g., "speed too fast for conditions" or "failed to yield right-of-way") relative to compliance. On the basis of professional expertise and the interest in avoiding duplication with other projects, six traffic control devices or laws were ultimately chosen for in-depth study.

The behavioral studies conducted as part of this project involved collecting compliance and other data at a large number of sites over extended periods of time. Hundreds of thousands of motorists were observed in the process. The clear conclusion was that motorist noncompliance does take place. The frequency of the noncompliance behavior depends on the nature of the noncompliant act and the traffic conditions. Whether acts of noncompliance can be construed as a problem cannot be ascertained. The relative frequency of conflicts (a surrogate measure of accidents) resulting from noncompliance was very low. These low levels are attributed to the motorists' assessing the reasonableness of failing to comply. It appears that the majority of drivers correctly assess risk and act prudently.

Compliance behavior was observed at locations believed to have a compliance problem. Few significant differences were noted between driver behavior at "problem" locations and "typical" locations. In a comparison of behaviors that resulted in vehicle conflicts at experimental and control locations, there were even fewer differences.

A panel of experts assessed the findings of the initial phases of the project and developed practical means to address motorist noncompliance. After thorough discussion of the selected problems and the identification of potential countermeasures, a set of practical countermeasures was identified. The last phase of this research focused on further investigations of motorist compliance to assess the practicality of the countermeasures. The conclusions drawn from these investigations are reflected in the recommendations made in the next section.

The compliance situation was summarized in a Highway Research Board paper presented by Burton Marsh in 1930:[50]

> The status of traffic law observance in any community is definitely related to a number of ... factors. Important among these factors are:
> 1. Reasonableness of traffic rules and regulations. It is well known that good observance can only be expected for regulations which are generally deemed sensible, necessary and reasonable. They should also be as simple and as few in number as possible. The Uniform Vehicle Code and the Model Traffic Ordinance constitute valuable guides to states and municipalities in setting up reasonable regulations.
> 2. Effective and sensible signs, signals and markings, wisely used.
> 3. Adequate public understanding and appreciation of traffic regulations, of the reasons for them, of results to be accomplished, and of methods of proper observance.
> 4. Uniform, impartial and business-like enforcement.
>
> To enforce traffic laws is to compel obedience of them. The fact that so much compulsion seems necessary is a clear indication of serious deficiency in one or more of the first three factors presented above. Thus, although enforcement should only be necessary for a small perverse minority, it is all too much invoked for large proportions .... The really needed steps to reduce violations are the effective promulgation of reasonable regulations and the education of the public as to the saneness, necessity and value of them and as to how the individual is expected to act in compliance with the said laws.

These words are still true today. In general, motorist noncompliance is indicative of a problem. The problem may be due to some failing on the part of the traffic engineers or a lack of understanding by the driver, but seldom is the problem a wanton disregard of the law by the motoring public. In light of this and the other conclusions reached, the following recommendations are made.

B. Recommendations for Improved Practice

The ultimate purpose of research is to provide information or tools for use by practitioners to enhance their efforts in maintaining a safe and efficient roadway network. The following general recommendations to improve efforts to implement traffic control devices and laws are made:

- Engineering.
  - -- Be cognizant of the changing traffic system; traffic volumes, traffic characteristics, and the condition of TCDs.
  - -- Consistently apply TCDs to assure that they command respect.
  - -- Compile compliance data to develop thresholds for determining when noncompliance rates are higher than acceptable.

- Enforcement.
  - -- Target enforcement to high accident locations.
  - -- Strive to have uniform enforcement policies (e.g., tolerances).

- -- Compile data for monitoring compliance levels and accidents.

- Education.
  - -- Educate drivers about how and why the traffic system functions as it does.
  - -- Provide continual reinforcement to motorists of the need to comply.

These general recommendations follow the traditional practices of addressing traffic control needs from a multidisciplined approach involving engineering, enforcement, and education. A similar orientation was used to outline recommendations for the specific noncompliance problems studied.

<u>Running the Red Indications at Traffic Signals</u>

- Engineering.
  - -- Improve loop surveillance and maintenance for all actuated and semiactuated signals.
  - -- Convert low-volume intersection controllers from fixed time to semiactuated.
  - -- Interconnect signals.
  - -- Improve network through green band.
  - -- Install large cross-street name signs with block numbers.
  - -- Adjust yellow times and consider use of an all-red phase.
  - -- Remove unwarranted signals.
  - -- Check and improve signal visibility.

- Enforcement.
  - -- Consider the use of photographic surveillance systems, if current pilot programs show them to be effective.
  - -- Implement enforcement activities at specific locations when noncompliance exceeds threshold levels.

- Education.
  - -- Educate drivers about the meaning of traffic signal displays such as protected/permissive indications.
  - -- Develop public information campaigns about compliance to signals.

<u>Improper Right Turn On Red at Traffic Signals</u>

- Engineering.
  - -- Convert the law from RTORAS to RTORAY.
  - -- Use supplemental signing to minimize RTOR prohibitions to only those times when it is needed.

- Enforcement.
  - -- Implement enforcement on a selected basis when noncompliance exceeds threshold values or site features dictate.

- Education.
  - -- Educate new drivers about the entire RTOR concept, especially the danger to pedestrians and bicyclists.
  - -- Educate pedestrians and bicyclists about the dangers of vehicles turning right on red.

Failing to Come to a Complete Stop at STOP Signs

- Engineering.
  - -- Develop and apply a volume- and sight-line-based set of warrants for the placement and/or removal of STOP signs.
  - -- Assess STOP-controlled intersections for unusual features which may contribute to safety problems when noncompliance takes place.

- Enforcement.
  - -- Implement enforcement on a selected basis when noncompliance exceeds threshold values or site features dictate.

- Education.
  - -- Develop information regarding the safety, energy and environmental benefits of STOP sign removal to counter adverse community reaction.

Violating No Left Turn Restrictions or Prohibitions

- Engineering.
  - -- Educate engineers to eliminate or reduce unnecessary left-turn restrictions.
  - -- Develop warrants to give guidance in the elimination or reduction of left-turn restrictions.
  - -- Reassess sign size and placement at problem locations.

- Education.
  - -- Educate drivers about operational, not just safety, issues in training courses and handbooks.
  - -- Emphasize better pre-trip planning to reduce confusion while driving.

Exceeding Advisory Curve Speeds

- Engineering.
  - -- Develop criteria for uniformity of application.
  - -- Check applicability of posted speeds to existing geometric conditions at problem (i.e., high accident) locations.
  - -- Assess the need to revise criterion for determining curve speeds.
  - -- Do not routinely lower the advisory speed in response to accidents. Consider other potential treatments: chevrons, large arrow signs, post-mounted delineators, raised pavement markers, etc. Unnecessarily low advisory speeds are not obeyed and they adversly affect the credibility of other posted speeds.

- Education.
  - -- Educate drivers about how curve speeds are set, and how appropriate speeds may be different under different conditions (e.g., wet/dry; car/truck/motorcycle).
  - -- Educate drivers about the curve/turn series of signs (W1-1 to 5, MUTCD).

Violating Stopped School Bus Laws

- Engineering.
  - -- Cooperate with enforcement and pupil transportation officials in locating bus routes and stops, including location of off-road stops, signing, etc. At intersection locations where motorist noncompliance is a problem, consideration should be given to locating the bus stop on the far side of the intersection. When possible, bus routes should also be designed to minimize the number of passengers that must cross the street after unloading.
  - -- Develop warrants/guidelines for standard safety equipment and operational practices, especially procedures to increase safety of passengers after they leave the bus and are crossing the road.

- Enforcement.
  - -- Target afternoon periods for enforcement when noncompliance and hazard are the highest.

- Education.
  - -- Educate the public about the equipment and operating practices of school buses.

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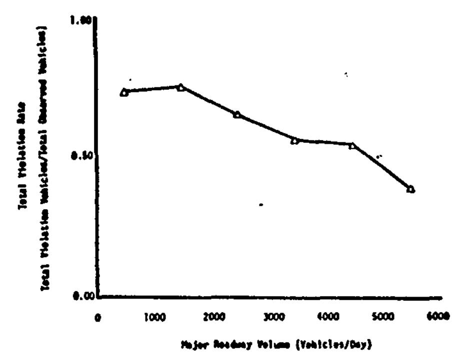
APPENDIX A - MOTORIST NONCOMPLIANCE SUMMARY

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R1-1, STOP	AASHTO Survey (California) - Disregard for STOP manifested as "rolling stop." Stops are regularly placed as speed control; placement has nothing to do with MUTCD warrants. AASHTO Survey (Colorado) - Numerous 4-way STOPS that are unjustified or unreasonable to the driver breed disregard and disrespect. AASHTO Survey (Illinois) - Rolling stops are relatively common, but the more serious problem may be confusion of 2-way STOPS with 4-way STOPS. This is inadvertent rather than deliberate. AASHTO Survey (Michigan) - Use of STOP signs for speed control are a cause for disrespect for all TCDs. When motorists do not believe restrictions are necessary, they tend to violated the STOP signs. AASHTO Survey (Minnesota) - STOP signs installed under political warrants are frequently violated. AASHTO Survey (Ohio) - STOP sign respect may be declining because of the misuse of this device for speed control or for railroad crossings. AASHTO Survey (Oregon) - Unwarranted STOP signs and multiway STOPS create disrespect. AASHTO Survey (Pennsylvania) - Many of the areas within cities and other residential districts are becoming so proliferated with STOP signs that a very small percentage of approaching traffic actually stops. This tendency seems to increase yearly.	Beaubien (1976) -- In a suburban area where stop signs were used for speed control, only 24 percent of the vehicles observed (N=275) at five different intersection legs came to a full stop. Beaubien (1986) -- In repeating the above referenced study, compliance rates had further degraded in the intervening 10-year period. The results showed: Drivers Coming to a Full-Stop (%) — 1975 / 1985 Intersection #1 — 25 / 13 Intersection #2 — 51 / 21 Intersection #3 — 26 / 16 Mounce (1981) -- In a study of low volume roads, the violation rate was related to cross street volume as shown in the figure below:  	

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R1-1, STOP	AASHTO Survey (Wyoming) - The "California Stop" is a continuing problem. Police Contacts (North Dakota - State) - STOP signs are not necessary at some locations. They are typically violated in light traffic areas or areas where enforcement is light. STOP sign violations are often manifested as "Failure to Yield" accidents. Police Contacts (Ohio - State) - Motorists try to save time by violating STOP signs at locations where long-sight distances let them feel safe in disregarding the device. Police Contacts (Oregon - State) - In an unfamiliar area, motorists may "miss" a STOP sign; or in a familiar area, they disregard the sign. Police Contacts (Virginia - State) - Drivers are inattentive and in a hurry. Police Contacts (Florida - County) - Inattention and intoxication play a role in the non-compliance problem. Police Contacts (Illinois - Local) - Motorists violating this device are "in a hurry." Police Contacts (Illinois - Local) - Motorists observe that no one else stops and that rolling stops are condoned. Police Contacts (Illinois - Local) - Motorists claim to be in a hurry. They say that they did not see the sign. Inattentive and intoxicated drivers contribute to the problem here. Police Contacts (Illinois - Local) - Drivers have a low perception of risk when they violate this device.	Stockton et al. (1981) - The authors provided this historical perspective of STOP sign compliance.	

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R1-1, STOP	Police Contacts (Virginia - Local) - Rolling stops in light traffic is the bulk of the problem.		
	User Groups (AAA - So. CA) - Motorists consider some of the devices unwarranted. Enforcement is sparse.		
R1-2, YIELD	AASHTO Survey (Pennsylvania) - We usually get several letters a year discussing drivers' complete disregard of Yield signs, in particular those installed on freeway on-ramps that have substandard acceleration lanes.		
	Police Contacts (North Dakota - State) - Yield signs are not necessary at some locations. They are typically violated in light traffic areas or areas where enforcement is light. Yield sign violations are often manifested as "Failure to Yield" accidents.		
	Police Contacts (Florida - County) - Inattention and intoxication play a role in the non-compliance problem.		
	Police Contacts (Illinois - Local) - This device is violated when no other traffic is in sight.		
	Police Contacts (Illinois - Local) - Driver inattention contributes to the problem.		
R2-1, 55 mi/h SPEED LIMIT	AASHTO Survey (Arkansas) - Disrespect for the 55 mi/h speed limit may cause disrespect for other speed limits.		
	AASHTO Survey (California) - A lack of moral belief helps to convince the public that a 55 mi/h speed limit is not appropriate under all circumstances.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R2-1, 55 mi/h SPEED LIMIT	AASHTO Survey (Colorado) - A 55 mi/h speed limit on a rural interstate is a TCD that is not obvious, not justified, and unreasonable to the driver; it breeds disrespect. AASHTO Survey (Illinois) - 55 mi/h speed limit on rural interstates makes compliance and respect for many speed limits very poor. The enforcement/judicial tolerances exercised also add to the problem. AASHTO Survey (Indiana) - With the advent of the 55 mi/h speed limit, speeds were reduced and driver respect for the law and its intent (to save energy), along with the sudden impact of gas shortages and price increases, were high. As the immediacy of these needs subsided, the speeds began to creep up. The public is aware of the tolerance given by the enforcement and judicial systems. AASHTO Survey (Iowa) - Approximately 50% of the drivers do not observe the 55 mi/h speed limit and many go to considerable expense to do so (i.e., use CB radios and/or radar detectors). AASHTO Survey (Michigan) - Blatant violation of this law on freeways maybe creating trends that lead to increasing disrespect for all TCDs. AASHTO Survey (Minnesota) - There is consistent violation of the 55 mi/h speed limit on rural interstate roads in Minnesota. This is not surprising in light of the design features and free-flowing traffic volumes of these roads.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R2-1, 55 mi/h SPEED LIMIT	AASHTO Survey (Nebraska) - There is low regard for the 55 mi/h speed limit. In Nebraska, a driver exceeding the speed limit on the interstate by no more than 10 mi/h is fined only $10, with no court costs and no loss of points. Drivers have stated that it is worth the possible $10 fine to be able to drive at at 65 mi/h. AASHTO Survey (New Mexico) - The national declaration of 55 mi/h, and its continuance, has brought realization to the public that regulations can be political and arbitrary; therefore, other devices are meaningless if compliance is slightly restrictive. AASHTO Survey (New York) - There is a growing feeling that the 55 mi/h speed limit is responsible for much of the erosion of respect for TCDs. We seem to be acknowledging to motorists that a violation rate of 60% or more is tolerable. AASHTO Survey (Ohio) - Highway speeds are exceeding the maximum speed limit by an ever-increasing margin. AASHTO Survey (Oklahoma) - The 55 mi/h speed limit is encouraging disrespect for TCDs. The large percentage of motorists exceeding the 55 mi/h speed limit show that this is an unreasonable law (in the eyes of the public) and is not being respected or obeyed by the motorists. AASHTO Survey (Oregon) - Unrealistic posted speeds create disrespect.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R2-1, 55 mi/h SPEED LIMIT	AASHTO Survey (Pennsylvania) - Our observations in driving interstate and other freeways have indicated that a large percentage of traffic is at least 10 to 15 mi/h over the 55 mi/h speed limit. We think this is due to the lack of enforcement and the 10+mi/h grace given by many police. We have also been told that some District Justices in our state automatically dismiss speeding citations unless they are more than 10 mi/h over the speed limit. AASHTO Survey (South Carolina) - The 55 mi/h National speed limit isn't enforced (at least not in the majority of states I've traveled) to any measurable extent, and the motorists simply view it as unrealistic for whatever reason. It may well be that this disrespectful attitude has spread from this source to all aspects of traffic regulation. My personal feeling is that we should raise the speed limit on select roads (perhaps rural freeways) but that won't necessarily change the attitudes that have developed. AASHTO Survey (Washington) - Speed study statistics indicate that motorists are increasingly exceeding the national 55 mi/h speed limit. Motorists are apparently less willing to accept the criteria that resulted in the establishment of this speed limit. Likewise if a motorist's perception of roadway and traffic conditions does not coincide with a lower regulatory speed limit, the speed limit will probably be exceeded by many unless enforcement is emphasized.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R2-1, SPEED LIMIT (<55 mi/h)	AASHTO Survey (Arkansas) - See 55 mi/h speed limit. AASHTO Survey (California) - Engineers may have to balance engineering judgment against political pressure in placing speed limits that have little to do with motorists' basic safe driving practice. AASHTO Survey (Illinois) - See 55 mi/h speed limit. In Construction and Maintenance (C&M) areas, these signs do not have the respect of most motorists and are therefore generally ignored. School speed limits <25 mi/h are not considered reasonable by most motorists and are not respected or observed. AASHTO Survey (Iowa) - Many speed limits are set too low by local officials making violators out of otherwise law-abiding citizens. AASHTO Survey (Maine) - Compliance for Construction and Maintenance (C&M) speed reductions is not great. Speed compliance seems better when the presence of workers and equipment relative to the roadway makes the motorists aware that a speed change is necessary. AASHTO Survey (Minnesota) - Lower speed limits (<55 mi/h) are violated on a fairly regular basis. Many motorists drive in the left lane at reduced speeds. AASHTO Survey (Nebraska) - Low regard for speed limits on residential streets. AASHTO Survey (North Dakota) - Some speed limits are unrealistic, which leads to noncompliance. AASHTO Survey (Oregon) - Unrealistic speeds create disrespect.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R2-1, SPEED LIMIT (<55 mi/h)	AASHTO Survey (Texas) - See Non-TCD. Police Contacts (North Dakota - State) - Motorists are unwilling to accept lower speed limits. They typically violate the speed limit in open rural areas with light traffic or in congested traffic keeping up with a high speed flow. Speeds too fast for conditions can cause safety problems. Police Contacts (Florida - County) - Motorists are often in a hurry, trying to make up for lost time. Police Contacts (Georgia - County) - There is a consensus that if everyone exceeds the limit by a small margin, the risk of any individual being singled out is minimal. Police Contacts (Maryland - County) - Most motorists do not believe that they will get caught speeding. User Groups (AAA - So. CA) - Unrealistically low limits with excessive tolerances and sparse enforcement are a cause of the problem here. User Groups (HUFSAM) - Motorists do not consider the regulation valid or believe it is strictly enforced.		
R3-1,2,4; LEFT/RIGHT/ U-TURN PROHIBITION	AASHTO Survey (California) - Noncompliance may be caused by lack of understanding. Also, these devices are often placed for the political expediency of restricting through traffic. If a street is designed as a collector, it is difficult to expect that a sign and/or pavement marking will divert traffic.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R3-1,2,4; LEFT/RIGHT/ U-TURN PROHIBITION	Police Contacts (Oregon - State) - Motorists are often confused by their traffic situation when they violate this sign. Others violate these signs because they are in a hurry and want to find a short cut. Police Contacts (Florida - County) - Motorists are lost or in a hurry and they do not want to drive any further to turn around. Police Contacts (Maryland - County) - Motorists are usually looking for an address or location and will ignore a sign to make a needed turn. Police Contacts (Illinois - Local) - In urban areas, motorists will violate these devices to get to an open parking space. Police Contacts (Illinois - Local) - Motorists claim they did not see the sign or they were in a hurry. Police Contacts (Virginia - Local) - Motorists violate these devices as a matter of convenience. User Groups (AAA - So. CA) - Comprehension problems and sparse sporadic enforcement play a role here. Non-uniform posting at cluttered signalized intersections may be a factor in failure to observe these signs.		
R3-11, PREFERENTIAL LANE	AASHTO Survey (Minnesota) - Heavy violation of the ramp meter bypass for buses and carpools (cars using the bypass lane have less than three people).		
R4-7,8; KEEP RIGHT/ LEFT	AASHTO Survey (California) - Noncompliance may be caused by lack of understanding.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
R10-11a, NO TURN ON RED	AASHTO Survey (Minnesota) - Note increased violations of NTOR signs. Overuse of NTOR signs may cause problem with this device. Police Contacts (Illinois - Local) - Motorists claim that they did not see the sign. Violation of this device often leads to pedestrian-vehicle accidents. Police Contacts (Illinois - Local) - From habit, motorists assume they can turn on red at all intersections.		
R10-12, LEFT TURN YIELD ON GREEN O	Police Contacts (Virginia - Local) - Motorists do not understand the Yield on Green concept.		
R11-1, KEEP OFF MEDIAN	Police Contacts (Illinois - Local) - When drivers miss an exit, they will violate this device rather than drive to the next exit.		
RIGHT TURN ON RED OPERATIONS	AASHTO Survey (Indiana) - The coining of RTOR changed a long-standing rule of the road: no movement on red. While there are very strict guidelines as to when this movement on red is permitted, these guidelines are frequently disregarded. AASHTO Survey (Iowa) - Not very many motorists come to a complete stop as required by law.	Baumgaertner (1981) -- Sixty-four percent (64%) of vehicles observed (N=4,910) did not come to a full stop before turning right on red. Two percent (2%) of the vehicles observed not coming to a full stop did so unsafely. During the 1-year period in which the study was conducted, the percentage of nonstoppers rose from 47% to 70%	

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
RIGHT TURN ON RED OPERATIONS	AASHTO Survey (Nebraska) - Drivers are not stopping before making the right turn on red movement. Unless cross traffic is heavy, most drivers are making a "rolling stop." Several instances have been noted where drivers will make a right turn on red when traffic is approaching, such that the approaching vehicle must reduce speed because of the slow moving right turn on red driver. AASHTO Survey (New York) - The "after stopping" provision of the RTOR law is often not observed by motorists. AASHTO Survey (Pennsylvania) - Our observations have found that very few drivers actually stop prior to making a "turn on red" unless forced way. The majority of drivers tend to drive through a "red signal" indication when making right turns similar to the way a Yield sign should be used. We are also of the opinion that the failure to stop before making a turn on red is a traffic violation that is seldom, if ever, enforced. AASHTO Survey (South Carolina) - RTOR violations are an obvious area of noncompliance. Police Contacts (Virginia - State) - Motorists are in a hurry. Time, or lack of it, erodes the intent of the law. Violations take place on frequently traveled urban roads. Police Contacts (Maryland - County) - Motorists are lazy in this situation and do not want to come to a complete stop.	He compares these results with those found in a Virginia Highway Research Council study using similar procedures. In a study of 15 locations 1-month after the advent of RTORAS, the compliance rate was found to be 3%. In a study of 13 locations where RTORAS had been allowed for a year or more, the rate was found to be 9%. Gordon (1987) -- This study found that 7.6 percent of right turning vehicles at 12 intersections do not come to a full stop before turning right on red.	

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
RIGHT TURN ON RED OPERATIONS	Police Contacts (Virginia - Local) - Motorists typically violate the stop portion of this device in areas with light traffic where they have an unobstructed view.		
WRONG WAY DRIVING	Police Contacts (Oregon - State) - Inattentive, intoxicated and elderly drivers all contribute to this problem. Police Contacts (Maryland - County) - This would occur when a motorist is not paying attention or in an unfamiliar area. User Groups (AAA - So. CA) - The Do Not Enter "meatball" and One Way signs do not adequately emphasize the severity of the potential hazard. User Groups (HUFSAM) - Motorists believe the regulation is valid, but they think other motorists will be the ones caught.		
W SERIES, WARNING SIGNS	Police Contacts (North Dakota - State) - Motorists often do not believe these signs. They may not be necessary at some locations. They are typically violated in light traffic areas or areas where enforcement is light. Violations of these signs are often manifested as "speed too fast for conditions" accidents.		
W4-2, LANE REDUCTION TRANSITION	AASHTO Survey (Ohio) - In C&M applications, drivers are not responding to this sign as well as they should be. The practice of staying in the closed lane until the lane closure taper forces the driver to change lanes, seems to be increasing.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
W13-1, ADVISORY SPEED PLATES	AASHTO Survey (Illinois) - These plates do not have the motorists' confidence because of their improper usage. In C&M areas, these signs don't have the respect of most motorists and are therefore generally ignored.		
	AASHTO Survey (Michigan) - The inconsistency in signing the advisory speeds for curves causes many problems around the country.		
	AASHTO Survey (Ohio) - Advisory speed plates for many years have been experiencing mixed reaction. In C&M situations, they are ineffective in many applications. They are not receiving as much respect as they should at horizontal curves.		
	AASHTO Survey (South Carolina) - Unrealistically low postings are culprits on advisory speeds.		
	AASHTO Survey (Utah) - These signs have long lacked credibility. Everyone knows you can make a curve at least 10 mi/h faster than the sign advises. The problems lie with the 1 to 2% which are advised realistically.		
	Police Contacts (Virginia - State) - Motorists' inability to "read" the road and weather conditions often cause problems.		
PAVEMENT MARKINGS (GENERAL)	Police Contacts (Virginia - State) - Drivers are inattentive, which promotes poor driving habits.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
LANE MARKINGS	Police Contacts (Ohio - State) - Inattention and intoxication contribute to this problem.		
	Police Contacts (Illinois - Local) - Motorists violate these devices because they claim they did not observe the markings.		
	Police Contacts (Virginia - Local) - Congestion contributes to the problem here. Motorists use turn lanes for through movements, when through lanes are backed up.		
NO PASSING ZONE MARKINGS	AASHTO Survey (Illinois) - Part of the passing maneuvers performed within the No Passing Zone.		Weaver and Wards (1978) -- 3% to 4% of the annual accident toll is passing related.
	AASHTO Survey (Ohio) - Passing within No Passing Zones appears to be more frequent now.		
	Police Contacts (Ohio - State) - Motorists in a hurry are part of the problem here. Drivers unfamiliar with the area also contribute to this problem.		
	Police Contacts (Oregon - State) - Motorists are in a hurry and anxious to pass a slower vehicle.		
	Police Contacts (Illinois - Local) - Motorists who violate these markings often claim to be in a hurry.		
	Police Contacts (Illinois - Local) - Motorists fail to weigh the consequences of this reckless behavior.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
SIGNALS	AASHTO Survey (California) - Longer cycle length may lead to more frequent violation of the yellow vehicle change interval. AASHTO Survey (Colorado) - Unwarranted signals place controls on the driver which are not justified, not obvious to the driver, or unreasonable and thus breed disrespect and disregard. AASHTO Survey (Illinois) - Lack of understanding of special signal messages causes compliance problems. Perhaps the new "Left Turn Yield on Green" will standardize that message. It appears that many motorists do not understand Protected/Permissive Turn Indications. Red Arrows are not understood by motorists, and therefore do not have the confidence of many motorists. AASHTO Survey (Iowa) - The yellow interval is often considered by the motorists as part of the green interval with many instances where the movements then spill over into the red interval. This is sometimes the product of poorly designed or ineffeciently operated signal systems. AASHTO Survey (Michigan) - Poorly timed signals, improper spacing which prevents traffic progression, lack of interconnection, lack of warranting criteria for signal placement, lack of or improper flasher schedules all contribute to the lack of respect and consequently greater violation of traffic signals. AASHTO Survey (Minnesota) - There is increased violation of left turn signals.	Hulscher et al. (1981) -- This Australian study showed an increase of 72% in a 4-year period of issuance of "disobeyance of traffic control light" summons. Gordon (1987) -- This study found that 0.52% of the left turning and straight vehicles at 12 intersections ran the red indication.	Hulscher et al. (1981) -- This study found the rate of "disobey traffic light" legal actions in intersection crashes rose from 1.6% in 1976 to 2.3% in 1979. (Total number of accidents each year approximately equal to 50,000.)

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
SIGNALS	AASHTO Survey (Nebraska) - There has been an increasing tendency for drivers to proceed through a signalized intersection on a yellow signal, or the beginning of a red signal. In numerous situations, there would have been adequate time for the driver to stop before entering the intersection. AASHTO Survey (New York) - Some traffic signal problems are due to motorist confusion caused by overly complicated signal displays. Red and green turn arrows are misunderstood by many motorists. AASHTO Survey (Oklahoma) - People don't understand flashing yellow operation. A large percentage of motorists stop at a flashing yellow signal creating a hazardous condition. Conversely, motorists stopping at the flashing red pull out in front of the other motorists, assuming the other (flashing yellow) motorists will stop. Motorists do not understand the protective/permissive green signal operation and will stop after the protective phase and not proceed on the green ball. Motorists are violating the yellow signal and even the red on a wide scale, speeding up when the yellow comes on and many times will pass through the intersection on red. This is due partially to lack of enforcement and is encouraged by too long yellow phases. AASHTO Survey (Oregon) - Unresponsive and uncoordinated signals are major culprits. AASHTO Survey (Pennsylvania) - We have noticed a larger number of vehicles that accelerate when the vehicle change interval is displayed. AASHTO Survey (South Carolina) - Long signal cycles seem to aggravate "running the red."		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
SIGNALS	AASHTO Survey (Texas) - An acute compliance problem is the increasing number of motorists who try to clear the intersection rather than stopping during the clearance phase of traffic signals. Time is becoming more important to motorists and they are more willing to take chances for the gain of a few minutes. Overly long signal cycles promote this chance taking since the perceived rewards are greater. AASHTO Survey (Washington) - Improperly timed traffic signals or signals that have long cycle lengths lead to increased violations, as do improperly maintained traffic signals or other devices. Police Contacts (Ohio - State) - Traffic signals with long yellow intervals create problems. Motorists violate as a time-saving measure. Police Contacts (Oregon - State) - Motorists try to beat the signal when it is changing from yellow to red. Police Contacts (Virginia - State) - Drivers are inattentive and in a hurry. Police Contacts (Florida - County) - Inattention and intoxication play a role in the non-compliance problem. Police Contacts (Maryland - County) - Motorists are often going too fast approaching an intersection and do not want to stop and be delayed. Police Contacts (Illinois - Local) - Motorists violate these devices because they are "in a hurry."		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
SIGNALS	Police Contacts (Illinois - Local) - Motorists all claim the light is yellow, but in reality they are all in a hurry.		
	Police Contacts (Illinois - Local) - Motorists that are inattentive, intoxicated, or in a hurry contribute to the problem here.		
	Police Contacts (Illinois - Local) - There is considerable tolerance of violations of this device by law enforcement agencies.		
	User Groups (AAA - So. CA) - Motorists stretch the yellow and use the all red phase for late entry. Failure to understand subtle phasing and complex displays are also part of the problem. Violations occur during low volume hours at high speed isolated intersections.		
PEDESTRIAN SIGNALS	AASHTO Survey (Illinois) - The flashing indications are not understood by many pedestrians.		
	AASHTO Survey (New York) - Many joggers and bicyclists stop for red indications only when cross-traffic poses an obvious hazard. The flashing "walk" indication is misunderstood by many pedestrians.		
	AASHTO Survey (Oklahoma) - Pedestrians have no understanding at all for the flashing Walk and Don't Walk.		
PEDESTRIAN OPERATIONS	AASHTO Survey (Minnesota) - Drivers repeatedly fail to yield to pedestrians in crosswalks but this is seldom enforced.		
	AASHTO Survey (Nebraska) - Drivers do not stop for pedestrians crossing a street or highway when the pedestrian is in an established crosswalk.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
PEDESTRIAN OPERATIONS	Police Contacts (Illinois - Local) - Violations regarding crosswalks are seldom enforced. There is minimal risk to the motorist. User Groups (AAA - So. CA) - Motorists fail to see and heed advance signing and crosswalk markings. Infrequent, sporadic, unexpected use by pedestrians contributes to the problem as well.		
S3-1, SCHOOL BUS STOP AHEAD & RELATED OPERATIONS	AASHTO Survey (Nebraska) - There is a higher incidence of passing loading/unloading school buses. AASHTO Survey (North Dakota) - School bus loading and unloading are problems. AASHTO Survey (Ohio) - School Bus Stop Ahead Signs are routinely ignored. Police Contacts (Ohio - State) - Motorists pass stopped school buses as a time-saving measure.	Henrico County Public Schools (1987). An internal study showed that for the 1986-87 school year, each bus in the fleet will be passed an average of 1.25 times per day. Prior to the use of stop arms (1980-81 school year), the year violation total was estimated at 120,000. Using the 1986-87 data, total violations for the year were expected to exceed 52,000.	
RAILROAD-HIGHWAY GRADE CROSSINGS	AASHTO Survey (Illinois) - Many motorists seem to question the credibility of signals (and to some extent even gates) and do not properly observe them. This is not the fault of the device (contrary to the opinion of some railroad people who would "solve" the problem by using intersection type signals) but the credibility of when the device is activated and consequence involved (waiting for a long train to pass rather than an intersection signal cycle). Police Contacts (North Dakota - State) - Drivers feel they can beat the train across the crossing. These TCDs are typically violated in light traffic areas or areas where enforcement is light.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
RAILROAD-HIGHWAY GRADE CROSSINGS	Police Contacts (Ohio - State) - Motorists violate at these locations as a time-saving measure. Police Contacts (Florida - County) - Motorists feel they can beat the train across the crossing. Police Contacts (Illinois - Local) - Motorists violate this device when the train is not in sight. Police Contacts (Illinois - Local) - Violations are not enforced. The perception of risk is minimized by successful violations.		
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (California) - Impairment; don't understand the TCD; lack of moral belief; specifically 55 mi/h. AASHTO Survey (Illinois) - The overuse of warning signs for conditions that the motorist seldom sees (e.g., Deer Crossing, School Bus Stop, Deaf Children) erodes the motorists' respect for this class of sign. C&M signs are so frequently displayed when not appropriate they do not have the respect of motorists. AASHTO Survey (Indiana) - Acceptance of violation of the 55 mi/h speed limit law, because of the institutional tolerances, has caused the public to expect a similar tolerance regarding other TCDs. RTOR has caused a watering down of a long-standing rule of the road which is passed along to other TCDs. AASHTO Survey (Iowa) - People have become more impatient. Time is money and any decrease in travel time is to their benefit even if it involves violations of the law. Impairment is also a problem.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (Maine) - In C&M areas, motorist compliance is directly proportional to the amount of congestion on the roadway. Better to give motorists a logical sequence of signs than to surprise them with one sign. AASHTO Survey (Minnesota) - Drivers may perceive the violated laws/devices to be unfair or inefficient and have no qualms about violating them. A lack of respect for authority. A greater need for public education on the positive aspects of obedience to TCDs. A lack of trust or confidence in government. An interpretation of personal freedom being a right which is independent of what is good for all. General proliferation of traffic signs. A judicial and enforcement system oriented toward the letter of the law while human nature tends towards the spirit of the law. AASHTO Survey (Montana) - If a driver does not perceive a need, often he will choose to not obey the device. AASHTO Survey (Nebraska) - Nebraska requires that drivers' licenses be renewed every 4 years. The State Legislature recently dropped a requirement that a written examination be taken if a driver has not had any violations during the preceding 4 years. The written examination dealt primarily with the meaning of, and required response to, traffic control devices. Law enforcement agencies contend that they do not have the manpower to provide continued and concentrated enforcement efforts on what they consider minor problems, such as		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (Nebraska)(continued) - speed limits, "rolling" stops, etc. Some smaller communities indicate they do not have funding for law enforcement and, consequently, have no law enforcement except for occasional visits by the county sheriff. Police officers who are in smaller communities are reluctant to provide strict enforcement for problem areas such as speed limits and vehicles stopping for a pedestrian in a crosswalk, because they recognize that the majority of the citations issued will be to local citizens who pay their salary. Another factor could be a growing dissatisfaction with the traffic engineering profession. Citizens are, it seems, more demanding, and they frequently do not understand why they cannot have a specific traffic control device, such as a signal, four-way stop, left-turn phasing, or a reduced speed limit. Complaints are received from citizens when traffic control devices are installed or implemented. If they don't understand the reason for the control, they will probably have little respect for the control device. AASHTO Survey (New Mexico) - Rural and smaller jurisdictions have posted unwarranted devices and no other groups such as police or the judicial branch have criticized such actions. Traffic engineering professionals do not request or produce education news releases on new treatments, changes in National standards and alternative control for traffic. We have fallen short in presenting the educational facts of our professional judgments. Tort Liability and claims against previously sovereign states has the public aware that not all transportation decisions and treatments are solid, safe and optimum. Enforcement also contributes to compliance or respect. Action to correct capacity failures, system breakdowns and install such priority items as signals,		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (New Mexico)(continued) - extra lanes, etc. do not come quickly enough for citizens. Perhaps more funds to local transportation corridors would help in opinions. While we all srtive for uniformity and keep in mind the beatitudes, "should," "shall" and "may" of the MUTCD, some jurisdictions such as my own State Highway Department do not use stop bars; other cities and counties do not use "4-Way" or "All Way" panels on stop controls. Even the paint striping colors are misused for gores, islands and emphasis in urban areas. The public knows of these inconsistencies and therefore takes government lightly. AASHTO Survey (New York) - Many of the disobedience problems may be traced to a lack of conformance to the five basic requirements for a TCD listed in Part 1A-2 of the MUTCD. AASHTO Survey (Oklahoma) - Respect and compliance with traffic control devices is tied to: the general condition of the TCD, the level of enforcement, complexity of the device and the appropriateness or need for the device. AASHTO Survey (Oregon) - The magnitude of the problem varies by location and time in proportion to the driver's perception of the validity of the control. AASHTO Survey (Pennsylvania) - Disrespect for traffic control devices is growing due to misuse of devices, unreasonable restrictions, lack of enforcement and a failure of the court system to uphold traffic citations.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (Texas) - Although we have no factual data on which to base our conclusion, it is felt that motorists' compliance with traffic control devices is decreasing. We suggest the mandatory 55 mi/h speed limit is a major contributing factor since it encouraged a widespread disregard for speed limit signs. Once motorists found that they could disregard the 55 mi/h limit and do so safely, the credibility fo our control devices began to suffer. The same problems would hold true for other types of control devices imposed for political purposes rather than based on accepted traffic engineering principles. Motorists will generally comply with controls they perceive as needed or those where noncompliance will endanger them. When we reach the point where the only thing a motorist fears, when he deliberately ignores a regulatory traffic control device, is a citation, our profession is in trouble. AASHTO Survey (Utah) - Signing for construction and maintenance activities is difficult to deal with since these two disciplines are expected to interface with what traffic engineers feel is important. Signing represents dollars to the contractor and production time to the maintenance personnel; therefore, accurate reliable signing is hard to come by. Once the 30 mi/h construction speed limit sign, which is necessary during the day, is up, it stays, even though a speed reduction is not needed for off-peak night time travel. If a "Right Lane Closed Ahead" sign gets put out, it is an accomplishment even if it is in the middle of the right lane. Tort liability is emphasizing the need, but the coordination problem of accurate up-to-date signing remains a challenge.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (Washington) - Drivers still respect and follow devices that appear rational and give them information they need for the driving task, but when traffic control devices appear superfluous or unclear, they will not be respected or followed. Generally, people drive from their perception of the roadway and traffic environment. The fewer devices installed, with these devices identifying conditions to which the driver must respond rather than prescribing a solution, the greater will be their compliance. Temporary signing in construction zones also appears to be an area of noncompliance. Reduced speed limits in zones frequently do not appear realistic, especially during periods when there are no construction activities. Frequently, signs such as Flagger Ahead or Lane Reduction, are not turned, covered or removed during non-work periods. This leads to disrespect for these signs at these and other locations. AASHTO Survey (Wisconsin) - The profession has for a long time expounded the principle that overuse as well as misuse of signs can breed disregard. Possibly that maxim is now proving itself. If so, we should certainly attempt to deal with the problem before it becomes worse. AASHTO Survey (Wyoming) - It may be partially the traffic engineering profession's responsibility for not upgrading TCDs. Motorists dislike delay. Political warrants may be part of the problem, or public attitude toward government in general. Enforcement tolerances and plea bargaining add to the problem. C&M signs up when they are not needed. Poor maintainance.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	AASHTO Survey (District of Columbia) - With greater political influence of traffic engineering, the traffic control devices have been "cheapened." Stop signs, traffic signals and other traffic control devices are now considered to be a panacea for an ill-conceived and designed street network. I believe that most motorists are astute enough to recognize when and where there is a proper traffic control device and they obey those, whereas others they completely ignore. Over the years city and state budgets have been reduced in the area of traffic control device enforcement. Lastly, substantial effort needs to be directed towards the motorist. Driver Education exists mostly in the form of how to learn driving. A need exists to completely inform our new drivers of the importance of traffic control devices and the ramifications of non-observance. Better yet, if they were informed as to how and why traffic control devices exist and what procedures were taken to implement them would be useful. I would also like to point out that in order to obtain a driver's license in European countries, several years of part-time study coupled with demonstrated skills in highway and city driving is required. Police Contacts (North Dakota - State) - Motorist impatience plays a role in noncompliance behavior. Police Contacts (Georgia - County) - Motorists violate any TCD in the belief that the violation will not be detected by the law enforcement agency.		

Traffic Control Device	Non-Compliance Problem	Level of Non-Compliance	Consequence of Non-Compliance
NONSPECIFIC REASONS FOR NONCOMPLIANCE	DMV Contacts (Oregon) - Although the majority of the motoring public are law-abiding, drivers realize that when they see others violate laws and get away with these violations, their own driving habits tend to deteriorate to the point where they are also violating particular laws. User Groups (AAA - So. CA) - All TCDs, if used indiscriminately, pose unreasonable demands on the driving public. Symbol signs with obscure or subtle variations are unrecognized by a sizable segment of unsophisticated motorists. Improper application, over-use and misuse contribute to noncompliance problems.		

APPENDIX B - THE 1987 LAW ENFORCEMENT VIEWPOINT ON MOTORIST COMPLIANCE WITH TRAFFIC CONTROL DEVICES

Human Factors and Transportation Workshop
Washington, D.C.
January 11, 1987

THE 1987 LAW ENFORCEMENT VIEWPOINT ON
NON-COMPLIANCE WITH TRAFFIC CONTROL DEVICES

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I am once again happy to have this opportunity to represent the Nation's law enforcement community on this panel on non-compliance with traffic control devices. Since last year when I spoke to this group, I have more carefully observed both the actions of law enforcement and engineering representatives, and have had the opportunity to check statistical references regarding non-compliance to traffic control devices.

What I have found in the past year, is that enforcement of traffic control device violations is still not a glamour issue as far as law enforcement is concerned. Interest in this type of enforcement has probably diminished rather than strengthened due to increasing budget pressures on traffic law enforcement agencies as well as continuing pressures on the Nation's law enforcement agencies to curb crimes against property and persons. These problems are continually stressed in legislative sessions while there is no real hue and cry for traffic law enforcement efforts except in the areas of driving under the influence and the 55 MPH speed limit.

Law enforcement administrators themselves readily recognize the need for continued emphasis on driving under the influence enforcement. The Federal Highway Administration and the U.S. Congress make it impossible for state law enforcement officials to forget their responsibilities as far as enforcement of the 55 MPH speed limit.

In preparation for today's presentation, I reviewed "Accident Facts" published by the National Safety Council. This publication in 1974, under the heading of "Improper Driving," indicated that investigators reported that for total accidents, disregarding of stop signs accounted for 2.5%, while disregarding of traffic signals accounted for 3.1%. In 1984, this same publication indicated that stop sign violations accounted for 1.7% of the total accidents while the disregarding of traffic control signals accounted for 4.7% of the accidents. As you can see, this is hardly an alarming change in either direction.

If you refer to Figure 1 of my paper, you will also see the figures for the same violations as far as their responsibilities in fatal and injury accidents.

If a law enforcement administrator applied the principles of selective enforcement on his accident problem in his jurisdiction, these figures would indicate that he would not get the best result on these two types of accident causes.

Looking at Figures 2 and 3, you will see that I have also researched the same types of statistics from my home state of Arizona for the years 1974-1985. Figure 2, disregard for stop signs, shows .7% of the total in 1974 increased to .9% in 1985. Figure 3, which gives the same figures for disregard of traffic control signals, shows that in 1974, this type of violation accounted for 1.7% of the total accidents and increased to 2.4% in 1985. Once again, if you were attempting to apply selective enforcement techniques, you would probably not select these two causes as primary targets.

In additional preparation for this presentation, I discussed the problem of non-compliance to traffic control devices with the captain in charge of traffic law enforcement for the City of Phoenix Police Department, who indicated that enforcement of traffic control device infractions was down 14% in 1986 compared to 1985. This does not mean that non-compliance with traffic control devices is necessarily down, but means that there has been less enforcement action on these types of infractions.

I had one of our lieutenant's conduct a survey of law enforcement students attending the long course at the Traffic Institute, Northwestern University. The participants in this long course are carefully selected from various law enforcement agencies around the United States on the basis of their past performance in traffic law enforcement supervision and administration, and their potential for management positions in traffic law enforcement.

The Traffic Institute has been referred to in traffic law enforcement circles as the West Point of law enforcement. He surveyed this group asking a series of questions, figuring that this elite group of students would be in the vanguard as far as traffic law enforcement thinking is concerned. These students were asked the following 20 questions:

1. Does your Department enforce traffic laws?

   24 Yes
   1 No

2. Does your Department also enforce criminal law?

   24 Yes
   1 No

3. Please distribute 100 points in the following areas regarding the time consumed by your Department's line officers.

	Mean	Mode
Criminal Law Enforcement	32	40
Traffic Law Enforcement	40	10
Other Police Services	28	40

TOTAL POINTS: 100

4. Motorist compliance with traffic control devices appears to be decreasing.

   8 Strongly Agree
   40 Agree
   36 Disagree
   4 Strongly Disagree

5. Indicate the current level of compliance with traffic control devices on city streets and local roads in your geographic area.

Low Compliance	1	___	2	1	3	5	5	5	1	1	High Compliance

68%

6. Indicate the current level of compliance with traffic control devices on Interstate Highways (excluding the 55 MPH speed limit) in your geographic area.

Low Compliance	___	___	___	2	2	5	4	6	4	___	High Compliance

76%

7. Indicate the current level of compliance with the NMSL 55 MPH in your geographic area.

Low Compliance	1	1	2	3	4	4	5	1	2	___	High Compliance

48%

8. People today prefer more freedom and less control.

   16% Strongly Agree
   68% Agree
   16% Disagree
   ___ Strongly Disagree

9. Engineering practices play an important part in increasing compliance with traffic control devices.

   40% Strongly Agree
   48% Agree
   12% Disagree
   ___ Strongly Disagree

10. Increased traffic enforcement would increase compliance with traffic control devices.

   40% Strongly Agree
   52% Agree
   8% Disagree
   ___ Strongly Disagree

11. Poor engineering practices result in non-compliance with traffic control devices.

   12% Strongly Agree
   56% Agree
   32% Disagree
   ___ Strongly Disagree

12. Poor traffic enforcement practices result in non-compliance with traffic control devices.

- 48% Strongly Agree
- 48% Agree
- 4% Disagree
- ____ Strongly Disagree

13. In the past five years there have been poor engineering practices in my geographic area.

- ____ Strongly Agree
- 12% Agree
- 68% Disagree
- 16% Strongly Disagree

14. In the past five years there have been poor traffic enforcement practices in my geographic area.

- 16% Strongly Agree
- 20% Agree
- 52% Disagree
- 4% Strongly Disagree

15. Five years ago, compliance with traffic control devices was higher than it is today.

- 44% Yes
- 56% No

16. The 55 MPH speed limit has been the cause of reduced compliance with other traffic laws.

- 4% Strongly Agree
- 12% Agree
- 72% Disagree
- 8% Strongly Disagree

17. If the resources were available I would: (rank order with (1) being your first choice and (7) being your last)

- 1 Provide more marked patrol units
- 3 Provide more public awareness programs
- 5 Increase my detective division
- 2 Increase traffic patrol
- 6 Improve highway engineering
- 7 Construct more highways
- 4 Provide driver education

18. Driver education programs should be mandatory for all drivers.

- 56% Strongly Agree
- 28% Agree
- 4% Disagree
- 4% Strongly Disagree

19. Commercial vehicle operators should have a more rigorous testing program than they currently have.

- 56% Strongly Agree
- 32% Agree
- 8% Disagree
- ____ Strongly Disagree

20. Driver testing should be more comprehensive than it currently is, relative to traffic control devices.

- 24% Strongly Agree
- 60% Agree
- 12% Disagree
- ____ Strongly Disagree

While this type of survey does not have the highest reliability, it gives a feeling of what future leading administrators in the traffic law enforcement field feel about the subject of non-compliance. It also gives some indication about what type of efforts will be put forth in this area unless there is something done to change the attitude of traffic law enforcement administrators on this subject.

I understand that today we will be hearing a progress report on a Federal Highway Administration research project on this matter which has been underway for three months and should be completed within the next year or year and a half.

As I indicated last year, I believe there is a real priority need for concentration on education of the motoring public on the subject of compliance with traffic control devices beginning with some sort of effort to educate the public in just what the various traffic control devices are meant to convey. We in the enforcement and engineering field, have a good idea of what these devices are to convey; however, in spot checking with the motoring public, I find that there is wide-spread ignorance in this field.

I also believe there is a need for both disciplines, traffic engineering and traffic law enforcement, to make a concentrated effort to advise each other of what our needs and aspirations are in the area of compliance with traffic control devices. I believe the International Association of Chiefs of Police and the Institute of Traffic Engineers need to develop course material which can be presented to both student law enforcement and traffic engineers so that we better understand each others' disciplines.

Along the line of education and information, in February in San Diego, WASHTO and the IACP are jointly sponsoring a conference on construction zone engineering and enforcement practices which is at least one step in this type of educational effort; however, its main thrust will be the ever-increasing problem of traffic accidents in construction zones.

I am aware that some of the statistical information gives a rather negative impression of law enforcement's view of the non-compliance problem. However, I think we need to face the fact that no matter how unpleasant it is, until some more convincing arguments can be marshalled, the law enforcement community will be hard pressed to assign increased enforcement efforts in an area which does not appear to be a significant factor statistically in accident causation.

In closing, one thing that will be helpful for this group to address in their breakout sessions today is one that we briefly looked at last year. The differing interpretations of the enforcement of Uniform Vehicle Code section 11-601D(2), is very illustrative of the conflict that we have within our own ranks as far as traffic control devices and their interpretation.

Look at Figure 4 at the section of the Uniform Vehicle Code 11-601, Required position and method of turning. See how you interpret 11-601D(2).

It is being interpreted in drastically different ways in various jurisdictions around the country. In fact in my own state, there are jurisdictions which interpret it one way and other jurisdictions bordering those first jurisdictions that interpret it in an entirely different manner. I am certain that this breeds, if not contempt, confusion in the mind of the driving public when they can be cited for a violation in one jurisdiction and it's perfectly allowable in another jurisdiction.

There is, I would imagine, a general feeling on the part of the motorist that if we in the traffic control device and traffic law enforcement field are not in agreement, how can we expect them to be.

Once again, thank you for the opportunity to be with you today to discuss this very important problem, and I look forward to further discussions.

Improper driving

In most accidents, factors are present relating to the driver, the vehicle, and the road, and it is the interaction of these factors which often sets up the series of events which culminates in the mishap.

The table below relates just to the driver and shows the principal kinds of improper driving which were factors in accidents. Correcting these improper practices could have an important effect on accident occurrences. This does not mean that road and vehicle conditions can be disregarded.

Improper Driving Reported in Accidents, 1974

Kind of Improper Driving	Fatal Accidents			Injury Accidents			All Accidents*		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Improper driving	70.4	73.1	69.8	79.8	82.2	76.3	84.6	87.1	79.3
Speed too fast†	31.3	20.1	34.0	19.8	10.9	32.8	14.9	8.3	29.2
Right of way	13.3	23.3	10.9	23.7	29.9	14.6	21.0	23.3	16.2
Failed to yield	8.7	17.7	6.5	17.0	21.0	11.0	15.4	16.7	12.7
Passed stop sign	2.7	2.4	2.8	2.8	3.2	2.2	2.5	2.8	1.7
Disregarded signal	1.9	3.2	1.6	3.9	5.7	1.4	3.1	3.8	1.8
Drove left of center	6.7	4.5	7.2	3.1	2.4	4.1	2.9	2.4	4.0
Improper overtaking	8.0	1.4	9.6	4.4	1.5	8.6	5.7	3.7	9.9
Made improper turn	0.6	0.7	0.6	2.2	2.6	1.7	4.1	4.7	2.8
Followed too closely	1.0	2.8	0.6	8.7	11.7	4.4	11.3	14.0	5.5
Other improper driving	9.5	20.3	6.9	17.9	23.2	10.1	24.7	30.7	11.7
No improper driving stated	29.6	26.9	30.2	20.2	17.8	23.7	15.4	12.9	20.7

Source: Reports of state and city traffic authorities, as follows: Urban—32 cities; Rural—13 states; Total—NSC estimates based on Urban and Rural reports.

*Principally property damage accidents, but also includes fatal and injury accidents.

†Includes "speed too fast for conditions."

Improper Driving Reported in Accidents, 1984

Kind of Improper Driving	Fatal Accidents			Injury Accidents			All Accidents*		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Improper driving	56.7	57.7	56.2	73.7	74.3	73.0	72.1	74.4	68.0
Speed too fast[b]	23.8	23.7	23.8	18.6	15.5	22.2	16.4	14.7	19.4
Right of way	15.7	16.8	15.2	26.2	31.8	19.3	26.4	30.4	19.2
Failed to yield	9.1	10.8	8.2	19.0	21.8	15.5	20.0	22.3	15.9
Passed stop sign	1.9	2.5	1.6	2.2	2.7	1.6	1.7	1.9	1.3
Disregarded signal	4.7	3.5	5.4	5.0	7.3	2.2	4.7	6.2	2.0
Drove left of center	6.6	6.3	6.7	3.4	1.9	5.3	2.8	1.9	4.3
Improper overtaking	2.7	1.5	3.3	2.3	1.5	3.3	2.8	2.3	3.6
Made improper turn	1.3	1.3	1.4	2.8	3.0	2.6	4.0	4.4	3.2
Followed too closely	0.7	0.8	0.7	6.4	7.5	5.2	7.0	8.1	5.3
Other improper driving	5.9	7.3	5.1	14.0	13.1	15.1	12.7	12.6	13.0
No improper driving stated	43.3	42.3	43.8	26.3	25.7	27.0	27.9	25.6	32.0

Source: Based on urban and rural reports from 8 state traffic authorities.

*Principally property damage accidents, but also includes fatal and injury accidents.

[b]Includes "speed too fast for conditions."

Figure 1

Figure 2

ARIZONA'S NON COMPLIANCE WITH CERTAIN TRAFFIC CONTROL DEVICES, AS ACCIDENT CAUSES

(Disregard of Stop Signs)

Year	Total s/s Accidents	% of Total t/a	# of s/s Fatals	% of Total Fatals	# of s/s Injury Acc.	% of Total Injury Acc.
1974	769	0.7	17	1.8	NA	NA
1975	764	0.7	10	1.1	NA	NA
1976	789	0.6	12	1.3	367	0.8
1977	863	1.0	5	0.0	423	1.0
1978	991	1.0	21	2.0	476	1.0
1979	1,061	0.6	18	1.4	517	0.9
1980	917	0.6	11	0.9	458	0.8
1981	799	0.6	11	0.9	427	0.8
1982	1,352	1.1	14	1.5	714	1.3
1983	1,360	1.0	16	1.7	733	1.3
1984	1,529	0.9	28	2.4	804	1.2
1985	1,612	0.9	18	1.5	879	1.2

s/s = stop signs
t/a = traffic accidents

Figure 3

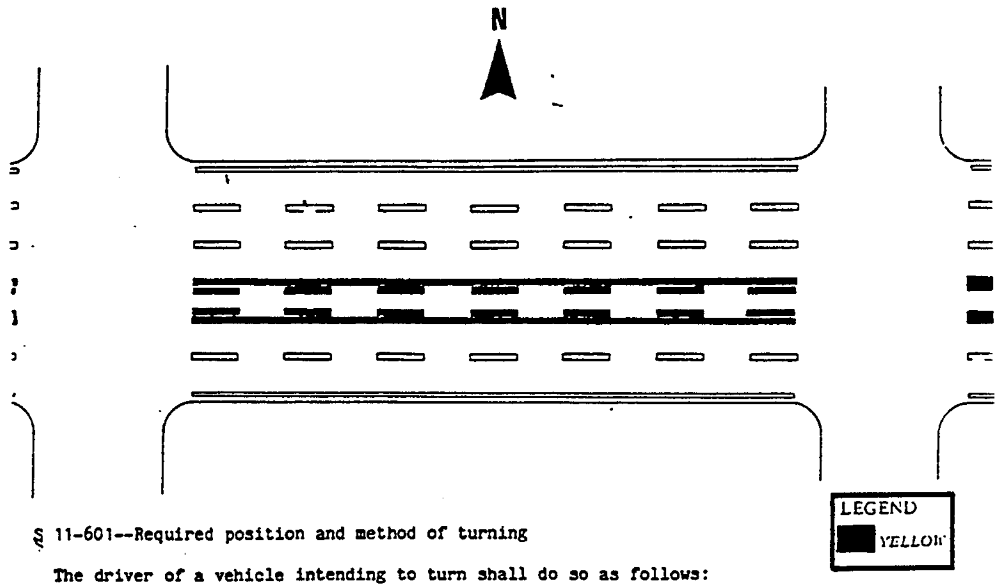
ARIZONA'S NON COMPLIANCE WITH CERTAIN TRAFFIC CONTROL DEVICES, AS ACCIDENT CAUSES

(Disregard of Traffic Signals)

Year	Total t/s Accidents	% of Total t/a	# of t/s Fatals	% of Total Fatals	# of t/s Injury Acc.	% of Total Injury Acc.
1974	1,938	1.7	11	1.2	NA	NA
1975	2,070	1.8	10	1.1	NA	NA
1976	2,266	1.8	12	1.3	1,072	2.4
1977	2,601	2.0	14	1.0	1,253	3.0
1978	2,908	2.0	18	1.0	1,406	2.0
1979	2,833	1.8	15	1.1	1,383	3.3
1980	2,652	1.8	13	1.1	1,315	3.3
1981	2,579	1.9	12	.9	1,366	2.4
1982	3,252	2.6	23	2.4	1,795	3.4
1983	3,657	2.5	21	2.3	1,947	3.3
1984	4,180	2.5	34	2.4	2,296	3.4
1985	4,281	2.4	34	2.9	2,327	3.2

t/s = traffic signals
t/a = traffic accidents

Figure 4



§ 11-601--Required position and method of turning

The driver of a vehicle intending to turn shall do so as follows:

(d) Two-way left turn lanes. -- Where a special lane for making left turns by drivers proceeding in opposite directions has been indicated by official traffic-control devices:

(1) A left turn shall not be made from any other lane.
(2) A vehicle shall not be driven in the lane except when preparing for or making a left turn from or into the roadway or when preparing for or making a U turn when otherwise permitted by law. (NEW, 1975.)

Prepared by the C. ational and Management Analysis Section, DPS December 1985

APPENDIX C - POLICE ENFORCEMENT SUMMARY BY TRAFFIC CONTROL DEVICE OR LAW

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
R1-1, STOP	KY(S)	Officer discretion.	Fines.	No	N/A
	ND(S)	If the vehicle rolling through a stop is moving faster than "walking" speed, a citation is issued.	There is a $20 fine for a violation.	No	95%
	OH(S)	Warnings are issued for minor violations. Citations are issued for flagrant accident-causing violations. Tolerances are dependent upon the accident history of the location and existing traffic conditions at the time of the violation.	Second offense in 1 year is punishable by up to a $250 fine and up to 30 days in jail.	No	>90%
	OR(S)	An officer uses his own discretion in the issuance of a warning or citation. Citations are normally issued for most hazardous traffic violations.	Fines up to $250.	No	N/A
	VA(S)	Warn or issue a citation depending upon the situation.	Fines.	No	97%
	FL(C)	A warning is issued if there is no hazard to other traffic. The officer uses his discretion in making this determination.	N/A	No	N/A
	IL(L)	A slow roll is normally allowed.	Fines.	No	60-80%
	IL(L)	A citation is issued for flagrant violations; a written warning for others. This is left entirely to the discretion of the officer.	Fines.	No	>90%
	IL(L)	Based on speed during violation; faster than a jog receives a citation.	Points against driving privileges.	No	High
	IL(L)	Cite all violators.	Fine of $35.	No	85%
	VA(L)	Enforced as seen.	N/A	No	N/A

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
R1-2, Yield	KY(S)	Officer discretion.	Fines.	No	N/A
	ND(S)	If the driver performs a "hazardous movement," a citation is issued.	There is a $20 fine for a violation.	No	95%
	FL(C)	A warning is issued if there is no hazard to other traffic. The officer uses his discretion in making this determination.	N/A	No	N/A
	IL(L)	Fairly rigid enforcement.	Fines.	No	60-80%
	IL(L)	Other traffic involvement.	Points against driving privileges.	No	High
R2-1, Speed Limits (All)	KY(S)	Officer discretion.	Fines.	Yes	N/A
	ND(S)	5 to 9 mi/h over the speed limit, a written warning is issued; over 10 mi/h a citation is issued.	No points are assessed for violations 1 to 9 mi/h over the limit; for "55" violations at 70 mi/h there is a $15 fine and no points against the driver's record.	Yes	95%
	VA(S)	At speeds of 56 to 60 mi/h a warning is issued. At or over 61 mi/h, a citation may or may not be issued depending on the situation.	Fines.	Yes	97%
	FL(C)	7 to 10 mi/h over the limit, a warning is issued; over 10 mi/h a citation is issued. Officer's discretion also influences the decision of issuance of a warning or a citation.	N/A	No	N/A
	GA(C)	In conjunction with regular patrol activities. Enforcement is intensified for motorists exceeding the posted speed by 10 mi/h.	Fines.	Yes	95%
	MD(C)	Heavy use of radar. In general, motorists are allowed 10 mi/h above the posted speed.	Fines.	Yes	Excellent

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
R3-2, No Left Turn	VA(L)	Enforced as observed; directed where accidents and/or complaints are frequent. Generally enforced except for late at night.	N/A	No	N/A
R3-4, No U-Turn	FL(C)	A warning is issued if there is no hazard to other traffic. The officer uses his discretion in making this determination.	N/A	No	N/A
	IL(L)	Other traffic involvement.	Points against driving privileges.	No	High
	IL(L)	Cite all violators.	Fine of $35.	No	85%
U-Turns in Highway Median	IL(L)	All violations except emergencies are cited.	Points against driving privileges.	No	High
R3-1,2,4 Turn Restrictions	OR(S)	An officer uses his own discretion in the issuance of a warning or citation. Citations are normally isued for most "hazardous traffic violations."	Fines up to $250.	No	N/A
	MD(C)	Enforced on an "as seen" basis. No tolerances are allowed.	Fines.	No	Fair
R6-1, One Way	MD(C)	Enforced on an "as seen" basis. No tolerances are allowed.	Fines.	No	Good
Wrong Way Driving	OR(S)	An officer uses his own discretion in the issuance of a warning or citation. Citations are normally issued for most "hazardous traffic violations."	Fines up to $250.	No	N/A
R10-11a, No Turn on Red	IL(L)	A citation is issued for flagrant violations; a written warning for others. This is left entirely to the discretion of the officer.	Fines.	No	>90%
	IL(L)	Cite all violators.	Fine of $30.	No	85%

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
Right Turn on Red	VA(S)	Warn or issue a citation, depending on the situation.	Fines.	No	97%
	MD(C)	Normal patrol, enforced on an "as seen" basis. No tolerances are allowed.	Fines.	No	Good
	VA(L)	Enforcement is directed where accidents are frequent. Rolling stops are generally overlooked if traffic is light.	N/A	No	N/A
R10-12, Left Turn Yield on Green O	VA(L)	Enforced in relation to accidents.	N/A	No	N/A
W Series Warning Signs	ND(S)	If the driver performs a "hazardous movement," a citation is issued.	There is a $20 fine for a violation.	No	95%
W13-1, Advisory Speed Plate	VA(S)	Warn or issue a citation depending on the situation.	Fines.	No	97%
Signals	KY(S)	Officer discretion.	Fines.	Yes	N/A
	OH(S)	Warnings are issued for minor violations. Citations are issued for flagrant accident-causing violations. Tolerances are dependent on the accident history of the location and the existing traffic conditions at the time of the violation.	Second offense in 1 year is punishable by up to a $250 fine and up to 30 days in jail.	No	>90%
	OR(S)	An officer uses his own discretion in the issuance of a warning or citation. Citations are normally issued for most "hazardous traffic violations."	Fines up to $250.	No	N/A
	VA(S)	Warn or issue a citation depending on the situation.	Fines.	No	97%
	FL(C)	A warning is issued if there is no hazard to other traffic. The officer uses his discretion in making this determination.	N/A	No	N/A

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
Signals (Continued)	GA(C)	In conjunction with routine patrol activities. Enforcement is directed toward motorists entering the boundaries of an intersection against a red light.	Fines.	No	95%
	MD(C)	Active enforcement. No tolerances are allowed.	Fines.	Yes	Good
	IL(L)	High tolerance.	Fines.	No	50-60%
	IL(L)	A citation is issued for flagrant violations; a written warning for others. This is left entirely to the discretion of the officer.	Fines.	No	>95%
	IL(L)	All violations are cited.	Points against driving privileges.	No	High
	IL(L)	Cite all violators.	Fine of $35.	No	85%
Pavement Markings	VA(S)	Warn or issue a citation depending on the situation.	Fines.	No	97%
Crosswalk Markings	IL(L)	Violations by pedestrians are usually ignored.	Fines.	No	N/A
Lane Markings	OH(S)	Warnings are issued for minor violations. Citations are issued for flagrant, accident-causing violations. Tolerances are dependent on the accident history of the location and existing traffic conditions at the time of the violation.	Second offense in 1 year is punishable by up to a $250 fine and up to 30 days in jail.	No	>90%
	IL(L)	Seldom enforced.	Fines.	No	>90%
	VA(L)	Seldom enforced except for accidents.	N/A	No	N/A

TRAFFIC CONTROL DEVICE	POLICE AGENCY	ENFORCEMENT PRACTICES/TOLERANCES	SANCTIONS	SPECIALIZED ENFORCEMENT PROGRAM	PROSECUTION SUCCESS RATE
No Passing Zones	KY(S)	Officer discretion.	Fines.	No	N/A
	OH(S)	Warnings are issued for minor violations. Citations are issued for flagrant, accident-causing violations. Tolerances are dependent on the accident history of the location and existing traffic conditions at the time of the violation.	Second offense in 1 year is punishable by up to a $250 fine and up to 30 days in jail.	No	>90%
	OR(S)	An officer uses his own discretion in the issuance of a warning or citation. Citations are normally issued for most "hazardous traffic violations."	Fines up $250.	No	N/A
	IL(L)	No tolerance allowed.	Fines.	No	75-85%
	IL(L)	Cite all violators.	Fine of $30.	No	85%
Railroad Highway Grade Crossings	ND(S)	Any violation warrants a citation.	There is a $20 fine for a violation.	No	95%
	OH(S)	Warnings are issued for minor violations. Citations are issued for flagrant, accident-causing violations. Tolerances are dependent on the accident history of the location and existing traffic conditions at the time of the violation.	Second offense in 1 year is punishable by up to a $250 fine and up to 30 days in jail.	No	>90%
	FL(C)	A warning is issued if there is no hazard to other traffic. The officer uses his discretion in making this determination.	N/A	No	N/A
	IL(L)	Enforcement is nearly nonexistent.	Fines.	No	N/A
	IL(L)	All violators are cited.	Points against driving privileges.	No	High

APPENDIX D - POLICE AGENCY COMPLIANCE INFORMATION REQUEST FORM

MOTORIST COMPLIANCE WITH STANDARD TRAFFIC CONTROL DEVICES

Please list six traffic control devices (TCDs) in each of these three categories:

		Motorist Noncompliance	Citations Written	Accidents Precipitated
most	TCD 1		1	1
↓	TCD 2		2	2
	TCD 3		3	3
	TCD 4		4	4
	TCD 5		5	5
least	TCD 6		6	6

For each of the six TCDs with the biggest noncompliance problem, please answer the following questions:

I. Why do motorists typically violate each TCD?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

II. Where do motorists typically violate each TCD? (We are interested in identifying the specific types of locations as well as specific problem locations.)

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

III. How often do motorists violate each TCD? Some agencies have done field studies of noncompliance rates. We are especially interested in any hard data you may have.

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

IV. What are your enforcement practices relative to each TCD?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

V. What are your "tolerances" for violators of each TCD?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

VI. Is each TCD part of a Specialized Enforcement Program? If so, what is being done?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

VII. What is your prosecution success rate for each TCD?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

VIII. What sanctions are used for each TCD?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

IX. What safety problems are associated with noncompliance to each TCD?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

X. How would you characterize the level of cooperation between your agency and each of the following? Please indicate the ways you work together, as well as how the relationship could be improved.

Department of Motor Vehicles: ____________________

Judiciary: ____________________

Prosecutors Office: ____________________

Completed by:
Name ____________________
Rank ____________________
Position ____________________
Mailing Address ____________________
Phone (   ) ____________________

APPENDIX E - MOTOR VEHICLE ADMINISTRATION COMPLIANCE INFORMATION REQUEST FORM

MOTORIST COMPLIANCE WITH STANDARD TRAFFIC CONTROL DEVICES

Please list six traffic control devices (TCDs) in each of these three categories:

		Motorist Noncompliance	Citations Written	Accidents Precipitated
most	TCD 1		1	1
	TCD 2		2	2
	TCD 3		3	3
	TCD 4		4	4
	TCD 5		5	5
least	TCD 6		6	6

For <u>each</u> of the six TCDs with the biggest <u>noncompliance</u> problem, please answer the following questions:

I. Why do motorists typically violate each TCD?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

II. Where do motorists typically violate each TCD? (We are interested in identifying the specific <u>types</u> of locations as well as specific problem locations.)

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

III. How often do motorists violate each TCD? Some agencies have done field studies of noncompliance rates. We are especially interested in any hard data you may have.

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

IV. What safety problems are associated with noncompliance to each TCD?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

V. Are any of the TCDs posing unreasonable demands?

TCD1

TCD2

TCD3

TCD4

TCD5

TCD6

VI. Are any of the TCDs too restrictive for the roadway operations or design?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

VII. Are any of the TCDs too confusing or not being understood by some drivers?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

VIII. Are any of the TCDs not properly conveying the potential risk or hazard?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

IX. Are any of the TCDs improperly applied, i.e., overused or misused?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

X. Are the applications of any of the TCDs straying from the Manual on Uniform Traffic Control Devices (MUTCD) standards?

TCD1 ____________________

TCD2 ____________________

TCD3 ____________________

TCD4 ____________________

TCD5 ____________________

TCD6 ____________________

XI. Does a change in a regulation (such as RIGHT-TURN-ON-RED) lead to disrespect for other regulations? _____ Yes _____ No

XII. Is the limited enforcement or known enforcement tolerance leading to driver disregard for regulations? _____ Yes _____ No

XIII. Is there a general trend for the motoring public to disregard all regulations? _____ Yes _____ No

XIV. How would you characterize the level of cooperation between your agency and each of the following? Please indicate the ways you work together, as well as how the relationship could be improved.

State Police/Local Police: ______________________________

Judiciary: ______________________________

Prosecutors Office: ______________________________

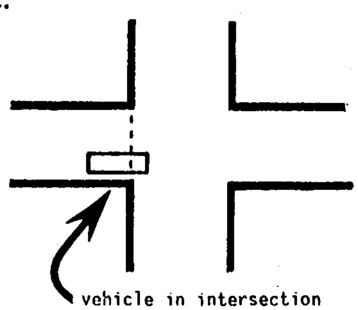
Completed by: Name ______________________________
Position ______________________________
Mailing Address ______________________________
Phone ( ) ______________________________

APPENDIX F - BEHAVIORAL STUDY INSTRUCTIONS AND FIELD DATA FORMS

Procedure Manual

General Instructions

1. This manual is written as a supplement to the instructions given to you by a member of the project team, and those already provided in the data form.
2. Each field investigator is expected to maintain a loose leaf notebook for this Procedure Manual. If and when a given page is modified, the old page is to be discarded and the revision kept in its place.
3. This manual is set up as a description of procedures to be followed when completing the detailed site report form and the individual compliance and conflict data forms. Each item, many of the responses, and field procedures will be discussed.
4. When performing the individual compliance and conflict studies, position yourself to be as inconspicuous as possible.
5. Trucks are those study vehicles with more than four tires. Buses are considered trucks.
6. Vehicles are considered "in the intersection" if any part of the vehicle breaks an imaginary line that is the extended curb line of the cross street.



7. A conflict is any action by a study vehicle that causes a change in the speed or travel path of the study vehicle and/or another vehicle or a pedestrian.

CODING INSTRUCTIONS FOR ADMINISTRATIVE DATA

Item #1 State: Code your state as indicated.

Item #2 Site Location: Indicate the study site location; this can be transcribed from the list of sites. Indicate street names and street or route numbers in the space provided.

Note: Items #1 and #2 are used to provide a unique identification number for each case being investigated. This three-digit number is to be placed in the boxes in the upper right-hand corner of each page of the data form as well as on the pictures and any other material that is to be attached to the data form.

Item #3 Field Investigator: Write your name in the space provided. Code your FI number in the boxes to the right.

Item #4 Date and Day of Site Visit: Indicate the month, day, and year that you visited the site to make the on-scene observation. Code the day of the week that you visited the site.

Item #5 Weather and Pavement Conditions: Indicate the weather and pavement condition.

Item #6 Activity Log: This item is used primarily for you to keep track of your time and mileage on the site work. When you prepare your bimonthly time sheets, you should be able to do so by looking at the information provided in this item.

CODING INSTRUCTIONS FOR AREA/INTERSECTION DATA

Item #7 Intersection Type: A four-leg intersection has two roads crossing and is shaped like a "+." "T," "Y," and "L" intersections are shaped as indicated. A multiple leg intersection is one having five or more legs. A jog is a four-leg intersection where two of the approaches are slightly offset from one another (——┴┬——). An interchange is a system of interconnecting roadways in conjunction with one or more grade separations, providing for the interchange of traffic between two or more roadways or highways on different levels, i.e., a grade-separated intersection. A rotary is a traffic circle.

Item #8 Leg Designation: Write the name of the study leg of the intersection and the principal cardinal direction (e.g., northbound, southbound, etc.) of the approach direction of that leg. Fill in the names and approach directions of the remaining legs of the intersection. From the study leg, the remaining legs should be recorded in a counterclockwise direction. For example, standing at the study leg, the leg on your right is Leg #2. Go around the intersection until all the legs have been designated.

Item #9 Intersection Control: Indicate if the intersection is controlled by signals, Stop signs, Yield signs, or some other type of intersection control. If there are no controls at the intersection, please indicate this.

Item #10 Signal Control Type: If there is a traffic signal controlling the traffic flows at the intersection, indicate what type of "controller" is being used at the intersection. (Your trainer will elaborate on this procedure.)

Item #11 Signal Phasing: If a traffic signal is used at the intersection, indicate the phasing and the length of the green, yellow and/or all red indications. Phasing is the order of the vehicle movements at the intersection. When the signal changes, some vehicles move, while others must wait. When the signal changes, other vehicles move, and others must wait. In each box indicate what movements are allowed, and what movements are prohibited. Arrows (↑↱) are used to indicate allowed movements. Tees (T) are used to

indicate prohibited movements. During each phase, check the right turn, straight through and left turn movements for all the legs of the intersection. After you have checked all the movements for each phase, check the amount of green and yellow signal time allocated to each phase. If the signals are red in all directions at the end of a phase, indicate the amount of "all red" time along with the green and yellow times. (Your trainer will elaborate on this procedure.)

Item #12 Cycle Length: If there is a traffic signal at the intersection, indicate the amount of time it takes for every movement from each leg to have a chance at passing through the intersection. For example, you would start timing when the northbound straight movement begins, and continue until the northbound straight movement begins a second time. The total time recorded is the cycle length.

Item #13 General Area Description: Indicate the land use along each leg and the intersection as a whole, for the general area where the study site is located (approximately 1/10 of a mile on each leg from the site). Decide if the area is industrial (factories, warehouses); commercial (stores, gas stations, shopping centers); residential; schools, parks, playgrounds, churches; or open (undeveloped woodland or farmland). The "mostly" categories should be used for areas that are a mixture of the land use described and some other land use, but the area is predominantly the land use described. If an area is half of one land use and half of another, use the "mostly" category associated with the more dense land use (e.g., most dense-industrial, commercial, residential, sppc, open-least dense).

Item #14 Roadway Functional Classification: The following definitions and/or descriptions apply:

Limited access - usually multi-lane with grade-separated intersections only, e.g., interstate, parkway, freeways, some expressways.

Controlled access - may have at-grade intersections (usually signal-controlled), but will have no direct access to abutting property; often a frontage or service road will parallel this type of roadway.

Major arterial highway - a highway primarily for through traffic, usually on a continuous route with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.

Collector-Distributor - provides for traffic movement between major arterials and local streets as well as direct access to abutting property.

Local street - primarily for access to residence, business, or other abutting property, and for local traffic movements.

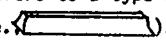
Frontage or service road - a local street or road auxiliary to and located on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

Classify the roadway according to the characteristics it exhibits within 1/10th mile in all directions of the site.

Item #15 Traffic Lanes: Record the number of traffic lanes, where a traffic lane is the portion of the traveled way for the movement of a single line of vehicles. Code the approach direction and the other direction of travel. These numbers do not include the number of lanes shared by both directions, such as a common center left-turn lane.

CODING INSTRUCTIONS FOR THE STUDY LEG (LEG #1) DATA

The following data items apply only to the study leg (Leg #1):

Item #16 Median: Code the best or predominant description of the median or that portion of a divided highway separating the traveled ways for traffic moving in opposite directions. If there is no median, code "1." In code "2," "barriers, N.J." refers to a type of concrete wall used to separate opposing traffic lanes, (i.e. ). Note that code "3," curb or island, takes precedence over code "5."

Item #17 Roadway Center Markings: A center marking divides lanes of traffic traveling in opposite directions. Do not confuse with lane markings (see Item #19). If there are neither center markings nor a median or barrier, e.g., a country road or a one-way street, code "1." Otherwise, code as follows according to the examples shown:

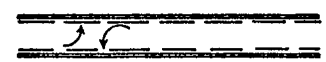
2. Double solid center line

3. Single solid center line

4. 1 dashed, 1 solid center line (passing prohibited for approach direction)

5. 1 dashed, 1 solid center line (passing permitted for other direction)

6. Common left-turn lane markings



7. Single dashed center line

8. Other (You draw it)

Item #18 Roadway Edge Markings: Edge markings mark or delineate the outside edge of the roadway. They may take the form of painted lines (code "2"), reflectors placed on posts or guardrails (code "3"), bumps or reflectors placed in the pavement (code "4"), a combination of markings and delineators (codes "5" and "6"), marked (painted) parking lanes (code "7"), or you name it (code "9"). Code the markings within 500 feet of the site.

Item #19 Roadway Lane Separation Markings: Lane separation markings separate lanes of traffic traveling in the same direction. Two-lane, two-way roadways, therefore, may have center markings, but may not have lane markings. Code the best descriptor of the lane markings at the site.

Item #20 Roadway Lane Designation Markings: Lane designation markings are the large arrows painted on the road that designate the movements allowed in each lane at the intersection. Code the arrow markings at the site for each marked lane (lane #1 is closest to the curb).

Item #21 Special Roadway Markings: Code appropriately if there was a marked crosswalk (painted on pavement) or words (painted on pavement) within 500 feet of the site.

Item #22 Pedestrian Accommodations at Site: Code the best description of the accommodations at the site.

Item #23 Traffic Signs - Before the Intersection: Use the matrix to identify warning signs that are within 500 feet of the intersection along the study leg. If the sign is located on a post alongside the road, check the curb/shoulder box for the sign. If the sign is hanging over the lanes on a post or wire, check the appropriate lane box for the sign (lane #1 is closest to the curb). If the sign is located in the median, check the median box for the sign. For example, if a Stop Ahead sign is located along the roadside, go to the Stop Ahead column, down to the curb/shoulder row, and check the box. Check as many boxes as necessary to describe all the signs listed that are within 500 feet of the intersection.

Item #24 Traffic Signs - At the Intersection: Use the matrix to identify regulatory signs that are placed at or near the intersection. First identify the sign and determine its location relative to the curb, median and lanes. Check the appropriate box to identify and locate the sign. Check as many boxes as necessary to describe the signs at the intersection.

Item #25 Traffic Signs - Lane Designation Signs: Indicate the signs at the intersection that designate the lanes to be used for selected movements. Code the appropriate sign number in the appropriate lane box.

Item #26 Posted or Legal Speed Limit: Code the speed limit whether posted or not at the site. Use state or local traffic laws to determine the speed limit if not posted.

Item #27 Traffic Signals: Use the matrix to identify the size and type of traffic signals used at the intersection. First determine the size of the lenses used, next identify any special features of the signal (other than the usual solid red, yellow and green lenses), then determine the location of the signal relative to the curb, median and lanes. Check the appropriate box to identify and locate the signal. Check as many boxes as necessary to describe the signal facing the study leg at the intersection.

Item #28 Elevation or Slope: Choose the slope line that most closely matches the slope of the roadway at the site. You only need to indicate the amount of slope in this item. The next item indicates whether it it uphill or downhill.

Item #29 Vertical Placement: Relative to approach direction of travel, code whether the study leg approach is located on the level (code "1"), the initial upgrade (code "2"), the upgrade (code "3"), the hill top or hill crest (code "4"), the downgrade (code "5"), the final downgrade (code "6"), or the bottom of a hill (code "7").

Item #30 Horizontal Curvature: Relative to the approach direction of travel, code whether roadway curved more than 90° left (code "1"), between 60° and 90° left (code "2"), between 30° and 60° left (code "3"), between 5° and 30° left (code "4"), between 0° and 5° right or left (code "5"), between 5° and 30° right (code "6"), between 30° and 60° right (code "7"), between 60° and 90° right (code "8"), or more than 90° right in the vicinity of the site.

CODING INSTRUCTIONS FOR THE SITE DIAGRAM

The site diagram is a very important part of the data collection effort. During the data analysis we may find that we would like to know some things about the sites which we did not code. We will be able to extract some of that information from good site diagrams and pictures.

The detailed diagram should be approximately to scale. Be sure to include all the physical features of the study site, e.g., sidewalks, crosswalks, vegetation, driveways, embankments, signs, traffic signals, markings, roadway shoulders, abutting land uses, bus stops, etc. Indicate certain measurements such as roadway widths, shoulder widths, and lane widths on the diagram.

Be sure to indicate all streets or highways by official name and number. Indicate North at the top right corner of the page.

INSTRUCTIONS FOR SITE PHOTOGRAPHS

Take four photographs of the site. Take one from each approach to the intersection. If there are more than four legs at the intersection, take photographs for each leg. Staple or tape the photographs to the page of the indicated location. You may take additional photographs if you feel there are characteristics of the site that should be documented.

MOTORIST COMPLIANCE SITE FORM
ADMINISTRATIVE DATA

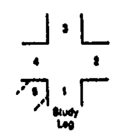
1. STATE 1) New York 2) Virginia 3) Texas 4) California .... ☐
2. SITE LOCATION ____________________ ☐☐
3. FIELD INVESTIGATOR ____________________ ☐☐
4. DATE OF SITE VISIT Month ☐☐ Day ☐☐ Year ☐☐
   DAY OF SITE VISIT 1) Monday 2) Tuesday 3) Wednesday 4) Thursday 5) Friday............. ☐
5. WEATHER 1) Clear 2) Cloudy 3) Rain 4) Snow 5) Other ____________________ ☐
   PAVEMENT 1) Dry 2) Wet 3) Snow 4) Ice 5) Other ____________________ ☐
6. ACTIVITY LOG

	Time	Odometer		
Left Home (site)	___:___	______	Time Worked	______
Arrive Site	___:___	______	Miles Driven	______
Leave Site	___:___	______	Other Expenses	______
Arrive Home (site)	___:___	______		______
Totals	______	______		______

AREA/INTERSECTION DATA

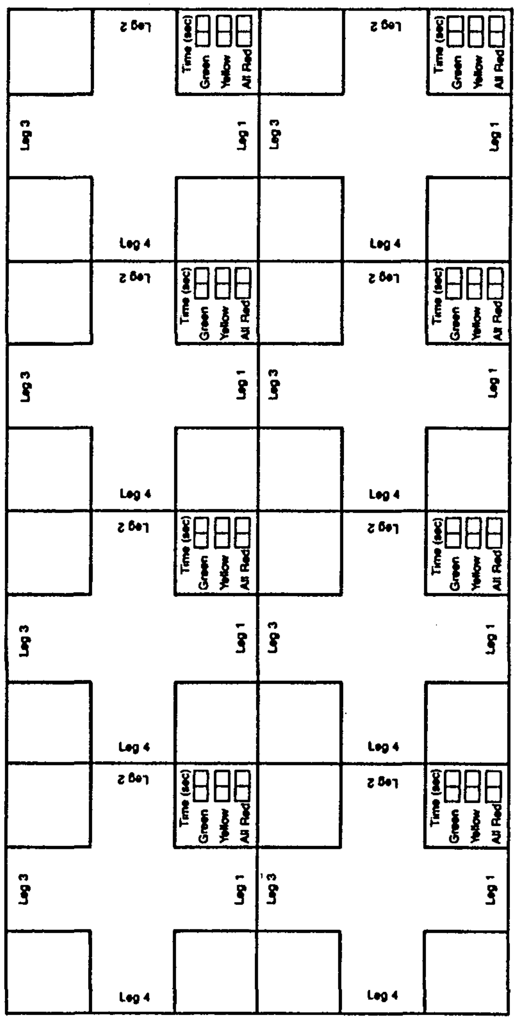
7. INTERSECTION TYPE.. ☐
   1) 4-leg 2) "T" 3) "Y" 4) "L" 5) Multiple Leg 6) Jog
   7) Interchange 8) Rotary 9) Other ____________________
8. LEG DESIGNATION

	Street Name	Approach Direction
Leg 1 (study leg)	______	______
Leg 2	______	______
Leg 3	______	______
Leg 4	______	______
Leg 5	______	______



9. INTERSECTION CONTROL .... ☐
   1) Signals 2) Stop Sign(s) 3) Yield Sign(s) 4) No controls 5) Other ____________________
10. SIGNAL CONTROL TYPE 1) Pre-timed 2) Activated .... ☐

11. SIGNAL PHASING



AREA/INTERSECTION DATA (Continued)

12. CYCLE LENGTH (seconds) .... ☐☐☐

13. GENERAL AREA DESCRIPTION (Provide a general area description for each leg individually.)

1) Industrial	6) Mostly Residential	Leg 1 (study leg) ..	☐☐
2) Mostly Industrial	7) Schools, Parks, Playgrounds, Churches	Leg 2	☐☐
3) Commercial	8) Mostly #7	Leg 3	☐☐
4) Mostly Commercial	9) Open	Leg 4	☐☐
5) Residential	10) Mostly Open	Leg 5	☐☐

(Provide a general area description for the intersection as a whole.) .... ☐☐

14. ROADWAY FUNCTIONAL CLASSIFICATION (Provide a roadway functional classification for each leg individually.)

1) Limited Access (grade separated intersections only)	4) Collector—Distributor	Leg 1 (study leg) ..	☐
2) Controlled Access (intersections, but no access to abutting property)	5) Local Street	Leg 2	☐
3) Major Arterial (direct access to abutting property)	6) Frontage or Service Road	Leg 3	☐
	9) Other ______	Leg 4	☐
		Leg 5	☐

15. TRAFFIC LANES (Record the number of lanes upstream from the intersection for each leg individually.)

	Approach Direction	Other Direction
Leg 1 (study leg)	☐	☐
Leg 2.........	☐	☐
Leg 3.........	☐	☐
Leg 4.........	☐	☐
Leg 5.........	☐	☐

STUDY LEG (LEG #1) DATA

16. MEDIAN (The portion of a divided highway separating the traveled ways for traffic in opposite directions within 500' of the site.) ☐

1) None	4) Painted Pavement (other than centerline markings)
2) Barrier (fence, guardrail, N.J., etc.)	5) Grass, Trees, Dirt, Gravel
3) Curb or Island (takes precedence over 5, 6, 7, or 8)	9) Other ______

17. ROADWAY CENTER MARKINGS (within 500' of the site) .... ☐
(If highway is divided by a median or barrier, code the marking nearest the center of the roadway.)

1) None	6) Common Left Turn-Lane Markings
2) Double Solid Center Line	7) Single Dashed Center Line
3) Single Solid Center Line	9) Other ______
4) 1 Dashed, 1 Solid Center Line (passing prohibited for V-1)	
5) 1 Dashed, 1 Solid Center Line (passing permitted for V-1)	

18. ROADWAY EDGE MARKINGS (within 500' of the site) .... ☐

1) None	5) Pavement Edge Markings and Roadside Delineators
2) Pavement Edge Markings (paint only)	6) Pavement Edge Markings and Pavement Delineators
3) Roadside Delineators (on post or guardrail)	7) Parking Lanes (marked)
4) Pavement Delineators (raised and/or reflectorized)	9) Other ______

STUDY LEG (LEG #1) DATA (Continued)

19. ROADWAY LANE SEPARATION MARKINGS .... ☐
(2 lane, 2-way roadways have no lane markings; may have center marking)
1) None
2) Dashed Lane Markings
3) Solid Lane Markings
4) Dashed or Solid Lane Markings With Pavement Delineators
9) Other ____________

20. ROADWAY LANE DESIGNATION MARKINGS (Record the lane designation marking for each lane individually.)
1) Left Turn
2) Thru
3) Right Turn
4) Left Turn and Thru
5) Right Turn and Thru
6) Left Turn, Right Turn and Thru
9) Other ____________

Lane 1 .... ☐
Lane 2 .... ☐
Lane 3 .... ☐
Lane 4 .... ☐
Lane 5 .... ☐

21. SPECIAL ROADWAY MARKINGS (within 500' of site) .... ☐
1) None
2) Crosswalk
3) Words
4) Crosswalk and Words
9) Other ____________

22. PEDESTRIAN ACCOMMODATIONS AT SITE
1) Unimproved Shoulder
2) Improved Shoulder
3) Pedestrian Pathway
4) Sidewalk, With Curb
5) Sidewalk, Without Curb
6) Curb Only, No Sidewalk
9) Other (specify) ____________

Approach Side .... ☐
Other Side .... ☐

23. TRAFFIC SIGNS (within 500' of the site)

BEFORE INTERSECTION WARNING SIGNS

	Intersection Ahead	Stop Ahead	Yield Ahead	Signal Ahead	Other
Curb/Shoulder					
Lane 1					
Lane 2					
Lane 3					
Lane 4					
Lane 5					
Median					

24. TRAFFIC SIGNS

AT INTERSECTION REGULATORY SIGNS

	Stop	Yield	No Left Turn	No Right Turn	No U Turn	No Turns	Other
Curb/Shoulder							
Lane 1							
Lane 2							
Lane 3							
Lane 4							
Lane 5							
Median							

STUDY LEG (LEG #1) DATA (Continued)

25. TRAFFIC SIGNS/LANE DESIGNATION SIGNS (Record the lane designation signing for each lane individually.)
1) Left Turn
2) Thru
3) Right Turn
4) Left Turn and Thru
5) Right Turn and Thru
6) Left Turn, Right Turn and Thru

Curb/Shoulder .... ☐
Lane 1 .... ☐
Lane 2 .... ☐
Lane 3 .... ☐
Lane 4 .... ☐
Lane 5 .... ☐
Median .... ☐

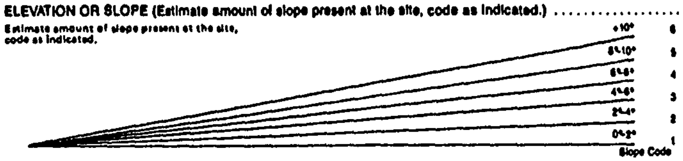
26. POSTED OR LEGAL SPEED LIMIT .... ☐☐

27. TRAFFIC SIGNALS

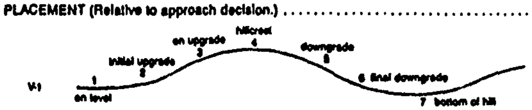
	8" Lenses (all lenses)	12" Lenses (all lenses)	Combination of 8" and 12" Lenses	Flashing Yellow	Flashing Red	Left Turn Lens	Right Turn Lens	Combination of Left and Right Turn Lenses	Pedestrian	Other
Curb/Shoulder										
Lane 1										
Lane 2										
Lane 3										
Lane 4										
Lane 5										
Median										

28. ELEVATION OR SLOPE (Estimate amount of slope present at the site, code as indicated.) .... ☐

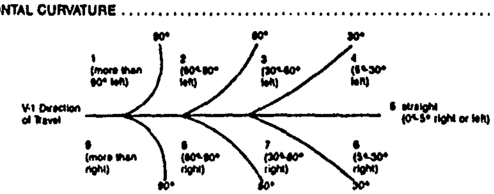
Estimate amount of slope present at the site, code as indicated.



29. SITE VERTICAL PLACEMENT (Relative to approach decision.) .... ☐



30. SITE HORIZONTAL CURVATURE .... ☐

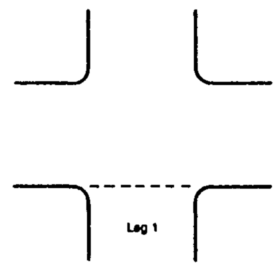


SITE DIAGRAM

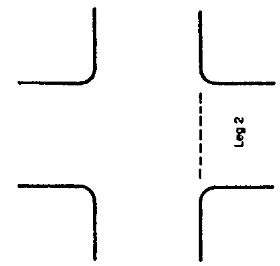
SITE PHOTOGRAPHS

Take 4 pictures at the site. Additional photos can be used to document any unusual conditions.

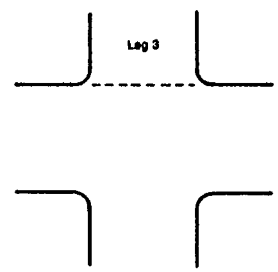
1. Leg 1 (study leg)



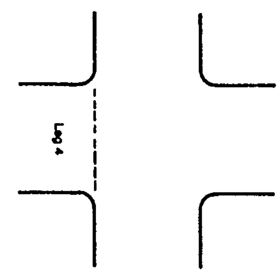
2. Leg 2 approach direction



3. Leg 3 approach direction



4. Leg 4 approach direction



PROCEDURE FOR THE TRAFFIC SIGNAL COMPLIANCE AND CONFLICT STUDY

Position yourself so that you are able to see the study vehicles as they enter the intersection as well as the traffic signals facing the study vehicles. Count the number of vehicles entering the intersection on green broken down by the number of left turning, straight through and right turning vehicles. Use the mechanical counter provided to you to perform this task. Use registration or tick marks (~~////~~ /) to count: the number of vehicles entering the intersection on yellow, broken down by turning movement; the number of vehicles entering the intersection on red without causing a conflict with cross street traffic, broken down by turning movement; the number of vehicles entering the intersection on red that cause a conflict with cross street traffic, broken down by turning movement (note whether the vehicles entering the intersection on red are cars or trucks); the number of vehicles that enter the intersection by "jumping the green," entering the intersection on red just before the signal turns green, broken down by conflict causation and turning movement. Right turn on red after stop vehicles are to be counted in the right turn green category.

Observe and record the behavior of every vehicle that passes through the intersection from the study leg. Every 15 minutes begin recording your observations on a new data sheet. Continue your data collection until you have observed 400 vehicles. After you have completed your observations, add up the tick marks in each cell of the matrix and transfer the numbers to the corresponding code boxes on the data form.

TRAFFIC SIGNAL COMPLIANCE & CONFLICT DATA ☐☐☐

TIME ☐☐☐☐ TO ☐☐☐☐

15 MINUTE PERIOD ☐☐

	LEFT		STRAIGHT		RIGHT		Codes
GREEN							L ☐☐☐ S ☐☐☐ R ☐☐☐
YELLOW							L ☐☐☐ S ☐☐☐ R ☐☐☐
	CARS	TRUCKS	CARS	TRUCKS	CARS	TRUCKS	
RED W/O CONFLICT							C: L ☐☐☐ S ☐☐☐ R ☐☐☐ T: L ☐☐☐ S ☐☐☐ R ☐☐☐
RED W/ CONFLICT							C: L ☐☐☐ S ☐☐☐ R ☐☐☐ T: L ☐☐☐ S ☐☐☐ R ☐☐☐
JUMPED SIGNAL W/O CONFLICT							L ☐☐☐ S ☐☐☐ R ☐☐☐
JUMPED SIGNAL W/ CONFLICT							L ☐☐☐ S ☐☐☐ R ☐☐☐

PROCEDURE FOR THE RIGHT TURN ON RED AFTER STOP COMPLIANCE AND CONFLICT STUDY

Position yourself so that you are able to see the study vehicles as they arrive at the traffic signal, and the cross traffic on the through street. When the signal is green, count the number of study vehicles that: turned on green or yellow; stopped on red, waited for green and turned on green; stopped on red, because someone in front of them had stopped and was waiting for a green signal, and turned on green; and attempted to turn on red, while they were attempting the turn the signal changed to green and then they turned on green.

When the signal is red, determine if the study vehicle arrived as a single vehicle or was part of a queue (line) of vehicles waiting at the signal. Next, decide if the study vehicle made a voluntary full stop (a stop is defined as a complete, however brief, cessation of movement), was stopped by vehicular or pedestrian cross traffic or did not stop at all before entering the intersections. After you have decided the type of action the study vehicle made at the intersection, you must determine if the action caused a conflict with any vehicular or pedestrian cross traffic. Next, note if the study vehicle is a car or a truck (a fact that was obvious to you from the start of your observation). Choose the appropriate box in the matrix, and make a registration or tick mark (~~||||~~ /) to record the observation. Observe and record the behavior of every right turning vehicle that passes through the intersection from the study leg. Every 15 minutes begin recording your observations on a new data sheet.

After you have observed the behavior of 200 vehicles, stop the procedure and begin to count for five minutes the number of vehicles passing through the intersection from Leg #4 approach. After you have completed this five minute volume count, enter the total in the appropriate box on the data form. Continue your observation of behavior on the study leg.

Collect data until you have observed 400 vehicles or until four hours have passed. After you have completed your observations, add up the tick marks in each cell of the matrix and transfer the numbers to the corresponding code boxes on the data form.

RIGHT TURN ON RED
AFTER STOP COMPLIANCE & CONFLICT DATA

☐☐☐

TIME ☐☐☐☐ TO ☐☐☐☐

15 MINUTE PERIOD ☐☐

				CARS	TRUCKS	CARS	TRUCKS
ON GREEN	TURNED ON G OR Y					☐☐☐	☐☐☐
	STOPPED ON R, WAITED FOR G, TURNED ON G					☐☐☐	☐☐☐
	BEHIND A WAITER (ABOVE) TURNED ON G					☐☐☐	☐☐☐
	ATTEMPTED TO TURN ON R, TURNED ON G					☐☐☐	☐☐☐
ON RED	NO Q	FULL STOP	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		STOP X-TRAFF	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		STOP PED-X	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		NO STOP	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
	Q	FULL STOP	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		STOP X-TRAFF	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		STOP PED-X	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐
		NO STOP	C			☐☐☐	☐☐☐
			NC			☐☐☐	☐☐☐

5 MINUTE VOLUME COUNT ☐☐☐

PROCEDURE FOR THE STOP SIGN COMPLIANCE AND CONFLICT STUDY

Position yourself so that you are able to see the study vehicles as they arrive at the Stop sign, and the cross traffic on the through street. First determine if the study vehicle arrived as a single vehicle or was part of a queue (line) of vehicles waiting at the Stop sign. Next, decide if the study vehicle made a voluntary full stop (a stop is defined as a complete, however brief, cessation of movement), was stopped by vehicular or pedestrian cross traffic or did not stop at all before entering the intersections. After you have decided the type of action the study vehicle made at the intersection, you must determine if the action caused a conflict with any vehicular or pedestrian cross traffic. Next watch to see if the study vehicle turns left or right, or continues straight through the intersection. Lastly, note if the study vehicle is a car or a truck (a fact that was obvious to you from the start of your observation). Choose the appropriate box in the matrix, and make a registration or tick mark (//// /) to record the observation. Observe and record the behavior of every vehicle that passes through the intersection from the study leg. Every 15 minutes begin recording your observations on a new data sheet.

After you have observed the behavior of 200 vehicles (or after 2 two hours of data collection), stop the procedure and begin to count for five minutes the number of vehicles entering the intersection from the cross street (Leg #2 and Leg #4). After you have completed this five minute volume count, enter the total in the appropriate box on the data form. Continue your observation of behavior on the study leg.

Collect data until you have observed 400 vehicles or until four hours have passed. After you have completed your observations, add up the tick marks in each cell of the matrix and transfer the numbers to the corresponding code boxes on the data form.

STOP SIGN COMPLIANCE & CONFLICT DATA

TIME ____ TO ____

15 MINUTE PERIOD __

			LEFT		STRAIGHT		RIGHT	
			CARS	T	CARS	T	CARS	T
NO Q	FULL STOP	C						
		NC						
	STOP X-TRAF	C						
		NC						
	NO STOP	C						
		NC						
Q	FULL STOP	C						
		NC						
	STOP X-TRAF	C						
		NC						
	NO STOP	C						
		NC						

5 MINUTE VOLUME COUNT ___

PROCEDURE FOR THE NO LEFT TURN COMPLIANCE AND CONFLICT STUDY

Position yourself so that you are able to see the study vehicles as they approach the No Left Turn prohibition location. Count the number of vehicles passing the study site that do not make an illegal left turn. That would be the through movements at a midblock location or "T" street intersection, and the through and right turn movements at a four or more legged intersection. These vehicles will be counted using the mechanical counter provided to you. Use registration or tick marks (~~////~~ /) to record the number of through and right turning trucks. Record the number of cars and trucks making illegal left turns. Differentiate between those turns that are made and cause a conflict with another vehicle and those that do not. Differentiate if the conflict is with a vehicle traveling in the same direction as the study vehicle or in the opposite direction of the study vehicle. Use tick marks to record this information. Observe and record the behavior of every vehicle that passes through the study leg. Continue your data collection until you have observed 400 vehicles. After you have completed your observations, add up the tick marks in each cell of the matrix and transfer the numbers to the corresponding code boxes on the data form.

NO LEFT TURN COMPLIANCE AND CONFLICT DATA ☐☐☐

TIME ☐☐☐☐ TO ☐☐☐☐

15 MINUTE PERIOD ☐☐

	LEFT: W/O CONFLICT	LEFT: W/ CONFLICT — DIRECTION SAME	LEFT: W/ CONFLICT — DIRECTION OPPOSITE	STRAIGHT & RIGHT	
CARS					LW/OC ☐☐☐ LW/C/S ☐☐☐ LW/C/O ☐☐☐ S/R ☐☐☐
TRUCKS					LW/OC ☐☐☐ LW/C/S ☐☐☐ LW/C/O ☐☐☐ S/R ☐☐☐

PROCEDURE FOR THE ADVISORY SPEED COMPLIANCE DATA AND CONFLICT STUDY

For this procedure, it is not necessary to fill out the entire site form. Do not include information about Items 7 to 12, 19 to 21, 23 to 25 and Item 27. Please include information about all of the remaining items, the site diagram and two site photographs (one in each direction) taken from your data collection position.

Study sites should be chosen so that they have the following characteristics. They should be isolated (no intersecting roads in either direction for 500 feet) two-lane (one lane in each direction) roads. The curve should be a single curve or the first curve in a series of curves that is marked by a single curve/turn warning sign with an advisory speed plate.

At the study site, position yourself off the road opposite the warning sign with the advisory speed plate. Aim the radar at the furthest visible point up the road. Do not move the radar. When a speed is detected by the radar, monitor the speed and record the maximum speed of the vehicle approaching your position. Clear the radar unit and aim the unit at the furthest visible point down the road in the opposite direction of your first aiming (this would be through the rear window of your car if you are doing this procedure from inside your vehicle). Monitor the speed of the target vehicle as it goes away from you. Do not move the radar. Record the lowest speed that the unit detects for the target vehicle. While monitoring the speed, check to see if the vehicle's brake lights come on. If you can see the centerline of the road, see if the vehicle crosses the centerline while still in sight from your position. Observe and record the behavior of only a single vehicle or the lead vehicle in a platoon. Continue until you have observed 50 vehicles.

ADVISORY SPEED COMPLIANCE DATA ☐☐☐

POSTED ADVISORY SPEED ☐☐ TIME ☐☐☐☐ TO ☐☐☐☐

SPEED IN TANGENT	SPEED IN CURVE	BRAKED IN CURVE?		CROSSED ℄ IN CURVE?		TRUCK?
		YES	NO	YES	NO	

PROCEDURE FOR THE SCHOOL BUS COMPLIANCE AND CONFLICT STUDY

Position yourself so that you are on the left side of the bus seated behind the driver. Do not speak to the driver or distract him in any way from the safe operation of the school bus. Each time the bus stops to drop off or pick up school children, note if the driver turns on the bus's flashing red lights prior to coming to a complete stop or after coming to a complete stop. Also note if the red flashers are not used at all. Note if there is any auxiliary warning equipment used with or in lieu of the red flashers. Note if there are any vehicles in the vicinity of the bus, that have stopped because of the presence of the school bus. Note if these vehicles are behind the bus (same category), facing the bus from the opposite direction (opposite category) or facing the road the bus is on from a side street location (turning category). Note if any vehicles pass the bus. Also note where these vehicles came from before they passed the bus. Note whether children were getting on (boarding) or off (alighting) at this stop location. Note the roadway classification and land use type for the stop location. (See the instructions for coding the site form.) Note if the stop location was at an intersection or in the middle of a block. Note if the terrain behind the bus and in front of the bus is flat and straight, or curvy and hilly. Observe and record this information for each stop that the bus makes along the route.

SCHOOL BUS COMPLIANCE DATA

TIME ☐☐☐☐ to ☐☐☐☐
ODOMETER ☐☐☐ to ☐☐☐

1. STATE 1.)New York 3.)Texas 2.)Virginia 4.)California ☐

2. SITE LOCATION ____________ ☐☐

3. FIELD INVESTIGATOR ____________ ☐☐

4. DATE OF SITE VISIT Month ☐☐ Day ☐☐ Year ☐☐

DAY OF SITE VISIT 1)Mon 2)Tues 3)Wed 4)Thur 5)Fri ☐

5. WEATHER 1)Clear 2)Cloudy 3)Rain 4)Snow 5)Other ____ ☐

PAVEMENT 1)Dry 2)Wet 3)Snow 4)Ice 5)Other ____ ☐

Stop#	Flasher Mode	Auxilary Equipment	Vehicles in Vicinity			Vehicles Passing the Bus			On/Off	X/No X	Roadway Classification	Landuse Type	Intersection/ Mid-Block	Terrain	
			Same	Opposite	Turning	Same	Opposite	Turning						Same	Opp.

SCHOOL BUS COMPLIANCE DATA FORM KEY

Flasher Mode

1 - Flash, Prior to Stop
2 - Flash, After Stop
3 - No Flash

Auxiliary Equipment

1 - None
2 - Swing Arm Stop Sign
3 - Other (Note)

On/Off

1 - Boarding
2 - Alighting

X/No X

1 - Crossing
2 - Not Crossing

Roadway Classification

1 - Limited Access
2 - Controlled Access
3 - Major Arterial
4 - Collector-Distributor
5 - Local Street
6 - Frontage or Service Road
7 - Other (Note)

Land Use Type

1 - Industrial
2 - Mostly Industrial
3 - Commercial
4 - Mostly Commercial
5 - Residential
6 - Mostly Residential
7 - Schools, Parks, Playgrounds, Churches
8 - Mostly #7
9 - Open
10 - Mostly Open

Intersection/Midblock

1 - Intersection
2 - Midblock

Terrain

1 - Flat, Straight
2 - Hilly, Curvy