# THE INFLUENCE OF RADAR DETECTORS ON TEXAS HIGHWAY TRAFFIC SPEEDS

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# THE INFLUENCE OF RADAR DETECTORS ON TEXAS HIGHWAY TRAFFIC SPEEDS

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## EXECUTIVE SUMMARY

Law enforcement and highway safety officials have held that the only function of radar detectors is to provide a means to avoid apprehension for speeding violations. In addition, the increasing use of detectors has been assumed to contribute to decreasing voluntary compliance with speed laws. The objective of the effort reported here was to provide quantitative information about the influence of detector use on Texas highways and to examine the impact of potential countermeasures to their use.

Vehicle speeds were measured both in the presence and absence of traffic radar signals that are detectable by commercially available radar detectors. Differences observed in speeds when radar is detectable and when it is not can be attributed largely to the influence of radar detectors, both on the speeds of drivers who use detectors and on other drivers who may respond to speed changes by detector--equipped vehicles.

Traffic speeds were measured on over a thousand miles of Texas highways with 55 mph speed limits. The speed data collected for this project clearly show that radar detectors do have an influence on traffic speeds. Analysis of the data aggregated over all highway types surveyed indicate the mean speed of trucks is nearly two miles per hour slower when radar is present. More importantly, the distribution of speeds change in the presence of a detectable radar signal. The influence of radar detectors is seen most dramatically among trucks and the fastest passenger vehicles. Although small under both conditions, the proportion of trucks on rural Interstates travelling between 66 and 70 mph was more than three times greater when no radar signal was present than when a detectable signal was transmitted. Nearly five times as many

trucks exceeded 70 mph in the absence of radar. The proportion of passenger cars exceeding 70 mph was 1.5 times greater when no radar signal was transmitted.

Limited data was collected to test the effect of non-radar microwave transmissions on traffic speeds. Signals that trigger radar detector warnings were generated by unmanned drone transmitters that do not require FCC licensing. These data suggest that traffic speeds can be controlled by such transmissions under some conditions without accompanying traffic law enforcement.

Analysis of the speed data collected for this project leads to two basic conclusions:

1. The presence of detectable radar transmissions has a suppressing effect on traffic speeds. The influence of radar transmissions on traffic speeds varies with highway and vehicle type, but is seen most clearly among trucks and the fastest passenger vehicles. This effect is attributable primarily to the use of radar detectors.

2. The use of drone transmitters has potentially the same effect on traffic speeds as conventional traffic radar. The impact of drone transmissions should be affected by the same variables that influence the effect of radar transmissions, e.g., highway and vehicle type, signal strength, traffic volume, etc.

The observed influence of radar detectors on speeds in the presence of detectable radar does not allow a conclusion that detector users drive faster than they would without detectors when enforcement is not perceived. It is recommended that the influence of radar detectors on driving speeds in the absence of a radar signal be investigated.

The implementation of drone transmissions for speed control should be selective. A preliminary evaluation of drone use in highway maintenance work zones is currently being undertaken by TTI. Additional candidates for drone use should be investigated. These include transitional areas between speed zones, especially on Interstate highways that change from 65 to 55 mph and on non-Interstates that intersect 65 mph rural Interstates.

## ACKNOWLEDGEMENTS

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# THE INFLUENCE OF RADAR DETECTORS ON TEXAS HIGHWAY TRAFFIC SPEEDS

## 1.0 INTRODUCTION

### 1.1 Background

The primary tool used in Texas and many other jurisdictions for the enforcement of traffic speed laws is Doppler effect traffic radar. Measurement of the speed of moving vehicles is made possible by virtue of the fact that a transmitted radio wave is altered in frequency in linear proportion to the speed of the object off of which it is reflected. Like any other radio transmissions, radio waves transmitted by traffic radar can be received by receivers tuned to the appropriate frequency. Radar detection devices are simply specialized radio receivers tuned to respond to the frequencies allocated by the Federal Communications Commission (FCC) for use by traffic radar. Radar detectors receive traffic radar transmissions and provide an audible and/or visual signal of the radar presence sufficiently in advance to allow speeders to slow down and avoid arrest.

The increasing use of radar detectors has long been assumed by traffic law enforcement agencies and others to decrease voluntary compliance with speed laws both by those motorists using detectors and by other drivers in the traffic stream who are influenced by detector- equipped vehicles. At least as early as 1980, the U.S. Department of Transportation held that,

> The only purpose for a radar detection device is to avoid apprehension for violating the speed limit. Therefore, law enforcement agencies should strongly oppose the manufacture, sale, possession and use of these devices.
>
> U.S. Department of Transportation, 1980, p2

Until recently, systematic efforts to quantify the influence of radar detectors on traffic speeds have been lacking. Two studies employing traffic radar which was modified to be undetectable by commercially available radar detectors have been reported. Based on a relatively small sample, Goodson (in Maryland State Police, 1986) reports mean vehicle speeds measured with undetectable radar to be nearly 3 miles per hour faster than speeds measured at the same Texas interstate highway location with standard detectable radar. The proportion of vehicles exceeding 60 mph decreased by 12 percent when measured with detectable radar compared with speeds determined using undetectable radar. A preliminary report of a similar, but more extensive, study conducted in Maryland and Virginia (Insurance Institute for Highway Safety, 1987) indicates much smaller differences in mean speeds, but found decreases in the proportion of vehicles exceeding 65 mph of up to 59 percent, depending on vehicle type, when speeds were measured with detectable rather than undetectable radar. An evaluation of unmanned radar installations designed to determine if the use of unmanned radar can reduce traffic speeds and speed variability is ongoing in Kentucky (J. G. Pigman, personal communication, March, 1987). Automated data collection at existing speed monitoring stations and manual time-distance techniques are being used to measure speeds in the presence and absence of both unmanned radar and active police speed enforcement. All of these studies monitored speeds at fixed locations with stationary speed measurement instrumentation.

The information gained from these studies and communications was sufficiently encouraging in terms of results and methodology to warrant a comprehensive evaluation of the use of radar detectors in Texas.

## 1.2 Objectives

There were two objectives for the present study:

1. To determine the magnitude of radar detector influence on traffic speed profiles in Texas, and
2. To examine the impact of potential radar detector countermeasures.

The remainder of this report describes the methodology and findings from the tasks performed to address these objectives. Section 2.0 presents the findings for objective one, while Section 3.0 describes the results for objective two. Section 4.0 presents a Summary of Conclusions and Recommendations.

## 2.0 RADAR DETECTOR INFLUENCE ON TRAFFIC SPEEDS

### 2.1 Method

Speed surveys were conducted on 46 Texas highway segments comprising a total of more than 1000 highway miles. Vehicle speeds were observed under two conditions: 1) in the presence of standard K band police traffic radar, and 2) in the absence of detectable radar.

Under both conditions, speeds were measured using traffic radar. The radar units used for data collection were modified to preclude detection by commercially available radar detectors. Radar detectors now in service are predominantly of the superheterodyne type. These receivers are characterized by narrow bandwidths and high sensitivity. They are sensitive to transmitted frequencies between 24.000 and 24.300 GHz and between 10.425 and 10.625 GHz. These bands include the 24.150 GHz (K band) and 10.525 GHz (X band) frequencies allocated by the Federal Communications Commission for police radar transmitters and other radio location services. The radar transmitters used for measuring vehicle speeds in this project were tuned to a frequency outside that received by radar detectors. The modifications to the radar units result in speed indications that are slightly (1.45%) higher than those of unmodified radar. Thus, the speeds reported here are inflated by a small amount compared to speeds measured with unmodified radar. Since all data were collected with the modified units, however, relative differences between speeds observed in the presence and absence of conventional radar are not affected.

Speed data were collected from two moving, unmarked vehicles. The first data collection vehicle was equipped with an undetectable radar unit and a commercially available radar detector. Vehicle speeds were sampled in the moving mode from the on-coming traffic stream. No data were collected when the radar detector indicated that police radar or other radio transmissions to which the detector is sensitive were present. The second data collection vehicle followed the first, maintaining approximately a five-mile gap. This vehicle was equipped with a standard, unmodified traffic radar unit and an undetectable unit. Speeds were measured using the undetectable unit while the unmodified, detectable unit was transmitting. The speed samples thus obtained were from the same traffic stream under both undetectable and detectable radar conditions. This sampling procedure allowed data collection under the two radar conditions on the same roadways with nearly identical time of day, weather, and general traffic conditions. Because data was collected in the moving mode in unmarked vehicles and because the lead vehicle only transmitted undetectable signals, the likelihood that visual identification of the survey vehicles affected sampled speeds is small. The majority of vehicles sampled were included in both conditions, albeit at different positions on the highway. The logic of the approach employed and its implications for evaluating the influence of radar detectors on traffic speeds is simple and straightforward. If the only salient distinction between the two speed surveys conducted on each highway segment is the detectability of a radar signal, then observed differences in traffic speeds between those samples can reasonably be attributed to the influence of radar detectors.

## 2.2 Results

The highways sampled are categorized in Table 2.1 by facility type and number of traffic lanes. A more complete specification of the individual segments is provided in Appendix A. The legal speed on all roadways sampled was 55 mph. Data collection for this effort was completed prior to the May 9, 1987 implementation of higher speed limits on rural interstate highways in

## TABLE 2.1 HIGHWAYS SAMPLED

| FACILITY TYPE | HIGHWAY MILES | |
|---|---|---|
| INTERSTATE HIGHWAYS | 558 | |
| FOUR LANE RURAL | | 488 |
| FOUR/SIX LANE URBAN LOOPS | | 70 |
| STATE AND U.S. RURAL HIGHWAYS | 484 | |
| FOUR LANE | | 146 |
| MIXED TWO/FOUR LANE | | 86 |
| TWO LANE | | 252 |
| FARM TO MARKET ROAD | 24 | |
| TOTAL | 1,066 | |

## TABLE 2.2 VEHICLES SAMPLED

| CONDITION | PASSENGER VEHICLES | TRUCKS | TOTAL |
|---|---|---|---|
| RADAR DETECTABLE | 4,435 | 1,431 | 5,866 |
| RADAR UNDETECTABLE | 4,137 | 1,434 | 5,571 |
| TOTAL | 8,572 | 2,865 | 11,437 |

Texas.

The speeds of 11,437 vehicles were observed. As shown in Table 2.2, 75% were classified as passenger vehicles and 25% were trucks. Passenger vehicles included automobiles, pickup trucks, small vans and recreational vehicles. A large majority of the vehicles classified as trucks were 18-wheel tractor/semi-trailer combinations. Also included as trucks were straight trucks, and other commercial cargo hauling vehicles.

The results presented here reflect the influence of radar detectors on speeds on all highways sampled collapsed over highway type and the influence of detectors on speeds as a function of highway type for: four lane rural Interstates; urban Interstate loops; State and U. S. highways, without regard to the number of traffic lanes; and a farm-to-market road. Speed profiles for each individual highway segment sampled are included in Appendix B. In all cases, speed data are provided for all vehicles combined and for passenger vehicles and trucks separately.

Summaries of speed data collected under the detectable and undetectable radar conditions for each of the highway categories are presented in Tables 2.3 through 2.7. A statistically significant difference in the mean speed of all vehicles was observed on all highway types combined and on each of the highway types sampled as a function of radar condition. In each case, average speeds are lower when measured in the presence of detectable radar. For most of the highway groups, this difference is the result of the decrease in mean truck speeds in the presence of detectable radar. On the rural Interstate highways sampled, the observed decrease in mean truck speeds is more than two miles per hour. Differences in mean passenger vehicle speeds are significant only on the urban interstates and the farm-to-market road sampled. The mean speeds are, again, lower when a radar signal is detectable.

TABLE 2.3 SUMMARY STATISTICS: ALL HIGHWAYS SAMPLED

| | MEAN SPEED | SD | PERCENT <56 | 56-60 | 61-65 | 66-70 | >70 |
|---|---|---|---|---|---|---|---|
| **ALL VEHICLES** | | | | | | | |
| UNDETECTABLE RADAR | 61.49** | 5.76 | 20.3* | 28.2 | 33.4 | 14.2** | 3.8** |
| DETECTABLE RADAR | 60.07 | 5.21 | 18.7 | 34.1** | 33.6 | 11.3 | 2.2 |
| **PASSENGER** | | | | | | | |
| UNDETECTABLE RADAR | 60.56 | 5.87 | 20.6** | 27.9 | 33.0 | 14.3 | 4.3** |
| DETECTABLE RADAR | 60.58 | 5.28 | 16.7 | 31.4** | 35.7** | 13.4 | 2.8 |
| **TRUCKS** | | | | | | | |
| UNDETECTABLE RADAR | 60.29** | 5.43 | 19.3 | 29.6 | 34.6** | 14.2** | 2.3** |
| DETECTABLE RADAR | 58.48 | 4.66 | 24.7** | 42.6** | 27.2 | 5.0 | 0.5 |

*, ** indicate values significantly larger than corresponding value for other radar condition, * = $p<.05$, ** = $p<.01$.

## TABLE 2.4 SUMMARY STATISTICS: FOUR LANE RURAL INTERSTATE HIGHWAYS

| | MEAN SPEED | SD | PERCENT <56 | 56-60 | 61-65 | 66-70 | >70 |
|---|---|---|---|---|---|---|---|
| **ALL VEHICLES** | | | | | | | |
| UNDETECTABLE RADAR | 61.16** | 5.75 | 17.5** | 25.4 | 35.6 | 17.0** | 4.5** |
| DETECTABLE RADAR | 60.72 | 5.00 | 14.5 | 33.5 | 36.8 | 12.6 | 2.6 |
| **PASSENGER** | | | | | | | |
| UNDETECTABLE RADAR | 61.33 | 5.95 | 18.2** | 25.5 | 35.7 | 17.2 | 5.3** |
| DETECTABLE RADAR | 61.65 | 4.93 | 10.4 | 29.4** | 40.6** | 16.0 | 3.6 |
| **TRUCKS** | | | | | | | |
| UNDETECTABLE RADAR | 60.82** | 5.32 | 16.3 | 29.0 | 35.5** | 16.4** | 2.9** |
| DETECTABLE RADAR | 58.71 | 4.53 | 23.3** | 42.6** | 28.5 | 5.0 | 0.6 |

*, ** indicate values significantly larger than corresponding value for other radar condition, * = $p<.05$, ** = $p<.01$.

TABLE 2.5 SUMMARY STATISTICS: URBAN INTERSTATE LOOPS

| | MEAN SPEED | SD | PERCENT <56 | 56-60 | 61-65 | 66-70 | >70 |
|---|---|---|---|---|---|---|---|
| **ALL VEHICLES** | | | | | | | |
| UNDETECTABLE RADAR | 60.03* | 5.69 | 21.9 | 29.7 | 32.0 | 13.4 | 2.9* |
| DETECTABLE RADAR | 59.26 | 5.41 | 23.8 | 35.7* | 27.7 | 11.4 | 1.4 |
| **PASSENGER** | | | | | | | |
| UNDETECTABLE RADAR | 60.48* | 5.64 | 20.1 | 28.1 | 33.3 | 15.4 | 3.1 |
| DETECTABLE RADAR | 59.66 | 5.37 | 22.7 | 33.3* | 29.7 | 12.7 | 1.6 |
| **TRUCKS** | | | | | | | |
| UNDETECTABLE RADAR | 57.97 | 5.49 | 30.4 | 37.0 | 26.1 | 4.4 | 2.2 |
| DETECTABLE RADAR | 57.30 | 5.18 | 29.3 | 47.4 | 18.2 | 5.0 | 0.0 |

*indicates values significantly larger than corresponding value for other radar condition, $p<.05$.

**TABLE 2.6 SUMMARY STATISTICS: STATE AND U.S. HIGHWAYS**

| | MEAN SPEED | SD | PERCENT <56 | 56-60 | 61-65 | 66-70 | >70 |
|---|---|---|---|---|---|---|---|
| **ALL VEHICLES** | | | | | | | |
| UNDETECTABLE RADAR | 59.43** | 5.71 | 25.2 | 32.4 | 29.6 | 9.9 | 2.9** |
| DETECTABLE RADAR | 58.96 | 5.37 | 25.9 | 34.8 | 29.0 | 8.6 | 1.7 |
| **PASSENGER** | | | | | | | |
| UNDETECTABLE RADAR | 59.52 | 5.74 | 24.6 | 33.0 | 28.9 | 10.1 | 3.4** |
| DETECTABLE RADAR | 59.18 | 5.37 | 24.6 | 34.3 | 30.1 | 9.1 | 1.9 |
| **TRUCKS** | | | | | | | |
| UNDETECTABLE RADAR | 58.90** | 5.51 | 28.7 | 28.7 | 33.9** | 8.7 | 0.0 |
| DETECTABLE RADAR | 57.47 | 5.12 | 34.6 | 38.2* | 21.7 | 5.1 | 0.5 |

*, ** indicate values significantly larger than corresponding value for other radar condition, * = p<.05, ** = p<.01.

## TABLE 2.7 SUMMARY STATISTICS: FARM TO MARKET ROAD

| | MEAN SPEED | SD | PERCENT <56 | 56-60 | 61-65 | 66-70 | >70 |
|---|---|---|---|---|---|---|---|
| **ALL VEHICLES** | | | | | | | |
| UNDETECTABLE RADAR | 61.00** | 5.38 | 15.4 | 38.5 | 28.8 | 13.5* | 3.8 |
| DETECTABLE RADAR | 58.22 | 5.13 | 27.6 | 41.4 | 25.9 | 3.4 | 1.7 |
| **PASSENGER** | | | | | | | |
| UNDETECTABLE RADAR | 61.08* | 5..45 | 14.6 | 39.6 | 27.1 | 14.6* | 4.2 |
| DETECTABLE RADAR | 58.36 | 5.34 | 30.2* | 35.8 | 28.3 | 3.8 | 1.9 |
| **TRUCKS** | | | | | | | |
| UNDETECTABLE RADAR | 60.00 | 5.10 | 25.0 | 25.0 | 50.0 | 0.0 | 2.2 |
| DETECTABLE RADAR | 56.80 | 1.30 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 |

*, ** indicate values significantly larger than corresponding value for other radar condition, * = $p<.05$, ** = $p<.01$.

The influence of detectable radar on vehicle speeds is not limited to average speed. More importantly for traffic law enforcement and safety, the influence of detectable radar is evident in the distribution of vehicle speeds, i.e. on speed profiles. Speed profiles are provided in Tables 2.3-2.7 in terms of the percent of vehicles travelling at or below the speed limit (< 56 mph), and in four additional speed categories, 56-60, 61-65, 66-70, and >70 mph. The percentage of vehicles in each speed category was subjected to a test of the difference between percentages for the two radar conditions.

The impact of detectable radar on vehicle speeds can be discerned from inspection of the tables. Differences in speeds as a function of radar condition are particularly evident in truck speeds. On most highway types, a significantly greater proportion of trucks were observed in the lower speed categories, < 61 mph, when speeds were measured in the presence of detectable radar than when the radar was not detectable. Conversely, the proportion of trucks in the higher speed groups, > 61 mph, was significantly greater when radar was undetectable. For passenger vehicles, this effect is considerably less pronounced. The influence of detectable radar is seen primarily among vehicles in the highest speed group. The percentage of passenger vehicles exceeding 70 mph is greater when radar is not detectable on all highways combined, rural Interstates, and State/U.S. highways.

Because the proportion of vehicles in the highest speed categories is relatively small under both radar conditions, the degree of radar detector influence is not well represented by the absolute difference in percentages. A better picture is obtained by a comparison of the ratio of the percentage of vehicles in each speed group observed when radar is not detectable to the percentage of vehicles in each group when radar is detectable. If no difference in speeds was observed as a function of radar condition, these ratios would in all cases be 1.0 except for small variations due to sampling error. That is, the percentage of vehicles in each speed category would be the same under both conditions. If the ratio is greater than one for a given speed category, then more motorists were observed in the undetectable sample than in the detectable sample. If the ratio is less than one for a speed category, then the reverse is true.

Figures 2.1, 2.2, 2.3, 2.4 and 2.5 graphically depict these ratios for all highways combined, four lane rural Interstate, urban Interstate loop, State/U.S., and farm to market highways respectively. For passenger cars, the ratio of "undetectable radar" to "detectable radar" generally does not differ greatly from 1.0 except in the highest speed group. The proportion of vehicles exceeding 70 mph was observed to be about one and a half to nearly two times greater when radar was not detectable than when it was, depending on highway type. For trucks this ratio reveals a substantially more pervasive influence of detectable radar. For all highways combined, the ratio is 1.27, 2.87, and 4.69 for the three highest speed categories. The proportion of trucks travelling between 66 and 70 mph inclusive is nearly three times greater when radar cannot be detected. It is more than four times greater among trucks exceeding 70 mph. In the highest speed categories, the ratios are even greater when only rural Interstates are considered. Only on urban Interstates and State/U.S. highways is the influence of detectable radar less evident on truck speeds than on passenger vehicles. Because of a very small sample size, no ratios are provided for trucks on the farm to market road.

## 2.3 Conclusions

Markedly different traffic speed profiles are produced when detectable radar is present than when it is not. These differences do not provide a direct measure of the absolute number or proportion of vehicles equipped with

ALL HIGHWAY SEGMENTS COMBINED

Ratio of the proportion of vehicles measured in absence of detectable radar (U%) to the proportion measured in the presence of detectable radar (D%)

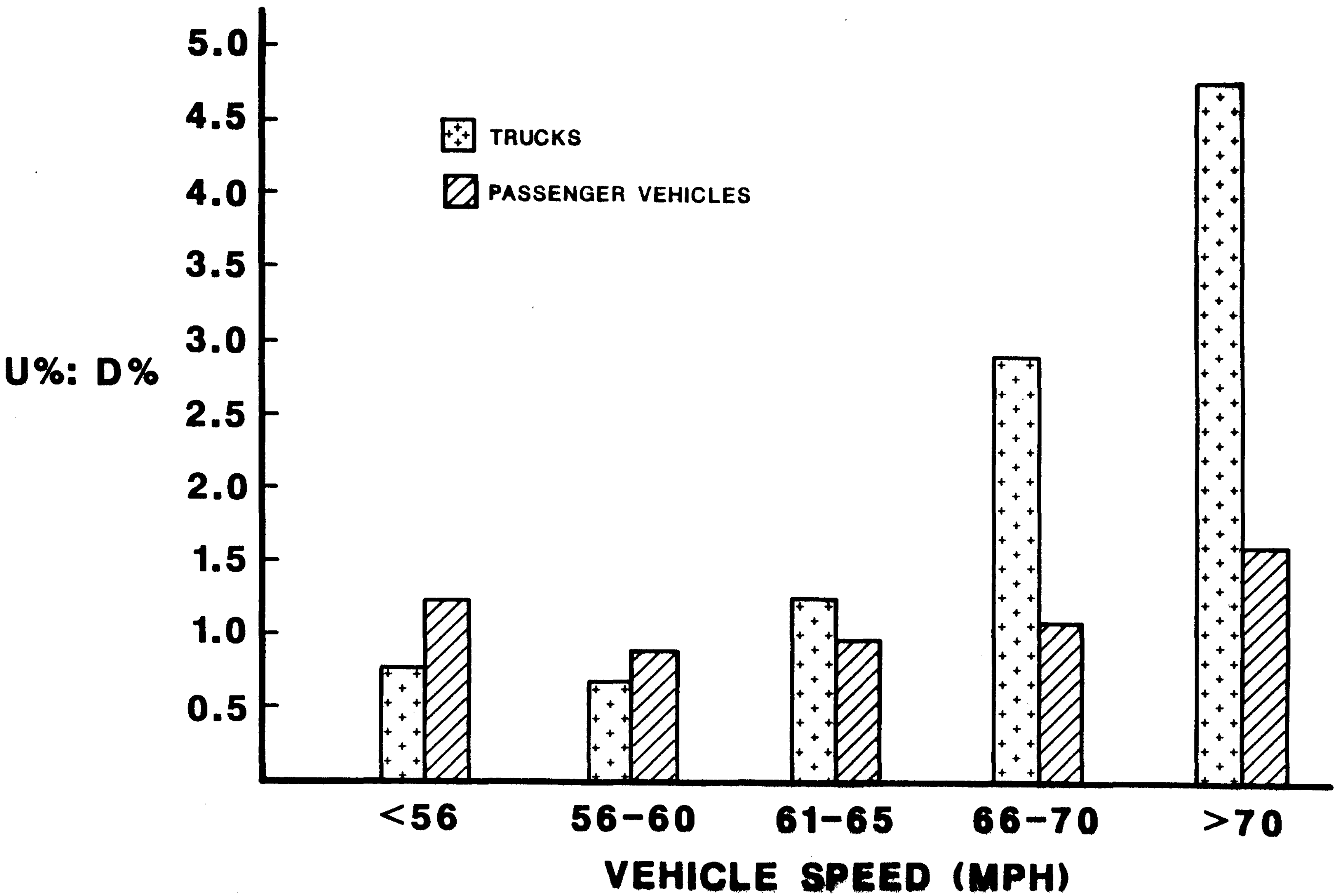


FIGURE 2.1

FOUR LANE RURAL INTERSTATE HIGHWAYS

Ratio of the proportion of vehicles measured in absence of detectable radar (U%) to the proportion measured in the presence of detectable radar (D%)

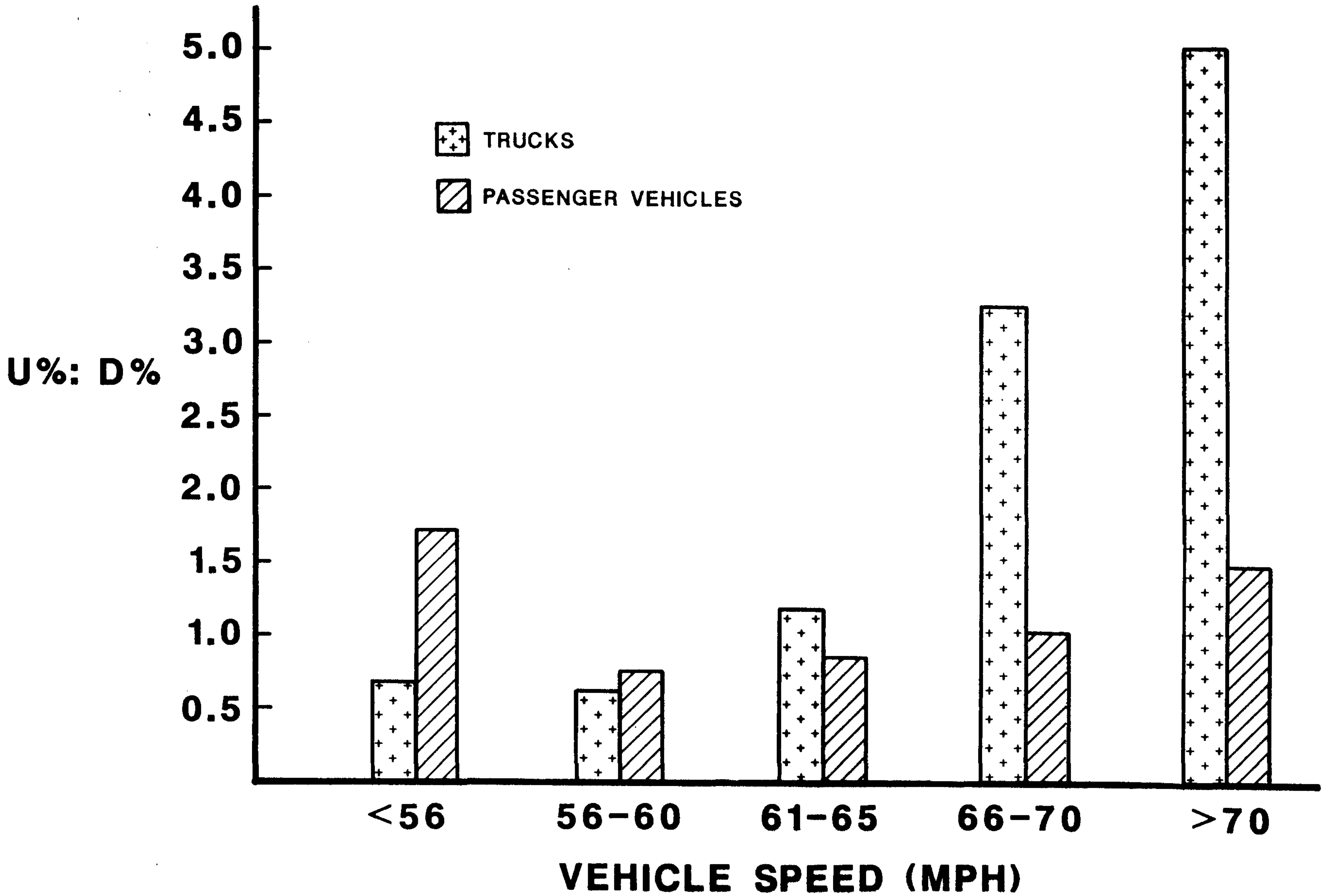


FIGURE 2.2

URBAN INTERSTATE LOOPS

Ratio of the proportion of vehicles measured in absence of detectable radar (U%) to the proportion measured in the presence of detectable radar (D%)

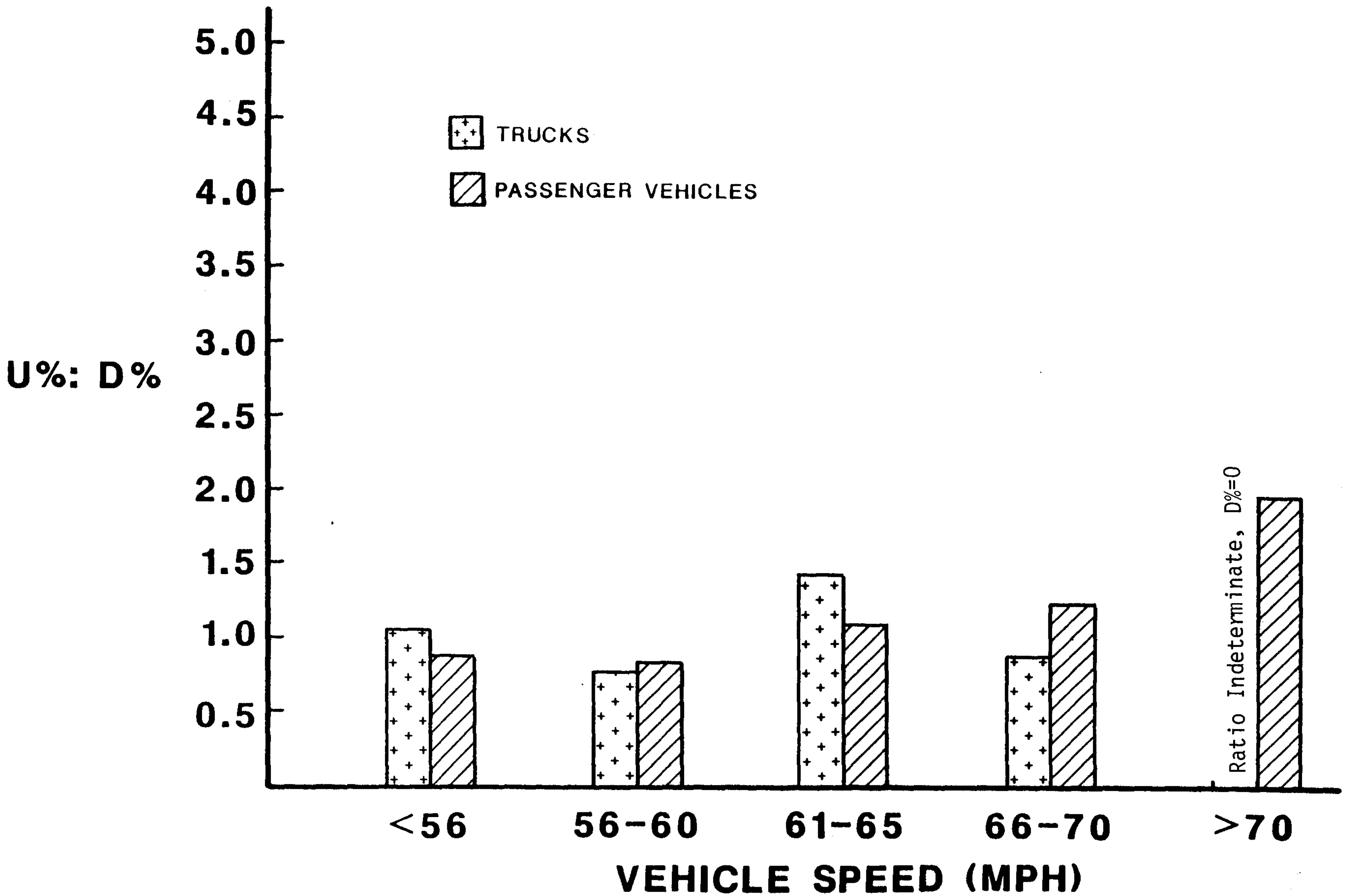


FIGURE 2.3

STATE AND U.S. HIGHWAYS

Ratio of the proportion of vehicles measured in absence of detectable radar (U%) to the proportion measured in the presence of detectable radar (D%)

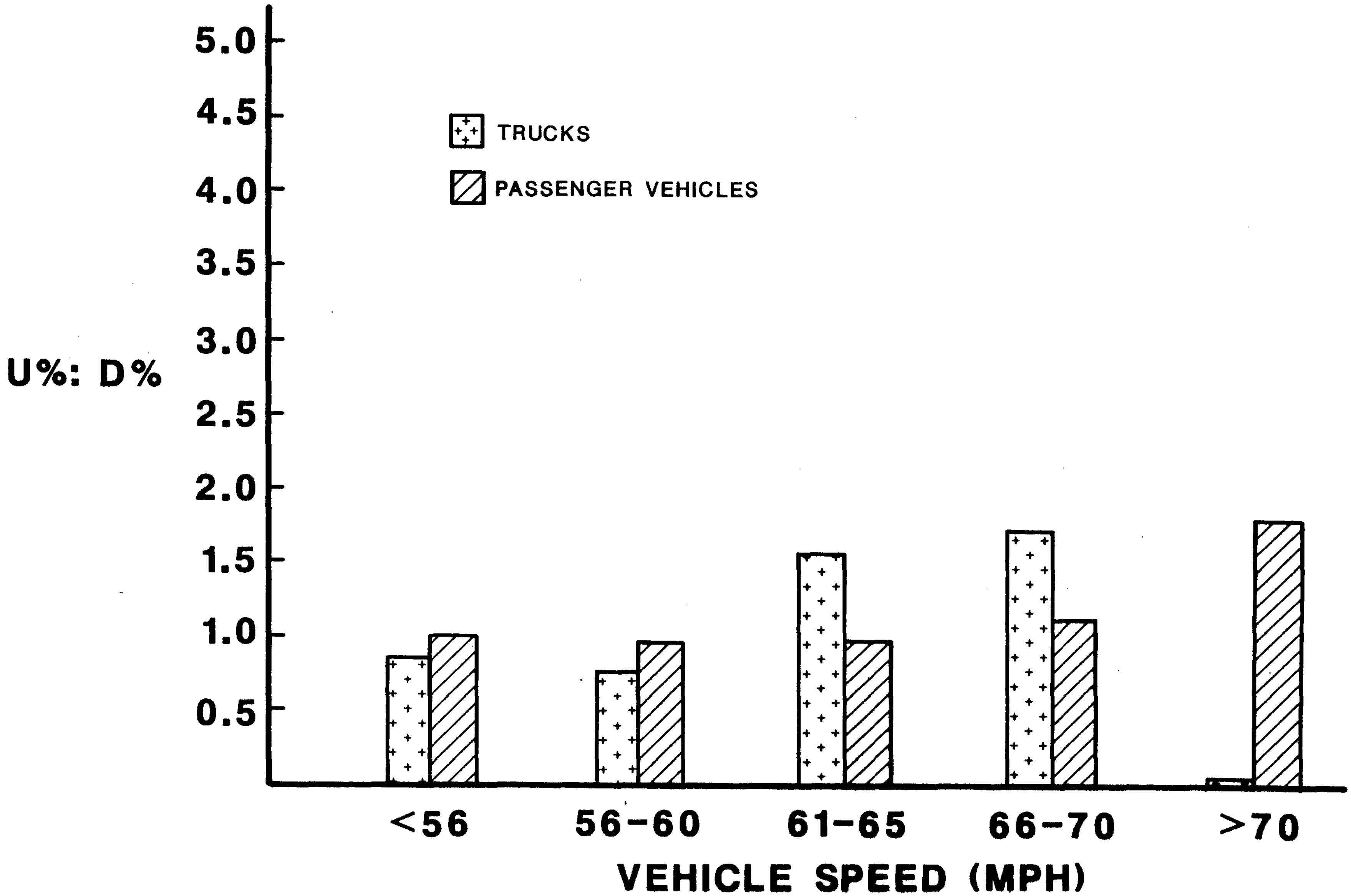


FIGURE 2.4

FARM TO MARKET ROADS

Ratio of the proportion of vehicles measured in absence of detectable radar (U%) to the proportion measured in the presence of detectable radar (D%)

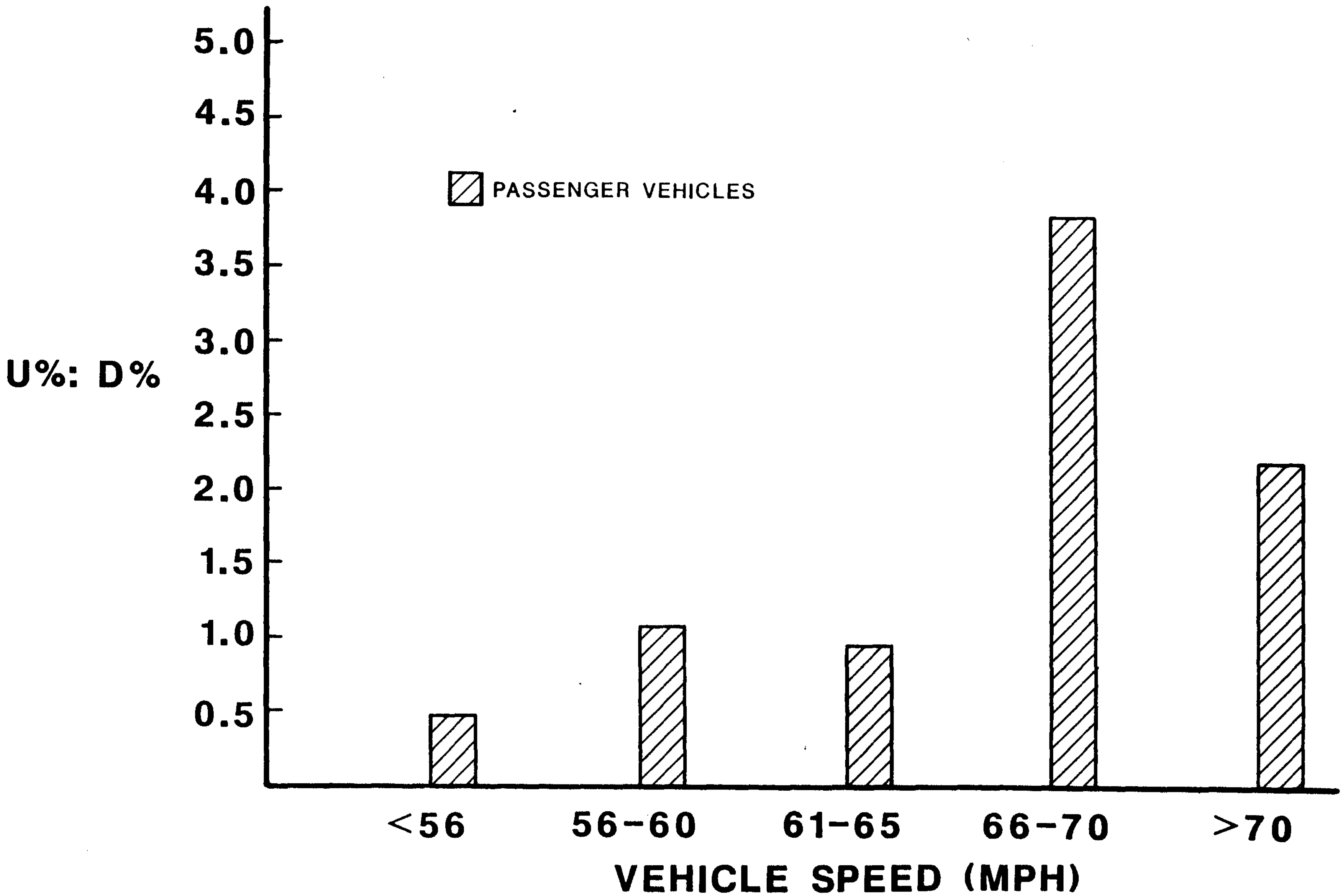


FIGURE 2.5

radar detectors. Some of the vehicles affected by the presence of detectable radar may have been responding to Citizen Band radio reports broadcast by drivers who used radar detectors. Others may have slowed down in response to the braking action of vehicles which were detector-equipped. Nonetheless, the speeds of these vehicles were affected by detectors. The degree of influence of detectable radar depends both on vehicle type and speed category. Truck speeds are clearly more affected than passenger vehicle speeds and, independent of vehicle type, the likelihood of influence increases at higher speeds.

Differences in speed profiles as a function of the two radar conditions can be attributed largely to the influence of radar detectors. Evidence that radar detectors have a substantial effect on traffic speeds in the presence of detectable radar does not, however, provide compelling evidence that the use of detectors encourages higher speeds. The differences in speeds observed in the present data are consistent with the hypothesis that radar detector use results in higher traffic speeds, but are not sufficient by themselves to support that contention. A plausible alternative hypothesis is that the population of detector users is different from the population of non-users in their propensity to drive in excess of legal speeds. If this is the case, a substantial proportion of those who speed and use a detector would also speed without one. Under this scenario, detector use can be viewed as a means for avoiding penalty for excessive speed rather than as an inducement for higher speeds. Where speed enforcement relies primarily on radar, detector-equipped drivers clearly are more likely to succeed in avoiding arrest for their speeding behavior.

Although the present data do not unequivocally support the contention that radar detector use encourages higher traffic speeds in the absence of radar based traffic law enforcement, the nature and magnitude of detector influence observed does have implications for enforcement tactics. Even if detector users do not drive faster because of their detectors, they undoubtedly do drive slower in the presence of a detector signal which is perceived to indicate the presence of enforcement. The greatest influence of detectors clearly resides among the fastest passenger vehicle drivers (>70 mph) and drivers of commercial vehicles. These are the very drivers that pose the greatest enforcement problems. The second phase of this project was directed at examining potential countermeasures to the use of radar detectors.

## 3.0 COUNTERMEASURES TO RADAR DETECTORS

Measures to reduce radar detector influence have been advocated by law enforcement and highway safety professionals. Two basic approaches to reducing the impact of detectors on speed law enforcement have been employed in various jurisdictions:

1. Reducing the availability of radar detectors, and

2. Reducing the effectiveness of detectors in identifying the presence of enforcement activity.

A third approach, investigated here, attempts to use the capability of detectors to receive microwave transmissions to raise the perception of enforcement beyond that which actually exists. In essence, the fact that detector equipped drivers slow down in the presence of a detector signal may be taken advantage of by propagating radar signals which may or may not be accompanied by actual enforcement.

### 3.1 Radar Detector Bans

To date, primary emphasis has been placed on the first approach. Connecticut, Virginia, the District of Columbia, and six Canadian Provinces have enacted legislation or administrative regulations specifically prohibiting the sale, possession and/or use of radar detectors. Similar legislation has been introduced, but not enacted, in other States, including Maryland, Michigan and New York. Kentucky and Michigan have laws that prohibit the use in vehicles of scanners and devices which enable persons to intercept police radio frequencies. Until recently, these laws were interpreted to include radar detectors (Maryland State Police, 1986).

The National Highway Traffic Safety Administration (NHTSA) recommended in

1980 that State legislative action be considered, including enactment of statutes prohibiting the possession and/or use of radar detector devices by motorists. In addition, the Subcommittee on Vehicle Regulation of the National Committee on Uniform Traffic Laws and Ordinances adopted a model ordinance prohibiting the sale, use or possession of radar detectors in June, 1986.

Challenges to detector laws, asserting that they are illegal or unconstitutional on several grounds, have generally met with little success in either State or Federal courts. The application to radar detectors of laws prohibiting in-vehicle devices for intercepting radio frequencies has been successfully challenged (D. H. Hugel in Maryland State Police, 1986).

Although the legality of narrowly drafted legislation specifically prohibiting radar detectors has been upheld, the effectiveness of such legislation is in doubt. Little objective evidence regarding detector ban effectiveness is available. The previously cited Insurance Institute for Highway Safety study (Ciccone, Goodson, and Pollner, 1987) suggests that speeds in Virginia, where detectors are illegal, were affected somewhat less by the presence of detectable radar than in Maryland, where detectors are legal. However, the same proportion of speeding vehicles in both states "reacted to police radar in ways strongly suggesting they had radar detectors." No useful data comparing traffic speeds before and after the introduction of detector bans are available. Opinions expressed by law enforcement officials in personal contacts made during the course of this project suggest limited effectiveness of radar bans. Although at least some of the jurisdictions with detector bans do actively enforce detector prohibitions, such enforcement was viewed by some officers as very ineffective. The opinion was also expressed that detector bans do have a discernible impact on detector use in passenger vehicles but little or no effect among commercial truck drivers. It was also suggested that detector bans can only be effective if they are applied on a broad national scale. Bans in small States with both easy access to detectors in adjacent jurisdictions and a large volume of interstate traffic are unlikely to be effective as a means for controlling traffic speeds.

### 3.2 Reducing the Effectiveness of Radar Detectors

At least two criteria must be met for radar detectors to be effective in allowing motorists to exceed the speed limit with a high degree of impunity. Detector users must be reasonably confident both that signals from their detectors are in fact indicative of the presence of enforcement and that the lack of a signal correctly informs them that enforcement is not present. Obviously, radar detectors provide no special protection against enforcement tactics that do not use radar, e.g. pacing, time and distance computations, e.g. VASCAR, etc. The use of radar is firmly entrenched in the law enforcement community. The advantages of radar traffic enforcement and its effectiveness in the absence of wide spread detector use render the abandonment of this tactic unlikely.

### 3.3 Using Detectors to Control Speeds

Theoretically, if the airwaves were flooded with radio transmissions that were indistinguishable from those transmitted by manned traffic radar, the utility of radar detectors would be eliminated. As a practical matter, it is unlikely that very large areas could be blanketed with such transmissions. In selected areas, however, it may be feasible to broadcast microwave signals that would activate the warning signal of radar detectors. Appropriate strategic deployment of these bogus or decoy signals in the presence and absence of actual enforcement may cause detector users to assume either that enforcement is in the immediate vicinity or that their radar detector is malfunctioning. In either case, the expected result is that at least some detector users would be less likely to speed in the presence of the bogus signals.

Federal Communications Commission (FCC) regulations currently disallow the use of unmanned traffic radar. An exception to this policy has been granted legislatively to Kentucky for the purpose of studying the effectiveness of unmanned radar in controlling speeds on a specific high accident-rate roadway. The results of the study are not yet available.

Microwave devices other than traffic radar, including garage door openers and motion detectors transmit in the same frequency bands as radar. The FCC does not require that these devices be manned. A small scale test of the potential for influencing traffic speeds by propagating microwave signals from non-radar devices was planned to meet the second objective of the present project, namely, to examine the impact of a potential radar detector countermeasure.

### 3.3.1 Drone Transmitters

Radar detectors receive and signal the presence of K band (24.150 GHz) and X band (10.525 GHz) microwave transmissions. Rechargeable battery operated drone transmitters were designed and built for this project that transmit in the K band. The transmitter and battery is contained in a case measuring 7.5 x 4.5 x 2.5 inches. When activated, the drones trigger radar detectors at distances up to approximately 0.5 miles. The effective range of the drones is dependent on terrain, aiming direction of both the drone and detector, detector sensitivity, and drone battery strength.

FCC regulations do not allow devices on the X or K bands which only transmit. The drones, therefore, also include receiver circuitry which provides for the received doppler signal to be used to activate an audible signal. The drones' components are type accepted under FCC regulations in 47 CFR Part 15. Unlike traffic radar, which is regulated under Part 90, Part 15 devices are not required to be licensed or manned.

### 3.3.2 Test of Drone Effectiveness

A rural two lane highway with a high volume of commercial truck traffic was selected for the initial test of drone effectiveness. Drones were placed in the highway right of way such that transmissions were received intermittently by radar detectors along ten miles of roadway in both directions of travel.

The test plan called for the drones to transmit 24 hours a day for a four day period. Speed surveys were to have been conducted within and outside of the signal reception area both in the presence and absence of radar enforcement. A survey of vehicle speeds was conducted on the day following drone deployment without accompanying enforcement. Summary statistics for truck and passenger vehicle speeds measured with undetectable moving radar are provided in Table 3.1. This table includes speed data collected within and outside of the drone signal reception area. As indicated in the table, mean truck speeds were significantly slower, by almost 3 mph, in the signal reception area. Only a very small difference, not statistically significant, was observed in passenger vehicle mean speed. The proportion of trucks exceeding 60 mph was significantly smaller in the signal reception area than in the area before and after reception. For passenger vehicles the observed decrease in the proportion exceeding 60 mph is not statistically significant. A second speed survey was scheduled two days following the first. At the start of data collection it was discovered that all 18 of the drones had been removed from the right of way. Although it can not be stated categorically, it is

**TABLE 3.1 VEHICLE SPEEDS IN DRONE SIGNAL RECEPTION AREA vs OUTSIDE OF RECEPTION AREA**

| | TRUCKS | |
|---|---|---|
| | SIGNAL AREA | NO SIGNAL |
| N= | 73.00 | 58.00 |
| MEAN= | 58.21 | 61.05** |
| SD | 4.62 | 4.72 |
| %>60 | 27.40 | 44.83* |

| | PASSENGER VEHICLES | |
|---|---|---|
| N= | 185.00 | 124.00 |
| MEAN= | 59.81 | 60.45 |
| SD | 4.35 | 4.42 |
| %>60 | 34.05 | 44.35 |

*, ** indicate values significantly larger than corresponding value for other radar condition, * = $p<.05$, ** = $p<.01$.

presumed that they were removed by a detector user or users. While some of the drones were visible from the roadway, many were placed in such a way that they were both difficult to locate visually and physically difficult to access. Although removal of the drones effectively ended the evaluation, the action itself indicates that the drones did have some impact. The limited data collected suggest that decoy transmissions have at least a transient downward influence on traffic speeds.

Clearly, further testing of unmanned drone transmitters will require significant changes in deployment to provide equipment security. Tests of a related application of the drones has been initiated at selected highway maintenance work zones.

Advocates of radar detector use have argued that detectors serve as a tool for motorists to monitor and regulate their speeds rather than as a means for avoiding penalty for speeding behavior. This view, of course, ignores the fact that heretofore such monitoring has only been available in the presence of radar enforcement. The observed differences in traffic speeds measured with detectable and undetectable radar and the limited experience with drone transmissions do indicate that some degree of speed control may in fact be obtained by enlisting the unwitting assistance of radar detector users.

## 4.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Summary of Conclusions

Analysis of the speed data collected for this project leads to two basic conclusions:

1. The presence of detectable radar transmissions has a suppressing effect on traffic speeds. The influence of radar transmissions on traffic speeds varies with highway and vehicle type, but is seen most clearly among trucks and the fastest passenger vehicles. This effect is attributable primarily to the use of radar detectors.

2. The use of drone transmitters has potentially the same effect on traffic speeds as conventional traffic radar. The impact of drone transmissions should be affected by the same variables that influence the effect of radar transmissions, e.g., highway and vehicle type, signal strength, traffic volume, etc.

### 4.2 Recommendations

1. The observed influence of radar detectors on speeds in the presence of detectable radar does not allow a conclusion that detector users drive faster than they would without detectors when enforcement is not perceived. It is recommended that the influence of radar detectors on driving speeds in the absence of a radar signal be investigated.

2. The implementation of drone transmissions for speed control should be selective. A preliminary evaluation of drone use in highway maintenance work zones is currently being undertaken by TTI. Additional candidates for drone use should be investigated. These include transitional areas between speed zones, especially on Interstate highways that change from 65 to 55 mph and on non-Interstates that intersect 65 mph rural Interstates.

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# APPENDIX A

# HIGHWAY SEGMENTS SAMPLED

## PROJECT 5281 DATA COLLECTION SITES

Data Collected 3/3/87 Antenna #D=4138 U=2349

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 1 | SH 6N | 14 | 4 SH | Bryan-Hearne | 9,000 |
| 2 | US 79N | 50 | 2 US | SH6, Hearne-I45, Buffalo | 3,300 |
| 3 | I 45S | 36 | 4 I | SH79, Buffalo-SH21, Madisonville | 16,100 |
| 4 | I 45S | 25 | 4 I | SH21, Madisonville-SH30, Huntsville | 17,000 |
| 5 | I 45S | 35 | 4 I | SH30, Huntsville-SH105, Conroe | 22,000 |
| 6 | I 45S | 20 | 4 I | SH105, Conroe-FM1960 (Maj Mdn&Shd Work Not included in analysis) | 46,000 |
| 7 | SH 6N/US290 | 27 | 4 US/SH | Cypress-Hempstead | 18,500 |
| 8 | SH 6N | 21 | 2/4 SH | Hempstead-SH90, Navasota | 6,400 |
| 9 | SH 6N | 19 | 4 SH | SH90, Navasota-College Station | 7,800 |
| | | 247-20=227 | | | |

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Data Collected 3/11/87 Antenna #D=2349 U=4138,

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| (Reversed order: started at seg. 29) | | | | | |
| 17 | FM 1604N | 24 | 2 FM | I-37 - I10 | ? |
| 18 | I 37S | 8 | 4 1 | I-410 - FM1604 | ? |
| 19 | I 410E | 18 | 4 1 | US90 - I-37 | ? |
| 20 | I 410S | 11 | 4/6 I | I-10 - US90 | ? |
| 21 | US 281S | 18 | 4 US | Spring Branch - FM1604 | 4,800 |
| 22 | US 281S | 23 | 2 US | US290 - Spring Branch | 4,500 |
| 23 | US 290W | 32 | 4 US | SH71, Oak Hill - US281 | 5,000 |
| 24 | I 35S | 14 | 4 I | SH29, Georgetown - North Austin | |
| 25 | I 35S | 30 | 4 I | US190, Belton - SH29, Georgetown | |
| 26 | US190/SH36 | 26 | 2 US/SH | US277, Cameron - SH95 | 5,400 |
| 27 | US190/SH36 | 11 | 2 US/SH | Milano - US77, Cameron | 3,500 |
| 28 | US190/US79 | 18 | 2 US/SH | Hearne - Milano | 4,000 |
| 29 | SH 6N | 14 | 4 SH | Bryan ByPass - Hearne | 8,200 |
| | | 247 | | | |

Data Collected 3/12/87 Antenna #D=2349 U=4138

(Reversed order: started at seg. 16)

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 10 | SH 21E | 18 | 2/4 | SH36, Caldwell ~ FM2818, Bryan | 7,300 |
| 11 | SH 21E | 21 | 2/4 SH | US77 ~ Caldwell | 4,700 |
| 12 | US 77N | 26 | 2/4 US | SH159, LaGrange ~ SH21, Lincoln | 4,100~7,60 |
| 13 | US 77N | 13 | 2 US | I~10 ~ FM155, LaGrange | 3,000 |
| 14 | I~10E | 41 | 4 I | US183, Luling ~ US77 | 10,900 |
| 15 | I~10E | 22 | 4 I | SH123, Seguin ~ US183, Luling | 9,900 |
| 16 | I~10E | 23 | 4 I | FM1604 ~ SH123, Seguin | 15,100 |
| | | 164 | | | |

Data Collected 3/23/87 Antenna #D=4138 U=2349

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 30 | SH 21E | 32 | 2 SH | Bryan ByPass ~ Madisonville | 4,700 |
| 31 | I 45N | 37 | 4 I | SH21, Madisonville ~ SH79, Buffalo | 16,100 |
| 32 | I 45N | 37 | 4 I | SH79, Buffalo ~ SH14, Richland | 14,500 |
| 33 | I 45N | 34 | 4 I | SH114, Richland ~ SH34, Ennis | 16,600 |
| 34 | I 45N | 25 | 4 I | SH34, Ennis ~ S of I635, Hutchins | 18,000 |
| 35 | I 20E | 20 | 4 I | Beltline Rd ~ SH34 | 24,000 |
| 36 | SH 34N | 25 | 2 SH | I 20 ~ I 30 | 4,500 |
| 37 | I 30W | 27 | 4 I | SH 34 ~ Lake Hubbard | 18,500 |
| | | 237 | | | |

Data Collected 3/24/87     Antenna #D=4138  U=2349

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 38 | I 820W | -- | | I 35W - I 30  No Data Collected | 60,000 |
| 39 | I 820N | 15 | 6 I loop | I 30 - I 35 | 50,000 |
| 40 | I 820S | 14 | 6 I loop | I 35 - I 30 | 50,000 |
| 41 | I 820E | 12 | 4 I loop | I 30 - I 35W | 60,000 |
| 42 | I 35W S | 22 | 4 I | SH 174, Burleson - FM916, Grandview | 16,900 |
| 43 | I 35W S | 18 | 4 I | FM916, Grandview - I 35E | 10,000 |
| 44 | I 35W S | 34 | 4 I | I 35E - Waco City Limit | 23,000 |
| 45 | SH 6S | 8 | 4 SH | Waco - SH 164 | 8,400 |
| 46 | SH 6S | 15 | 2 SH | SH 164 - SH7, Marlin | 5,000 |
| 47 | SH 6S | 39 | 2 SH | SH 7, Marlin - SH 79, Hearne | 3,600 |
| 48 | SH 6S | 14 | 4 SH | S Hearne - Bryan ByPass | 8,200 |
| | | 191 | | | |

**TOTAL MILES FOR 46* SEGMENTS = 1066**

***SEGMENT #6 DELETED, NO SEGMENT #38**

# APPENDIX B

## SPEED PROFILES FOR INDIVIDUAL HIGHWAY SEGMENTS

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| SEGMENT : 1 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 73 | 58.47 | 4.76 | 22.61 | 26.03 | 73.97 | 38.36 | 5.48 | 1.37 |
| UNDETECTABLE | 73 | 59.47 | 5.90 | 34.86 | 23.29 | 76.71 | 36.99 | 12.33 | 5.48 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 60 | 58.95 | 4.56 | 20.79 | 21.67 | 78.33 | 41.67 | 6.67 | 1.67 |
| UNDETECTABLE | 55 | 59.84 | 5.63 | 31.69 | 21.82 | 78.18 | 36.36 | 12.73 | 7.27 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 13 | 56.23 | 5.18 | 26.86 | 46.15 | 53.85 | 23.08 | . | . |
| UNDETECTABLE | 18 | 58.33 | 6.72 | 45.18 | 27.78 | 72.22 | 38.89 | 11.11 | . |
| SEGMENT : 2 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 93 | 59.15 | 4.75 | 22.56 | 21.51 | 78.49 | 33.33 | 8.60 | 3.23 |
| UNDETECTABLE | 86 | 59.60 | 5.55 | 30.81 | 20.93 | 79.07 | 39.53 | 9.30 | 4.65 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 75 | 58.97 | 4.79 | 22.92 | 25.33 | 74.67 | 33.33 | 9.33 | 2.67 |
| UNDETECTABLE | 74 | 59.58 | 5.76 | 33.23 | 21.62 | 78.38 | 40.54 | 9.46 | 5.41 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 18 | 59.89 | 4.65 | 21.63 | 5.56 | 94.44 | 33.33 | 5.56 | 5.56 |
| UNDETECTABLE | 12 | 59.75 | 4.18 | 17.48 | 16.67 | 83.33 | 33.33 | 8.33 | . |
| SEGMENT : 3 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 174 | 61.32 | 4.68 | 21.93 | 10.92 | 89.08 | 58.62 | 17.82 | 3.45 |
| UNDETECTABLE | 218 | 61.61 | 5.36 | 28.76 | 9.17 | 90.83 | 55.96 | 20.18 | 5.50 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 99 | 62.48 | 4.72 | 22.23 | 9.09 | 90.91 | 70.71 | 26.26 | 5.05 |
| UNDETECTABLE | 112 | 62.41 | 5.57 | 31.07 | 6.25 | 93.75 | 58.93 | 25.89 | 8.93 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 75 | 59.79 | 4.20 | 17.63 | 13.33 | 86.67 | 42.67 | 6.67 | 1.33 |
| UNDETECTABLE | 106 | 60.77 | 5.02 | 25.21 | 12.26 | 87.74 | 52.83 | 14.15 | 1.89 |
| SEGMENT : 4 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 128 | 61.96 | 4.35 | 18.89 | 6.25 | 93.75 | 60.16 | 21.09 | 3.13 |
| UNDETECTABLE | 128 | 62.24 | 5.26 | 27.70 | 12.50 | 87.50 | 66.41 | 25.78 | 5.47 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 65 | 62.91 | 4.36 | 19.02 | 1.54 | 98.46 | 66.15 | 29.23 | 4.62 |
| UNDETECTABLE | 61 | 62.57 | 5.14 | 26.42 | 13.11 | 86.89 | 67.21 | 27.87 | 4.92 |
| TRUCK | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| DETECTABLE | 63 | 60.98 | 4.14 | 17.14 | 11.11 | 88.89 | 53.97 | 12.70 | 1.59 |
| UNDETECTABLE | 67 | 61.94 | 5.39 | 29.09 | 11.94 | 88.06 | 65.67 | 23.88 | 5.97 |
| SEGMENT : 5 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 150 | 61.48 | 4.71 | 22.21 | 8.00 | 92.00 | 53.33 | 20.67 | 2.67 |
| UNDETECTABLE | 164 | 61.64 | 5.31 | 28.24 | 12.80 | 87.20 | 60.98 | 21.34 | 4.88 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 94 | 62.78 | 4.89 | 23.96 | 7.45 | 92.55 | 64.89 | 29.79 | 4.26 |
| UNDETECTABLE | 104 | 61.93 | 5.60 | 31.31 | 11.54 | 88.46 | 61.54 | 22.12 | 6.73 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 56 | 59.30 | 3.46 | 11.96 | 8.93 | 91.07 | 33.93 | 5.36 | . |
| UNDETECTABLE | 60 | 61.13 | 4.79 | 22.96 | 15.00 | 85.00 | 60.00 | 20.00 | 1.67 |
| SEGMENT : 7 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 129 | 61.14 | 4.28 | 18.31 | 7.75 | 92.25 | 55.04 | 13.18 | 1.55 |
| UNDETECTABLE | 139 | 59.14 | 5.52 | 30.44 | 25.90 | 74.10 | 43.17 | 12.23 | 0.72 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 101 | 61.61 | 3.92 | 15.34 | 2.97 | 97.03 | 59.41 | 13.86 | 1.98 |
| UNDETECTABLE | 102 | 59.70 | 5.49 | 30.09 | 22.55 | 77.45 | 47.06 | 13.73 | 0.98 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 28 | 59.43 | 5.11 | 26.11 | 25.00 | 75.00 | 39.29 | 10.71 | . |
| UNDETECTABLE | 37 | 57.59 | 5.38 | 28.91 | 35.14 | 64.86 | 32.43 | 8.11 | . |
| SEGMENT : 8 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 77 | 61.32 | 5.80 | 33.67 | 16.88 | 83.12 | 58.44 | 23.38 | 5.19 |
| UNDETECTABLE | 85 | 61.51 | 5.75 | 33.11 | 14.12 | 85.88 | 60.00 | 24.71 | 5.88 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 69 | 61.67 | 5.67 | 32.11 | 15.94 | 84.06 | 59.42 | 24.64 | 5.80 |
| UNDETECTABLE | 75 | 61.71 | 5.91 | 34.94 | 13.33 | 86.67 | 61.33 | 26.67 | 6.67 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 8 | 58.38 | 6.52 | 42.55 | 25.00 | 75.00 | 50.00 | 12.50 | . |
| UNDETECTABLE | 10 | 60.00 | 4.35 | 18.89 | 20.00 | 80.00 | 50.00 | 10.00 | . |
| SEGMENT : 9 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 127 | 60.47 | 4.80 | 23.08 | 11.02 | 88.98 | 51.97 | 11.81 | 3.15 |
| UNDETECTABLE | 119 | 60.22 | 5.31 | 28.21 | 20.17 | 79.83 | 48.74 | 13.45 | 4.20 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 112 | 60.64 | 4.98 | 24.77 | 11.61 | 88.39 | 55.36 | 13.39 | 3.57 |
| UNDETECTABLE | 104 | 60.49 | 5.40 | 29.18 | 19.23 | 80.77 | 50.96 | 15.38 | 4.81 |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | PERCENT <56 | >55 | >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| TRUCK | | | | | | | | | |
| DETECTABLE | 15 | 59.20 | 3.05 | 9.31 | 6.67 | 93.33 | 26.67 | . | . |
| UNDETECTABLE | 15 | 58.33 | 4.32 | 18.67 | 26.67 | 73.33 | 33.33 | . | . |
| SEGMENT : 10 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 91 | 57.23 | 4.87 | 23.76 | 39.56 | 60.44 | 25.27 | 4.40 | 1.10 |
| UNDETECTABLE | 94 | 59.22 | 5.54 | 30.67 | 23.40 | 76.60 | 43.62 | 14.89 | 1.06 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 79 | 57.33 | 4.77 | 22.79 | 36.71 | 63.29 | 26.58 | 3.80 | 1.27 |
| UNDETECTABLE | 84 | 59.36 | 5.38 | 28.91 | 21.43 | 78.57 | 42.86 | 15.48 | 1.19 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 12 | 56.58 | 5.68 | 32.27 | 58.33 | 41.67 | 16.67 | 8.33 | . |
| UNDETECTABLE | 10 | 58.10 | 6.98 | 48.77 | 40.00 | 60.00 | 50.00 | 10.00 | . |
| SEGMENT : 11 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 80 | 60.15 | 6.05 | 36.58 | 20.00 | 80.00 | 47.50 | 18.75 | 3.75 |
| UNDETECTABLE | 72 | 61.43 | 6.18 | 38.25 | 13.89 | 86.11 | 54.17 | 25.00 | 6.94 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 71 | 60.25 | 6.13 | 37.62 | 18.31 | 81.69 | 46.48 | 18.31 | 4.23 |
| UNDETECTABLE | 64 | 61.72 | 6.30 | 39.67 | 12.50 | 87.50 | 56.25 | 28.13 | 7.81 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 9 | 59.33 | 5.59 | 31.25 | 33.33 | 66.67 | 55.56 | 22.22 | . |
| UNDETECTABLE | 8 | 59.13 | 4.91 | 24.13 | 25.00 | 75.00 | 37.50 | . | . |
| SEGMENT : 12 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 69 | 57.20 | 6.08 | 36.99 | 36.23 | 63.77 | 27.54 | 10.14 | 1.45 |
| UNDETECTABLE | 65 | 58.17 | 5.65 | 31.89 | 35.38 | 64.62 | 40.00 | 7.69 | 1.54 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 57 | 57.77 | 6.07 | 36.82 | 33.33 | 66.67 | 31.58 | 12.28 | 1.75 |
| UNDETECTABLE | 59 | 58.05 | 5.66 | 31.98 | 35.59 | 64.41 | 38.98 | 6.78 | 1.69 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 12 | 54.50 | 5.62 | 31.55 | 50.00 | 50.00 | 8.33 | . | . |
| UNDETECTABLE | 6 | 59.33 | 5.96 | 35.47 | 33.33 | 66.67 | 50.00 | 16.67 | . |
| SEGMENT : 13 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 34 | 58.47 | 5.96 | 35.47 | 29.41 | 70.59 | 35.29 | 11.76 | 2.94 |
| UNDETECTABLE | 29 | 58.55 | 5.54 | 30.68 | 27.59 | 72.41 | 37.93 | 17.24 | 3.45 |
| PASSENGER | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| DETECTABLE | 29 | 59.17 | 5.79 | 33.50 | 24.14 | 75.86 | 37.93 | 13.79 | 3.45 |
| UNDETECTABLE | 26 | 58.88 | 5.65 | 31.87 | 26.92 | 73.08 | 42.31 | 19.23 | 3.85 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 5 | 54.40 | 5.81 | 33.80 | 60.00 | 40.00 | 20.00 | . | . |
| UNDETECTABLE | 3 | 55.67 | 4.16 | 17.33 | 33.33 | 66.67 | . | . | . |
| SEGMENT : 14 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 225 | 60.86 | 5.43 | 29.46 | 15.11 | 84.89 | 52.44 | 12.00 | 3.56 |
| UNDETECTABLE | 221 | 63.46 | 5.70 | 32.49 | 9.05 | 90.95 | 75.57 | 32.58 | 8.60 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 138 | 62.56 | 5.65 | 31.87 | 7.97 | 92.03 | 68.84 | 18.84 | 5.80 |
| UNDETECTABLE | 128 | 63.57 | 6.05 | 36.59 | 8.59 | 91.41 | 75.00 | 32.81 | 8.59 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 87 | 58.16 | 3.74 | 13.97 | 26.44 | 73.56 | 26.44 | 1.15 | . |
| UNDETECTABLE | 93 | 63.30 | 5.21 | 27.15 | 9.68 | 90.32 | 76.34 | 32.26 | 8.60 |
| SEGMENT : 15 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 100 | 61.25 | 5.36 | 28.71 | 15.00 | 85.00 | 59.00 | 20.00 | 4.00 |
| UNDETECTABLE | 115 | 62.98 | 5.45 | 29.67 | 10.43 | 89.57 | 72.17 | 33.91 | 6.96 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 78 | 62.17 | 5.04 | 25.41 | 8.97 | 91.03 | 66.67 | 24.36 | 5.13 |
| UNDETECTABLE | 87 | 62.94 | 5.46 | 29.80 | 11.49 | 88.51 | 72.41 | 33.33 | 5.75 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 22 | 58.00 | 5.29 | 28.00 | 36.36 | 63.64 | 31.82 | 4.55 | . |
| UNDETECTABLE | 28 | 63.11 | 5.51 | 30.32 | 7.14 | 92.86 | 71.43 | 35.71 | 10.71 |
| SEGMENT : 16 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 139 | 60.39 | 4.47 | 19.99 | 12.95 | 87.05 | 50.36 | 11.51 | 2.16 |
| UNDETECTABLE | 133 | 60.60 | 4.44 | 19.76 | 13.53 | 86.47 | 55.64 | 10.53 | 2.26 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 112 | 60.89 | 4.22 | 17.84 | 9.82 | 90.18 | 56.25 | 13.39 | 1.79 |
| UNDETECTABLE | 104 | 60.52 | 4.56 | 20.78 | 14.42 | 85.58 | 56.73 | 11.54 | 2.88 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 27 | 58.30 | 4.93 | 24.29 | 25.93 | 74.07 | 25.93 | 3.70 | 3.70 |
| UNDETECTABLE | 29 | 60.90 | 4.07 | 16.60 | 10.34 | 89.66 | 51.72 | 6.90 | . |
| SEGMENT : 17 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 58 | 58.22 | 5.13 | 26.28 | 27.59 | 72.41 | 31.03 | 5.17 | 1.72 |
| UNDETECTABLE | 52 | 61.00 | 5.38 | 28.98 | 15.38 | 84.62 | 46.15 | 17.31 | 3.85 |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| PASSENGER | | | | | | | | | |
| DETECTABLE | 53 | 58.36 | 5.34 | 28.47 | 30.19 | 69.81 | 33.96 | 5.66 | 1.89 |
| UNDETECTABLE | 48 | 61.08 | 5.45 | 29.70 | 14.58 | 85.42 | 45.83 | 18.75 | 4.17 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 5 | 56.80 | 1.30 | 1.70 | . | 100 | . | . | . |
| UNDETECTABLE | 4 | 60.00 | 5.10 | 26.00 | 25.00 | 75.00 | 50.00 | . | . |
| SEGMENT : 18 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 67 | 61.21 | 5.82 | 33.90 | 13.43 | 86.57 | 50.75 | 20.90 | 7.46 |
| UNDETECTABLE | 49 | 63.27 | 4.49 | 20.12 | 4.08 | 95.92 | 69.39 | 38.78 | 6.12 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 54 | 61.78 | 6.22 | 38.70 | 14.81 | 85.19 | 55.56 | 25.93 | 9.26 |
| UNDETECTABLE | 32 | 63.84 | 4.55 | 20.72 | 3.13 | 96.88 | 75.00 | 37.50 | 9.38 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 13 | 58.85 | 2.82 | 7.97 | 7.69 | 92.31 | 30.77 | . | . |
| UNDETECTABLE | 17 | 62.18 | 4.28 | 18.28 | 5.88 | 94.12 | 58.82 | 41.18 | . |
| SEGMENT : 19 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 144 | 58.49 | 5.38 | 28.98 | 34.03 | 65.97 | 34.03 | 10.42 | 0.69 |
| UNDETECTABLE | 147 | 60.52 | 5.41 | 29.28 | 20.41 | 79.59 | 52.38 | 18.37 | 2.72 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 130 | 58.58 | 5.58 | 31.10 | 33.85 | 66.15 | 36.15 | 11.54 | 0.77 |
| UNDETECTABLE | 129 | 60.66 | 5.28 | 27.85 | 19.38 | 80.62 | 54.26 | 18.60 | 2.33 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 14 | 57.57 | 3.03 | 9.19 | 35.71 | 64.29 | 14.29 | . | . |
| UNDETECTABLE | 18 | 59.50 | 6.36 | 40.50 | 27.78 | 72.22 | 38.89 | 16.67 | 5.56 |
| SEGMENT : 20 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 74 | 59.96 | 5.64 | 31.77 | 22.97 | 77.03 | 50.00 | 17.57 | 2.70 |
| UNDETECTABLE | 50 | 60.92 | 5.18 | 26.85 | 12.00 | 88.00 | 60.00 | 14.00 | 4.00 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 73 | 60.12 | 5.49 | 30.19 | 21.92 | 78.08 | 50.68 | 17.81 | 2.74 |
| UNDETECTABLE | 42 | 62.24 | 4.05 | 16.43 | 2.38 | 97.62 | 69.05 | 16.67 | 4.76 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 1 | 48.00 | . | . | 100 | . | . | . | . |
| UNDETECTABLE | 8 | 54.00 | 5.15 | 26.57 | 62.50 | 37.50 | 12.50 | . | . |
| SEGMENT : 21 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| DETECTABLE | 91 | 57.99 | 4.76 | 22.61 | 42.86 | 57.14 | 31.87 | 7.69 | . |
| UNDETECTABLE | 86 | 60.09 | 5.42 | 29.36 | 23.26 | 76.74 | 48.84 | 16.28 | 1.16 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 88 | 57.84 | 4.52 | 20.41 | 43.18 | 56.82 | 30.68 | 5.68 | . |
| UNDETECTABLE | 84 | 60.04 | 5.47 | 29.91 | 23.81 | 76.19 | 47.62 | 16.67 | 1.19 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 3 | 62.33 | 10.02 | 100.33 | 33.33 | 66.67 | 66.67 | 66.67 | . |
| UNDETECTABLE | 2 | 62.50 | 0.71 | 0.50 | . | 100 | 100 | . | . |
| SEGMENT : 22 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 77 | 59.17 | 5.79 | 33.56 | 27.27 | 72.73 | 42.86 | 11.69 | 2.60 |
| UNDETECTABLE | 79 | 60.06 | 5.32 | 28.29 | 25.32 | 74.68 | 41.77 | 12.66 | 3.80 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 72 | 59.43 | 5.80 | 33.66 | 25.00 | 75.00 | 44.44 | 12.50 | 2.78 |
| UNDETECTABLE | 71 | 60.17 | 5.38 | 28.97 | 22.54 | 77.46 | 42.25 | 14.08 | 4.23 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 5 | 55.40 | 4.62 | 21.30 | 60.00 | 40.00 | 20.00 | . | . |
| UNDETECTABLE | 8 | 59.13 | 4.94 | 24.41 | 50.00 | 50.00 | 37.50 | . | . |
| SEGMENT : 23 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 102 | 59.59 | 5.83 | 33.97 | 19.61 | 80.39 | 48.04 | 14.71 | 0.98 |
| UNDETECTABLE | 102 | 59.55 | 5.76 | 33.16 | 26.47 | 73.53 | 46.08 | 14.71 | 2.94 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 101 | 59.59 | 5.86 | 34.30 | 19.80 | 80.20 | 48.51 | 14.85 | 0.99 |
| UNDETECTABLE | 95 | 59.67 | 5.75 | 33.12 | 26.32 | 73.68 | 46.32 | 14.74 | 3.16 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 1 | 59.00 | . | . | . | 100 | . | . | . |
| UNDETECTABLE | 7 | 57.86 | 5.98 | 35.81 | 28.57 | 71.43 | 42.86 | 14.29 | . |
| SEGMENT : 24 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 146 | 60.60 | 4.84 | 23.39 | 15.07 | 84.93 | 51.37 | 15.07 | 2.05 |
| UNDETECTABLE | 140 | 60.40 | 4.92 | 24.24 | 17.86 | 82.14 | 50.71 | 16.43 | 1.43 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 112 | 61.53 | 4.60 | 21.17 | 8.04 | 91.96 | 58.93 | 19.64 | 2.68 |
| UNDETECTABLE | 92 | 60.48 | 4.85 | 23.53 | 16.30 | 83.70 | 51.09 | 15.22 | 1.09 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 34 | 57.53 | 4.35 | 18.92 | 38.24 | 61.76 | 26.47 | . | . |
| UNDETECTABLE | 48 | 60.25 | 5.11 | 26.11 | 20.83 | 79.17 | 50.00 | 18.75 | 2.08 |
| SEGMENT : 25 | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 244 | 59.61 | 4.55 | 20.67 | 20.49 | 79.51 | 43.85 | 7.38 | 1.23 |
| UNDETECTABLE | 228 | 61.54 | 5.48 | 30.06 | 17.54 | 82.46 | 60.09 | 24.12 | 3.51 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 175 | 59.99 | 4.41 | 19.46 | 17.71 | 82.29 | 46.86 | 8.57 | 1.14 |
| UNDETECTABLE | 151 | 61.55 | 5.57 | 31.08 | 18.54 | 81.46 | 59.60 | 25.83 | 3.31 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 69 | 58.65 | 4.77 | 22.79 | 27.54 | 72.46 | 36.23 | 4.35 | 1.45 |
| UNDETECTABLE | 77 | 61.52 | 5.33 | 28.44 | 15.58 | 84.42 | 61.04 | 20.78 | 3.90 |
| SEGMENT : 26 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 64 | 58.39 | 4.40 | 19.38 | 26.56 | 73.44 | 34.38 | 1.56 | . |
| UNDETECTABLE | 66 | 61.26 | 5.29 | 28.01 | 12.12 | 87.88 | 57.58 | 19.70 | 3.03 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 57 | 58.49 | 4.46 | 19.90 | 28.07 | 71.93 | 36.84 | 1.75 | . |
| UNDETECTABLE | 49 | 60.47 | 5.52 | 30.42 | 16.33 | 83.67 | 51.02 | 14.29 | 4.08 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 7 | 57.57 | 4.12 | 16.95 | 14.29 | 85.71 | 14.29 | . | . |
| UNDETECTABLE | 17 | 63.53 | 3.89 | 15.14 | . | 100 | 76.47 | 35.29 | . |
| SEGMENT : 27 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 31 | 58.06 | 5.69 | 32.33 | 32.26 | 67.74 | 41.94 | 6.45 | . |
| UNDETECTABLE | 28 | 59.68 | 4.09 | 16.74 | 17.86 | 82.14 | 39.29 | 3.57 | . |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 27 | 58.85 | 5.47 | 29.90 | 25.93 | 74.07 | 48.15 | 7.41 | . |
| UNDETECTABLE | 24 | 59.38 | 3.61 | 13.03 | 16.67 | 83.33 | 37.50 | . | . |
| TRUCK | | | | | | | | | |
| DETECTABLE | 4 | 52.75 | 4.57 | 20.92 | 75.00 | 25.00 | . | . | . |
| UNDETECTABLE | 4 | 61.50 | 6.76 | 45.67 | 25.00 | 75.00 | 50.00 | 25.00 | . |
| SEGMENT : 28 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 46 | 57.89 | 6.56 | 43.03 | 39.13 | 60.87 | 41.30 | 10.87 | . |
| UNDETECTABLE | 44 | 60.02 | 4.86 | 23.60 | 22.73 | 77.27 | 47.73 | 9.09 | . |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 36 | 58.58 | 6.52 | 42.54 | 36.11 | 63.89 | 44.44 | 13.89 | . |
| UNDETECTABLE | 36 | 60.44 | 4.77 | 22.71 | 16.67 | 83.33 | 50.00 | 11.11 | . |
| TRUCK | | | | | | | | | |
| DETECTABLE | 10 | 55.40 | 6.40 | 40.93 | 50.00 | 50.00 | 30.00 | . | . |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| UNDETECTABLE | 8 | 58.13 | 5.14 | 26.41 | 50.00 | 50.00 | 37.50 | . | . |
| SEGMENT : 29 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 85 | 57.82 | 5.39 | 29.03 | 29.41 | 70.59 | 37.65 | 3.53 | . |
| UNDETECTABLE | 78 | 59.72 | 5.48 | 30.00 | 25.64 | 74.36 | 42.31 | 8.97 | 2.56 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 77 | 57.75 | 5.57 | 31.06 | 29.87 | 70.13 | 38.96 | 3.90 | . |
| UNDETECTABLE | 69 | 59.74 | 5.60 | 31.31 | 24.64 | 75.36 | 42.03 | 10.14 | 2.90 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 8 | 58.50 | 3.25 | 10.57 | 25.00 | 75.00 | 25.00 | . | . |
| UNDETECTABLE | 9 | 59.56 | 4.75 | 22.53 | 33.33 | 66.67 | 44.44 | . | . |
| SEGMENT : 30 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 113 | 58.45 | 4.98 | 24.84 | 25.66 | 74.34 | 35.40 | 7.96 | 0.88 |
| UNDETECTABLE | 108 | 58.65 | 6.05 | 36.62 | 25.00 | 75.00 | 36.11 | 12.96 | 1.85 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 101 | 58.75 | 4.88 | 23.79 | 21.78 | 78.22 | 36.63 | 7.92 | 0.99 |
| UNDETECTABLE | 97 | 58.90 | 5.86 | 34.39 | 24.74 | 75.26 | 36.08 | 13.40 | 2.06 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 12 | 55.92 | 5.37 | 28.81 | 58.33 | 41.67 | 25.00 | 8.33 | . |
| UNDETECTABLE | 11 | 56.45 | 7.47 | 55.87 | 27.27 | 72.73 | 36.36 | 9.09 | . |
| SEGMENT : 31 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 285 | 60.96 | 5.40 | 29.16 | 13.68 | 86.32 | 52.98 | 17.19 | 4.21 |
| UNDETECTABLE | 258 | 62.28 | 5.20 | 27.04 | 11.63 | 88.37 | 64.34 | 25.19 | 5.04 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 197 | 62.39 | 5.36 | 28.76 | 8.12 | 91.88 | 64.97 | 23.86 | 6.09 |
| UNDETECTABLE | 160 | 62.63 | 5.39 | 29.10 | 10.00 | 90.00 | 66.87 | 25.62 | 5.62 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 88 | 57.77 | 3.94 | 15.49 | 26.14 | 73.86 | 26.14 | 2.27 | . |
| UNDETECTABLE | 98 | 61.70 | 4.84 | 23.41 | 14.29 | 85.71 | 60.20 | 24.49 | 4.08 |
| SEGMENT : 32 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 281 | 61.52 | 4.83 | 23.29 | 13.52 | 86.48 | 62.63 | 18.51 | 1.42 |
| UNDETECTABLE | 176 | 62.22 | 5.24 | 27.47 | 13.07 | 86.93 | 67.05 | 22.16 | 6.25 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 137 | 62.04 | 4.34 | 18.83 | 7.30 | 92.70 | 65.69 | 18.98 | 1.46 |
| UNDETECTABLE | 119 | 62.69 | 5.38 | 28.98 | 12.61 | 87.39 | 68.91 | 23.53 | 8.40 |
| TRUCK | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | | | PERCENT | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | <56 | >55 | >60 | >65 | >70 |
| DETECTABLE | 144 | 61.02 | 5.21 | 27.20 | 19.44 | 80.56 | 59.72 | 18.06 | 1.39 |
| UNDETECTABLE | 57 | 61.23 | 4.83 | 23.32 | 14.04 | 85.96 | 63.16 | 19.30 | 1.75 |
| SEGMENT : 33 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 243 | 60.18 | 4.29 | 18.38 | 14.40 | 85.60 | 44.86 | 10.70 | 0.82 |
| UNDETECTABLE | 188 | 60.05 | 5.23 | 27.31 | 18.09 | 81.91 | 50.00 | 15.43 | 1.06 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 171 | 61.16 | 4.36 | 19.04 | 11.70 | 88.30 | 56.14 | 15.20 | 1.17 |
| UNDETECTABLE | 132 | 59.89 | 5.38 | 28.97 | 18.94 | 81.06 | 49.24 | 15.91 | 1.52 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 72 | 57.85 | 3.04 | 9.23 | 20.83 | 79.17 | 18.06 | . | . |
| UNDETECTABLE | 56 | 60.43 | 4.86 | 23.63 | 16.07 | 83.93 | 51.79 | 14.29 | . |
| SEGMENT : 34 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 186 | 58.37 | 5.09 | 25.88 | 30.11 | 69.89 | 36.02 | 7.53 | 0.54 |
| UNDETECTABLE | 157 | 57.71 | 5.25 | 27.59 | 34.39 | 65.61 | 29.94 | 7.64 | 1.27 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 135 | 59.96 | 4.45 | 19.78 | 19.26 | 80.74 | 47.41 | 10.37 | 0.74 |
| UNDETECTABLE | 113 | 57.96 | 5.47 | 29.97 | 36.28 | 63.72 | 33.63 | 8.85 | 1.77 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 51 | 54.16 | 4.22 | 17.77 | 58.82 | 41.18 | 5.88 | . | . |
| UNDETECTABLE | 44 | 57.07 | 4.63 | 21.46 | 29.55 | 70.45 | 20.45 | 4.55 | . |
| SEGMENT : 35 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 181 | 59.08 | 5.01 | 25.11 | 22.10 | 77.90 | 43.65 | 6.08 | 1.66 |
| UNDETECTABLE | 181 | 57.18 | 6.77 | 45.81 | 46.96 | 53.04 | 29.83 | 9.94 | 4.42 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 142 | 59.94 | 4.81 | 23.12 | 16.20 | 83.80 | 50.00 | 7.75 | 2.11 |
| UNDETECTABLE | 133 | 58.24 | 7.03 | 49.47 | 42.86 | 57.14 | 36.09 | 12.78 | 6.02 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 39 | 55.97 | 4.53 | 20.50 | 43.59 | 56.41 | 20.51 | . | . |
| UNDETECTABLE | 48 | 54.23 | 4.94 | 24.44 | 58.33 | 41.67 | 12.50 | 2.08 | . |
| SEGMENT : 36 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 102 | 57.13 | 5.37 | 28.83 | 40.20 | 59.80 | 19.61 | 7.84 | 1.96 |
| UNDETECTABLE | 93 | 56.49 | 4.51 | 20.34 | 43.01 | 56.99 | 18.28 | 2.15 | . |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 101 | 57.22 | 5.32 | 28.27 | 39.60 | 60.40 | 19.80 | 7.92 | 1.98 |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| UNDETECTABLE | 91 | 56.57 | 4.52 | 20.43 | 41.76 | 58.24 | 18.68 | 2.20 | . |
| TRUCK | | | | | | | | | |
| DETECTABLE | 1 | 48.00 | . | . | 100 | . | . | . | . |
| UNDETECTABLE | 2 | 53.00 | 2.83 | 8.00 | 100 | . | . | . | . |
| SEGMENT : 37 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 336 | 62.54 | 4.93 | 24.31 | 6.25 | 93.75 | 63.69 | 26.19 | 5.65 |
| UNDETECTABLE | 302 | 63.66 | 5.67 | 32.15 | 9.93 | 90.07 | 75.50 | 37.09 | 8.61 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 263 | 63.43 | 4.87 | 23.67 | 4.56 | 95.44 | 72.24 | 31.94 | 7.22 |
| UNDETECTABLE | 230 | 64.00 | 5.82 | 33.88 | 10.87 | 89.13 | 77.39 | 39.57 | 10.43 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 73 | 59.34 | 3.71 | 13.73 | 12.33 | 87.67 | 32.88 | 5.48 | . |
| UNDETECTABLE | 72 | 62.60 | 5.05 | 25.51 | 6.94 | 93.06 | 69.44 | 29.17 | 2.78 |
| SEGMENT : 39 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 120 | 59.42 | 5.06 | 25.62 | 22.50 | 77.50 | 43.33 | 10.83 | 1.67 |
| UNDETECTABLE | 123 | 59.11 | 5.52 | 30.47 | 32.52 | 67.48 | 41.46 | 14.63 | 1.63 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 94 | 60.13 | 5.07 | 25.75 | 19.15 | 80.85 | 48.94 | 12.77 | 2.13 |
| UNDETECTABLE | 96 | 59.46 | 5.67 | 32.10 | 31.25 | 68.75 | 43.75 | 17.71 | 2.08 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 26 | 56.88 | 4.20 | 17.63 | 34.62 | 65.38 | 23.08 | 3.85 | . |
| UNDETECTABLE | 27 | 57.85 | 4.86 | 23.59 | 37.04 | 62.96 | 33.33 | 3.70 | . |
| SEGMENT : 40 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 146 | 61.27 | 5.00 | 25.01 | 7.53 | 92.47 | 54.11 | 19.86 | 2.05 |
| UNDETECTABLE | 113 | 61.81 | 5.59 | 31.26 | 10.62 | 89.38 | 59.29 | 23.01 | 5.31 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 110 | 61.98 | 4.66 | 21.67 | 4.55 | 95.45 | 60.00 | 22.73 | 2.73 |
| UNDETECTABLE | 87 | 62.47 | 5.64 | 31.76 | 10.34 | 89.66 | 64.37 | 27.59 | 5.75 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 36 | 59.08 | 5.44 | 29.62 | 16.67 | 83.33 | 36.11 | 11.11 | . |
| UNDETECTABLE | 26 | 59.62 | 4.92 | 24.25 | 11.54 | 88.46 | 42.31 | 7.69 | 3.85 |
| SEGMENT : 41 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 104 | 56.83 | 5.11 | 26.09 | 34.62 | 65.38 | 20.19 | 4.81 | . |
| UNDETECTABLE | 82 | 57.55 | 5.85 | 34.18 | 30.49 | 69.51 | 29.27 | 7.32 | 1.22 |
| PASSENGER | | | | | | | | | |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | PERCENT <56 | >55 | >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| DETECTABLE | 82 | 57.28 | 4.83 | 23.29 | 34.15 | 65.85 | 23.17 | 6.10 | . |
| UNDETECTABLE | 69 | 57.99 | 5.91 | 34.90 | 28.99 | 71.01 | 31.88 | 8.70 | 1.45 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 22 | 55.14 | 5.86 | 34.31 | 36.36 | 63.64 | 9.09 | . | . |
| UNDETECTABLE | 13 | 55.23 | 5.10 | 26.03 | 38.46 | 61.54 | 15.38 | . | . |
| SEGMENT : 42 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 140 | 59.71 | 5.41 | 29.24 | 18.57 | 81.43 | 40.71 | 15.00 | 2.14 |
| UNDETECTABLE | 147 | 59.04 | 5.67 | 32.19 | 31.29 | 68.71 | 40.14 | 12.24 | 2.04 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 112 | 60.30 | 5.53 | 30.56 | 16.07 | 83.93 | 46.43 | 17.86 | 2.68 |
| UNDETECTABLE | 119 | 59.03 | 5.95 | 35.42 | 32.77 | 67.23 | 40.34 | 12.61 | 2.52 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 28 | 57.32 | 4.19 | 17.56 | 28.57 | 71.43 | 17.86 | 3.57 | . |
| UNDETECTABLE | 28 | 59.07 | 4.39 | 19.25 | 25.00 | 75.00 | 39.29 | 10.71 | . |
| SEGMENT : 43 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 84 | 60.75 | 5.00 | 24.98 | 11.90 | 88.10 | 52.38 | 13.10 | 2.38 |
| UNDETECTABLE | 78 | 59.86 | 5.27 | 27.79 | 19.23 | 80.77 | 48.72 | 12.82 | 2.56 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 54 | 62.00 | 4.76 | 22.64 | 7.41 | 92.59 | 61.11 | 20.37 | 3.70 |
| UNDETECTABLE | 51 | 59.31 | 5.29 | 28.02 | 21.57 | 78.43 | 45.10 | 7.84 | 1.96 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 30 | 58.50 | 4.69 | 21.98 | 20.00 | 80.00 | 36.67 | . | . |
| UNDETECTABLE | 27 | 60.89 | 5.17 | 26.72 | 14.81 | 85.19 | 55.56 | 22.22 | 3.70 |
| SEGMENT : 44 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 256 | 60.53 | 4.46 | 19.91 | 14.06 | 85.94 | 50.78 | 12.89 | 0.78 |
| UNDETECTABLE | 326 | 59.95 | 5.73 | 32.79 | 22.09 | 77.91 | 47.55 | 15.64 | 2.15 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 168 | 61.43 | 4.40 | 19.38 | 10.71 | 89.29 | 60.71 | 17.26 | 1.19 |
| UNDETECTABLE | 201 | 60.04 | 6.18 | 38.19 | 25.37 | 74.63 | 50.75 | 17.91 | 2.99 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 88 | 58.81 | 4.07 | 16.57 | 20.45 | 79.55 | 31.82 | 4.55 | . |
| UNDETECTABLE | 125 | 59.81 | 4.93 | 24.32 | 16.80 | 83.20 | 42.40 | 12.00 | 0.80 |
| SEGMENT : 45 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 34 | 57.65 | 4.85 | 23.57 | 26.47 | 73.53 | 23.53 | 5.88 | . |

ANALYSIS OF DETECTABLE vs. UNDETECTABLE RADAR UNITS

| | N | MEAN SPEED | STANDARD DEVIATION | VARIANCE | <56 | >55 | PERCENT >60 | >65 | >70 |
|---|---|---|---|---|---|---|---|---|---|
| UNDETECTABLE | 37 | 57.62 | 4.49 | 20.19 | 40.54 | 59.46 | 32.43 | . | . |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 30 | 57.90 | 5.12 | 26.23 | 26.67 | 73.33 | 26.67 | 6.67 | . |
| UNDETECTABLE | 33 | 57.58 | 4.33 | 18.75 | 39.39 | 60.61 | 30.30 | . | . |
| TRUCK | | | | | | | | | |
| DETECTABLE | 4 | 55.75 | 0.50 | 0.25 | 25.00 | 75.00 | . | . | . |
| UNDETECTABLE | 4 | 58.00 | 6.48 | 42.00 | 50.00 | 50.00 | 50.00 | . | . |
| SEGMENT : 46 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 48 | 61.54 | 5.61 | 31.49 | 12.50 | 87.50 | 56.25 | 20.83 | 4.17 |
| UNDETECTABLE | 44 | 58.93 | 7.15 | 51.13 | 29.55 | 70.45 | 36.36 | 11.36 | 4.55 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 39 | 62.15 | 5.72 | 32.77 | 7.69 | 92.31 | 61.54 | 23.08 | 5.13 |
| UNDETECTABLE | 37 | 59.22 | 7.44 | 55.29 | 29.73 | 70.27 | 37.84 | 13.51 | 5.41 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 9 | 58.89 | 4.43 | 19.61 | 33.33 | 66.67 | 33.33 | 11.11 | . |
| UNDETECTABLE | 7 | 57.43 | 5.62 | 31.62 | 28.57 | 71.43 | 28.57 | . | . |
| SEGMENT : 47 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 86 | 58.85 | 4.89 | 23.87 | 26.74 | 73.26 | 33.72 | 11.63 | . |
| UNDETECTABLE | 101 | 59.19 | 6.91 | 47.73 | 29.70 | 70.30 | 40.59 | 14.85 | 5.94 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 68 | 59.32 | 4.97 | 24.70 | 26.47 | 73.53 | 36.76 | 14.71 | . |
| UNDETECTABLE | 79 | 58.91 | 7.20 | 51.85 | 31.65 | 68.35 | 36.71 | 16.46 | 7.59 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 18 | 57.06 | 4.21 | 17.70 | 27.78 | 72.22 | 22.22 | . | . |
| UNDETECTABLE | 22 | 60.18 | 5.78 | 33.39 | 22.73 | 77.27 | 54.55 | 9.09 | . |
| SEGMENT : 48 | | | | | | | | | |
| ALL VEHICLES | | | | | | | | | |
| DETECTABLE | 76 | 58.43 | 5.11 | 26.06 | 34.21 | 65.79 | 34.21 | 6.58 | 2.63 |
| UNDETECTABLE | 83 | 58.43 | 5.40 | 29.13 | 31.33 | 68.67 | 33.73 | 7.23 | 2.41 |
| PASSENGER | | | | | | | | | |
| DETECTABLE | 61 | 58.93 | 5.28 | 27.83 | 31.15 | 68.85 | 37.70 | 8.20 | 3.28 |
| UNDETECTABLE | 73 | 58.47 | 5.50 | 30.20 | 31.51 | 68.49 | 32.88 | 8.22 | 2.74 |
| TRUCK | | | | | | | | | |
| DETECTABLE | 15 | 56.40 | 3.85 | 14.83 | 46.67 | 53.33 | 20.00 | . | . |
| UNDETECTABLE | 10 | 58.20 | 4.87 | 23.73 | 30.00 | 70.00 | 40.00 | . | . |

Data Collected 3/12/87 Antenna #D=2349 U=4138

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| (Reversed order: started at seg. 16) | | | | | |
| 10 | SH 21E | 18 | 2/4 | SH36, Caldwell - FM2818, Bryan | 7,300 |
| 11 | SH 21E | 21 | 2/4 SH | US77 - Caldwell | 4,700 |
| 12 | US 77N | 26 | 2/4 US | SH159, LaGrange - SH21, Lincoln | 4,100-7,60 |
| 13 | US 77N | 13 | 2 US | I-10 - FM155, LaGrange | 3,000 |
| 14 | I-10E | 41 | 4 I | US183, Luling - US77 | 10,900 |
| 15 | I-10E | 22 | 4 I | SH123, Seguin - US183, Luling | 9,900 |
| 16 | I-10E | 23 | 4 I | FM1604 - SH123, Seguin | 15,100 |
| | | 164 | | | |

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Data Collected 3/23/87 Antenna #D=4138 U=2349

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 30 | SH 21E | 32 | 2 SH | Bryan ByPass - Madisonville | 4,700 |
| 31 | I 45N | 37 | 4 I | SH21, Madisonville - SH79, Buffalo | 16,100 |
| 32 | I 45N | 37 | 4 I | SH79, Buffalo - SH14, Richland | 14,500 |
| 33 | I 45N | 34 | 4 I | SH114, Richland - SH34, Ennis | 16,600 |
| 34 | I 45N | 25 | 4 I | SH34, Ennis - S of I635, Hutchins | 18,000 |
| 35 | I 20E | 20 | 4 I | Beltline Rd - SH34 | 24,000 |
| 36 | SH 34N | 25 | 2 SH | I 20 - I 30 | 4,500 |
| 37 | I 30W | 27 | 4 I | SH 34 - Lake Hubbard | 18,500 |
| | | 237 | | | |

Data Collected 3/24/87 Antenna #D=4138 U=2349

| SEG | HIGHWAY | MILES | TYPE | FROM TO | ADT(83) |
|---|---|---|---|---|---|
| 38 | I 820W | -- | | I 35W - I 30 No Data Collected | 60,000 |
| 39 | I 820N | 15 | 6 I loop | I 30 - I 35 | 50,000 |
| 40 | I 820S | 14 | 6 I loop | I 35 - I 30 | 50,000 |
| 41 | I 820E | 12 | 4 I loop | I 30 - I 35W | 60,000 |
| 42 | I 35W S | 22 | 4 I | SH 174, Burleson - FM916, Grandview | 16,900 |
| 43 | I 35W S | 18 | 4 I | FM916, Grandview - I 35E | 10,000 |
| 44 | I 35W S | 34 | 4 I | I 35E - Waco City Limit | 23,000 |
| 45 | SH 6S | 8 | 4 SH | Waco - SH 164 | 8,400 |
| 46 | SH 6S | 15 | 2 SH | SH 164 - SH7, Marlin | 5,000 |
| 47 | SH 6S | 39 | 2 SH | SH 7, Marlin - SH 79, Hearne | 3,600 |
| 48 | SH 6S | 14 | 4 SH | S Hearne - Bryan ByPass | 8,200 |
| | | 191 | | | |

**TOTAL MILES FOR 46* SEGMENTS = 1066**

***SEGMENT #6 DELETED, NO SEGMENT #38**