"EVALUATION OF UNMANNED RADAR INSTALLATIONS"

COMBINED INTERIM AND FINAL REPORT

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Evaluation of Unmanned Radar Installations

An opinion set forth by many safety and enforcement officials is that the only purpose of radar detectors is to allow drivers to speed, and thus avoid speeding citations. If this is the case--and it is not the purpose of this report to pursue this issue--there are two basic approaches to take to mitigate their use. One is to legislatively prohibit their use and the other is to, in some manner, neutralize their operational effectiveness. This report specifically deals with one possible method to neutralize the use of radar detectors--intermittent emission of radar signals from unattended locations and from which no enforcement will follow. Even though motorists may be aware of the use of unattended radar, theoretically those using radar detectors will slow down because of the possibility that the source of the signal being detected is actual police radar speed enforcement.

The concept of unattended radar as an approach to speed control is not new and has been proposed for use many times, especially since the 55 mph national maximum speed limit has been in effect.

The use of unattended radar is allowed by the Federal Communications Commission (FCC) if the return signal is used for a specific purpose such as activating a traffic control device or the analysis of traffic characteristics. Not allowed by the FCC, however, is what is commonly referred to as "broadcast radar" wherein a signal is emitted, but no use is made of the return signal. The FCC regulations covering this subject are found in Title 47 Code of Federal Regulations beginning with Part 90.

The basis for this report was provided by Section 12016 of Public Law 99-570, known as the Commercial Motor Vehicle Safety Act of 1986,enacted October 26, 1986. That section called for the Secretary of Transportation to conduct a demonstration project to assess the benefits of the use of unattended broadcast radar on highway safety, and specified that the project be conducted on a section of Interstate Highway 71/75 in northern Kentucky during the 24-month period commencing with enactment of the section. In calling for the demonstration, Congress granted up to a 2-year exemption from the FCC's regulation regarding unattended broadcast radar at this specific location. The legislation also called for the Secretary to provide an interim report within 18 months, and a final report within 26 months of bill enactment.

Both reports were to contain the results of the demonstration project, together with any recommendations on whether or not to (1) extend the duration of the project, and (2) expand the scope.

This report had been planned in response to the interim report requirement, but events in the project area have unfolded in a manner that will make any further study at this site inconclusive with respect to the goal of the demonstration project. Therefore, in line with a recommendation to terminate the project, it is proposed that this report serve as both the project's interim and final report.

The demonstration project was sponsored by the Kentucky Transportation Cabinet under a contract with the Federal Highway Administration. The actual work was performed on a subcontract to the University of Kentucky Transportation Research Program (UKTRP). Their study is entitled "Evaluation of Unmanned Radar Installations" and provides the results portion of this report. The approach used by UKTRP was to see if the use of unmanned broadcast radar would cause a reduction in overall vehicle speeds as well as a reduction in speed variance. In addition, accident data in the section were also to be reviewed.

Previous research suggests that reductions in both overall speeds and speed variance at a location can be expected to reduce the probability of accidents.

The study demonstrated reductions in speed of the fastest vehicles as well as small changes in speed of overall traffic flow due to the use of unattended broadcast radar signals. The report thoroughly documents all of the statistical methodology; however, the benefits to highway safety in terms of accidents along Interstate 71/75 in northern Kentucky have proven to be unmeasurable.

Due to a multitude of coincidental actions in the project area it was not possible to quantify the safety benefits of unattended broadcast radar at the specified location nor will it be possible within the 24-month period originally provided, or for several years thereafter. These actions include: (1) implementation of a through truck traffic ban, away from the section in question, (2) the 65 mph speed limit posting at the southern end of the project study area affecting speed profiles, and (3) continued advancement of a major reconstruction project in the study section of highway that, when started in 1989, will alter local traffic patterns for several years.

Accordingly, the Department of Transportation recommends that neither the duration of the demonstration project be extended, nor the scope expanded, and that the demonstration project be terminated.

While the safety aspect of this study proved to be indeterminate, the UKTRP study did produce results describing changes in vehicular speeds. Of the several noteworthy conclusions reached, two should be highlighted for consideration. First, unmanned broadcast radar was demonstrated to be an effective means of reducing the number of "high speed" drivers. At the Florence data collection site, for example, with the radar units on, approximately 900 fewer vehicles per day exceeded the speed limit by 15 mph. This amounts to approximately 3 percent of the northbound Annual Average Daily Traffic (AADT) at this location.

Second, at the six speed data collection sites used (2 automated and 4 manual), the reduction in mean speeds of the traffic flow with the radar units on was less than 2 mph. Speed changes of this amount proved to be statistically significant at only 1 of the 2 automated locations.

These two findings suggest that while unattended broadcast radar may not lead to a significant change in the mean speed of vehicles at a given site, it may have application to locations wherein extremely high speeds are known to be contributing to a safety problem.

Existing FCC regulations already allow the use of unattended radar if the return signals are used, such as in the operation of traffic control devices or for the purpose of analyzing traffic characteristics. If the Congress desires to pursue the issue with respect to the use of broadcast radar, however, a second demonstration project would require authorization. The location would have to be one at which high speed drivers are demonstrated to have been associated with accidents at a rate that exceeds statewide rates for highways of similar design and traffic volume.

In summary, the Department of Transportation recommends that:

(1) This specific study be terminated, and

(2) With respect to the reporting requirements in the originating legislation, this report be accepted as a combined interim and final report.

The complete UKTRP report follows.

Research Report
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EVALUATION OF UNMANNED RADAR INSTALLATIONS

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EXECUTIVE SUMMARY

The section of I 75 in northern Kentucky covering a length of approximately four miles from Ft. Mitchell to the Ohio River has been previously noted for its exception to the general interstate guidelines for grade and curvature. Most of I 75 in the study area (Figure 1) was constructed in the early 1960's and the problems associated with excessive grade and curvature in an urban area have been documented since. Improvements have been made over the years but the positive impact of improved safety has generally been offset by increased volume of traffic and resulting congestion. Another recent change in an attempt to improve safety was the diversion of through trucks from I 75 onto the I 275 circle route around Cincinnati.

In an attempt to improve safety by reducing speeds on I 75 in northern Kentucky, five unmanned radar units were installed in the summer of 1986 between Florence and the Ohio River. These units remained in operation for approximately three months, and were then turned off after the Federal Communications Commission ruled that unmanned radar transmitters were in violation of their regulations. Legislation was subsequently passed by the U.S. Congress that exempted a short section of I 75 in northern Kentucky from Federal Communications Commission requirements and mandated that a demonstration project be conducted to assess the benefits of continuous use of unmanned radar equipment.

An evaluation study was to be performed by the University of Kentucky's Transportation Research Program, in cooperation with the Kentucky Department of Highways and the Federal Highway Administration. After additional radar units were installed in the spring of 1987, there was full coverage of the radar signal for northbound traffic from about 0.5 mile south of the Ft. Mitchell (US 25) interchange to the Ohio River (Figure 1). Partial coverage extended from 1.0 mile south of Florence to 0.5 mile south of Ft. Mitchell. The full coverage area was approximately four miles long and the partial coverage area was about nine miles long. The radar units were positioned so that the radar signal could be received over about one-half of the partial coverage area. While the radar units were installed for northbound traffic, the signal could be picked up by southbound traffic.

Because of the geometric characteristics of I 75 in northern Kentucky and other documentation of the speed-safety relationship, it was assumed that reducing speeds would result in a reduction in the frequency of accidents. Accident histories on this section of highway have shown that an unusually high rate of accidents does occur. The accident rate for the section of I 75 between the Ft. Mitchell interchange and the Ohio River was calculated to be 245 accidents per 100 million vehicle miles (ACC/100 MVM) for a three-year period preceding July 1986. This rate was substantially above the statewide average of 156 ACC/100 MVM for urban interstate highways and was also above the critical rate of 171 ACC/100 MVM, which is calculated using the section length and traffic volume.

The objective of this study was to evaluate the speed effects of unmanned radar installations on I 75 in northern Kentucky. Emphasis was placed on the collection and analysis of speed-related data. In addition, a survey of radar detector usage was made and historical accident patterns were documented. The following types of data were collected and analyzed:

1) Automatic speed data,
2) Manual speed data,
3) Speed data for vehicles with and without radar detectors,
4) Speed data with and without the presence of active police enforcement,
5) Radar detector usage data, and
6) Accident data.

Speed measures analyzed included mean speed, standard deviation (variance) in speed, percentages or numbers of vehicles exceeding specified speed levels, and 85th-percentile speed. Statistical tests were used to evaluate the effects of radar.

Results indicate that unmanned radar was an effective means of reducing the number of vehicles traveling at excessive speeds on the study section of I 75. The daily reduction in number of vehicles exceeding the speed limit (55 mph) by 15 mph was determined to be approximately 900 at Florence. At Ft. Wright (where the speed limit was 50 mph for cars and 45 mph for trucks), the number exceeding the speed limit (50 mph) by 15 mph was approximately 350 vehicles per day. When comparing mean speeds with "radar on" and "radar off", there was no statistical difference at Ft. Wright. At Florence, the mean speeds showed a statistically significant decrease with "radar on".

Results from the data collected manually did not reveal any significant differences when comparing mean speeds with "radar on" and "radar off". Apparently the sampling periods were insufficient to identify differences that were shown at locations where automatic equipment was used to collect continuous data.

Approximately 42 percent of the trucks and 11 percent of the cars were found to be equipped with radar detectors.

The use of radar detectors had a significant effect on vehicle speeds. With "radar on" the speeds of vehicles with radar detectors decreased significantly compared to the "radar off" speeds, while the speeds of vehicles without detectors were not affected.

Accidents in the northbound direction of I 75 between Ft. Mitchell and the Ohio River decreased in the one-year period after July 1986, as compared to the three-year period before. Data after July 1986 corresponded to the start of the truck diversion and original installations of the unmanned radar units.

ACKNOWLEDGMENTS

This study was a cooperative effort with the Kentucky Department of Highways. Primary credit for the idea of unmanned radar as a speed control device on I 75 in northern Kentucky should be given to Dale Appel, a Traffic Engineer in District 6. His active participation in the installation and maintenance of radar devices was a major contribution to the overall evaluation. In addition, there were several other employees of the Department of Highways in District 6 who were involved and contributed to the installation and maintenance. A special mention of appreciation is given to Tim McCarthy for his efforts.

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The contributions of the Kentucky State Police, the Kenton County Police, and the Covington Police agencies were very important for the purpose of evaluating the effects of unmanned radar with and without police enforcement.

Data collection efforts by the Kentucky Transportation Cabinet's Division of Motor Vehicle Enforcement were beneficial. The presence of radar detectors in trucks could not have been determined without their assistance.

This report was prepared in consultation with and through the guidance of the following members of the Study Advisory Committee:

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INTRODUCTION

In an attempt to improve safety by reducing speeds on I 75 in northern Kentucky, five unmanned radar units were installed in the summer of 1986. These units remained on for approximately three months, and were then turned off after the Federal Communications Commission ruled that unmanned radar transmitters were in violation of their regulations. In the fall of 1986, legislation was passed by the U.S. Congress that exempted a short section of I 75 in northern Kentucky from Federal Communications Commission requirements (1). Copies of the Federal Communications Commission ruling and the legislation are included as Appendix A. This legislation mandated that a demonstration project be conducted to assess the benefits of continuous use of unmanned radar equipment. After the legislation was signed by the President on October 27, 1986, plans were made for conducting the demonstration project. As a result of a meeting in Frankfort on December 21, 1986, between representatives of the Kentucky Transportation Cabinet, the Federal Highway Administration, and the Federal Communications Commission, the units were turned on again.

Preliminary plans were made for an evaluation study to be performed by the University of Kentucky's Transportation Research Program, in cooperation with the Kentucky Department of Highways and the Federal Highway Administration. Additional radar units were installed in the spring of 1987, with all except one unit operational by June 11, 1987. The last unit to be installed began operating in early August 1987. The study area was divided into two sections of radar signal coverage as shown in Figure 1: 1) the full coverage area included nine unmanned units and extended from Milepoint 187.2, 0.5 mile south of the Ft. Mitchell (US 25) interchange, to Milepoint 191.2 at the Ohio River and 2) the partial coverage area included six units and extended from Milepoint 178.2, about 1.0 mile south of Florence, to 0.5 mile south of the Ft. Mitchell interchange at Milepoint 187.2. The full coverage area was approximately four miles long and the partial coverage area was nine miles long. In the partial coverage area, the radar units were spaced intermittently; however, there were approximately equal distances (4.5 miles) where the radar signal could and could not be received with a radar detector. A listing of the locations of unmanned radar units in the partial coverage area and the full coverage area is presented in Table 1. While the radar units were installed for northbound traffic, the signal also could be received by southbound traffic.

STUDY AREA CHARACTERISTICS

The section of I 75 in northern Kentucky covering a length of approximately four miles from Ft. Mitchell to the Ohio River has been noted for its exception to the general interstate guidelines for grade and curvature. Most of I 75 in the study area (Figure 1) was constructed in the early 1960's and the problems associated with excessive grade and curvature in an urban area have been documented since. Parts of the study area have grades of five percent (downgrade for northbound traffic) and curves of six degrees. In 1971, a Congressional Subcommittee held a public hearing in Covington to discuss the hazardous nature of that section of I 75. Soon afterwards, the Department of Highways' Division of Research conducted an evaluation of various safety features that had been installed on the subject section of I 75 and the results indicated a reduction in accidents (2). Other improvements have been made over the years but the positive impact of improved safety has generally been offset by increased volume of traffic and resulting congestion. Another recent change in an attempt to improve safety was the diversion of through trucks onto the I 275 circle route around Cincinnati (started on July 8, 1986).

The section between Ft. Mitchell and the Ohio River has six lanes of through traffic and carries the highest volumes of any roadway in Kentucky. Average daily volumes for this section are in the range of 120,000 vehicles. This compares to an AADT of about 60,000 at Florence, which is approximately 10 miles south. For northbound traffic, the percentage of trucks ranged from approximately 26 percent just south of the I 275 interchange to 9 percent in Covington.

The speed limit on I 75 is 55 mph in the southern part of the study area and changes to 50 mph for cars at Milepoint 188.0, 0.3 mile north of the Ft. Mitchell (US 25) interchange. In the area of 50-mph speed limit for cars, the limit for trucks is 45 mph. It also should be noted that the breakpoint for change from the 65-mph speed limit (effective June 8, 1987 for rural interstates in Kentucky) to 55 mph is at the KY 338 interchange (MP 175.4), just south of the study area.

RELATIONSHIP BETWEEN SPEED AND SAFETY

Speed has been determined to be one of the most common contributing factors in vehicular accidents. In Kentucky, speed is listed as a contributing factor in 8.9 percent of all accidents and 36.7 percent (the most frequently cited factor) of fatal accidents (3). Consideration of speed presents a dilemma in highway transportation because it affects both safety and efficiency. The basic relationship between speed and stopping distance indicates that stopping distance increases in relation to the square of the speed and the result can be a higher accident potential. Conversely, increased speed can reduce travel costs and increase the operating efficiency of a highway.

The relationship between speed variance and safety has been investigated and it has been shown that the greater the variation in speeds, the higher the probability of an accident, assuming equal exposure (4, 5). Another study examined speed variance and it was found that both slow drivers and fast drivers had accident rates that were approximately six times that of drivers operating close to the mean traffic speed (6).

It also has been documented that the greater the absolute speed, the greater the likelihood of increased accident severity (7). The energy dissipated during a collision is directly proportional to the vehicle's weight and to the square of its speed. Therefore, increased speed results in more energy dissipation, which translates into greater damage to the vehicle and more injuries to the occupants.

The question of whether the use of radar detectors results in increased accidents remains unanswered. Insufficient research has been conducted to address the issues that are necessary for proper evaluation. Those issues include: 1) socio-economic characteristics of drivers using radar detectors as compared to the normal driving population, 2) accident rates based on exposure by type of highway, and 3) overall safety and handling characteristics of vehicles in which radar detectors are used.

EFFECT OF ENFORCEMENT ON SPEED

The presence of police enforcement has been shown to have the effect of decreasing speeds (8, 9). The use of speed enforcement, a speed-check zone, or a parked patrol vehicle produced significant reductions in speeds in the vicinity of the enforcement unit in another study (10). Increased police enforcement in work zones has produced positive effects in terms of speed reduction (11). Active police enforcement in conjunction with the use of radar units has been used in many situations to reduce speed.

Because of the geometric characteristics of I 75 in northern Kentucky, it was assumed that reducing speeds would result in a reduction in the frequency of accidents. Accident histories on this section of highway have revealed an unusually high rate of accidents. The accident rate for the section of I 75 between the Ft. Mitchell interchange and the Ohio River was calculated to be 245 accidents per 100 million vehicle miles (ACC/100 MVM) for a three-year period proceeding July 1986. This rate is substantially above the statewide average of 156 accidents per 100 MVM for urban interstate highways and also above the critical rate of 171 accidents per 100 MVM (3). The critical rate is a calculated value based on statistical tests to determine whether the accident rate for a specific class of highway is high as compared to similar highways.

In an attempt to reduce speeds and accidents on the section of I 75 between Ft. Mitchell and the Ohio River, a decision was made to install unmanned radar units at several locations on I 75 where they would be directed primarily at northbound traffic. The decision was based on the assumption that one practical method to achieve the effect of active police enforcement would be to install unmanned radar units that would simulate the effect of active police units over a long period of time. The assumption also was made that a significant number of drivers used radar detectors in their vehicles to alert them to the presence of police so that their speeds could be reduced accordingly. If drivers use radar detectors to exceed the speed limit and create a condition where there is a wider variance between their speeds and the speeds of other vehicles in the traffic stream, then the probability of accidents would be increased. It also has been speculated that a small percentage of drivers noted the presence of radar detectors in other vehicles and travel behind those vehicles in order to maintain a higher level of speed. It was surmised that if those vehicles with radar detectors and others that may be following in a queue could be affected by unmanned radar units, then the reduction in speeds would have the potential of resulting in a reduction in accidents.

DATA COLLECTION

Several types of data were collected in an attempt to evaluate the impact of unmanned radar installations on speed. In addition to speed-related data, a survey of radar detector usage was made and historical accident patterns were documented.

AUTOMATIC SPEED DATA

Automatic speed data were collected at two locations. The speed monitoring station at Ft. Wright (MP 189.7), installed specifically to collect data for this study, became operational on July 6, 1987. Data were collected for approximately 70 days, with some gaps, through November 1, 1987. During the period of data collection, each of the three northbound lanes of I 75 were monitored separately and data for a sample of 2,180,512 vehicles were collected with "radar on" and 1,576,615 vehicles with "radar off".

The second speed monitoring station was located at Florence (MP 179.2), approximately 10.5 miles south of the Ft. Wright location. This site is among those included in the 55 MPH Compliance Speed Monitoring Program of the Kentucky Department of Highways. Problems associated with the equipment and the form of the data collected during the summer months resulted in data that was questionable for use as part of this evaluation. Useful data were, therefore, limited to an 18-day period in October. The sample size was 236,471 vehicles with "radar on" and 266,267 vehicles with "radar off". While this sample size is considerably smaller than that at Ft. Wright, it is sufficiently large for reliable statistical analysis. It should be noted that the accuracy of speed monitoring equipment was recognized and considered as part of the data collection procedure. For example, the equipment used at Ft. Wright had an accuracy level of plus or minus 1.0 mph for speeds of 60 mph or less and plus or minus 2.0 mph for speeds greater than 60 mph. Because of the procedure used, it was assumed that accuracy-related differences would be equally distributed with "radar on" and "radar off". The locations of the two automatic speed monitoring stations and four manual data collection points are identified in Table 2.

MANUAL SPEED DATA

Manual speed data were collected to supplement the automatic data so that speed data could be collected at additional points in the study area. Data were collected using time-distance methods (stopwatch measurements over a pre-selected distance) rather than radar to insure that radar signals would not be present in the "radar off" condition. Data were collected by three observers at four locations in the study area (Table 2) between June 11 and August 27, 1987. A sample of 150 vehicles was collected for each of the three lanes on each of 15 days. The result was a total sample of 2,250 vehicles per lane at each location. The proportions of cars and trucks, by lane, was determined by means of lane distribution counts in the study area prior to beginning speed data collection.

The sample size of 150 vehicles in each of the three lanes of travel was sufficient to insure, at the 95-percent confidence level, that estimates for the mean speed were statistically reliable within plus or minus 1.0 mph. The procedures for determining sample size were obtained from the publication titled <u>Manual of Traffic Engineering Studies</u>, published by the Institute of Transportation Engineers (12).

Vehicles were classified as cars and trucks. Cars were defined as passenger cars, station wagons, pickups, and vans. Trucks were defined as single-unit trucks and tractor trailers with three axles or more (vehicles with 2 axles and 6 or more tires were also classified as trucks).

SPEED DATA - WITH AND WITHOUT RADAR DETECTORS

A determination was made that, in addition to automatic and manual speed data, it would be desirable to determine the speeds of individual vehicles and also be able to note the presence of radar detectors in those vehicles. This type of data was collected at the Ft. Wright speed monitoring location with the speed-classifier unit used to determine speed, and the presence of radar detectors determined by visual inspection. An observer was stationed on the side of the road at the speed-classifier unit so that speeds of vehicles could be noted at the same time as detectors were observed. Data were collected on 14 days between September 1 and November 19, 1987. Total samples were 1,223 with "radar off" and 2,074 with "radar on".

SPEED DATA - WITH AND WITHOUT POLICE ENFORCEMENT

In an attempt to assess the impact of police enforcement on speeds in the study area, additional data were collected with "radar on" and "radar off" in the vicinity of the Ft. Wright speed monitoring station. The Kentucky State Police cooperated in this effort and data were collected on October 21 with "radar on" and October 28 with "radar off". There were three hours of active enforcement on each day. Speed citations issued by the police officers numbered 23 on October 21 and 28 on October 28. The speed limit in the area of enforcement was 50 mph for cars and 45 mph for trucks. Most of the citations issued were for speeds in excess of 65 mph.

RADAR DETECTOR DATA

Samples of data were collected throughout the study period in order to determine the percentages of vehicles in the I 75 corridor with visible radar detectors. The samples of cars were collected manually by observers as they were traveling on I 75 from Lexington to northern Kentucky. Visual observations were made as they passed or were passed by other vehicles. It also was recognized that some vehicles have built-in detectors that are not visible to observers positioned in another vehicle. Approximately half of the data for cars were collected without distinguishing whether they had in-state or out-of-state licenses. In the second part of the data collection, a distinction was made.

Additional radar detector data were collected by the Kentucky Transportation Cabinet's Division of Motor Vehicle Enforcement. These data were collected as part of vehicle/driver safety inspections (at the truck weight station on I 75 in Scott County) during which truck cab interiors were checked and the presence of radar detectors was noted.

ACCIDENT DATA

Accident data were obtained from the Department of Highways' Division of Traffic and analyzed for the period July 1, 1983 through June 30, 1987. This included three years before the initial radar installations in the summer of 1986 and one year during which radar was on part of the time and trucks were being rerouted. The accident data were collected for two sections of I 75; one section representing the area between MP 175.4 (the KY 338 interchange) and MP 187.7 (the Ft. Wright interchange) and the other for the section between MP 187.7 and MP 191.7 (the Ohio River bridge). These sections represent contrasting conditions in terms of geometrics and volume levels. The section between MP 175.4 and MP 187.7 is relatively straight and level with AADT's in the range of 50,000 to 60,000. By contrast, the section starting at MP 187.7 and continuing to the Ohio River at MP 191.7 is the area of sharp curvature and steep grades with AADT's in excess of 100,000.

ANALYSIS OF DATA

AUTOMATIC SPEED DATA

Highway safety researchers generally agree that the safest traffic conditions include those in which vehicles travel at uniform speeds and those in which excessive speeding is minimized. Since any likely impact of radar on safety stems from its effect on speed, measures of primary interest to this study included those which measure both lack of uniformity--that is, speed variability--and those which measure excessive speeding--that is, the fractions of vehicles in the traffic stream exceeding stipulated speeds. Speed levels chosen for analysis herein included several at the high end of the speed spectrum, namely, 65, 70, 75, and 80 miles per hour. Other speed measures chosen for analysis included the mean speed and the 85th percentile speed, two measures often examined by traffic engineers in speed studies. The statistical procedure used to analyze these data depended on the speed measure of interest as well as how other factors affecting these speed measures were treated.

The major hypothesis being examined herein is that radar signals can beneficially impact these speed measures, reducing both variability and level of speeds. To test this hypothesis, speed measurements were taken on I 75 during both "radar on" and "radar off" conditions. Unfortunately, simple differences between these two conditions may be quite misleading: many factors affect speeds and it is imperative to assure that the analysis is conducted to isolate effects of radar from those of such other factors.

Factors potentially affecting speed that were controlled in the collection of the automatic data included radar (on or off), day of week (weekday or weekend), light condition (daylight or darkness), and lane of travel (median, center, or shoulder). Unfortunately, other variables possibly affecting speed, such as amount of truck traffic and amount of precipitation, could be neither measured nor controlled. Since data were collected over a sufficiently long interval, the potential confounding effects of these other variables was considered to be small enough to be treated as part of measurement error. An effect not thought to be minimal, however, is that due to volume. That speeds are reduced by the congestion of increased volume levels is an established fact. Volume, however, can not be controlled in the sense that the above factors can and is therefore treated as a covariate in the analysis of mean speeds and variability of speeds described below.

For the mean speed, the analysis considers the experiment to be a 2^3 factorial (factors: radar, day, and light) with repeated measures (the three lanes of traffic) each with a separate covariate (volume of vehicles in a given lane). The unit of analysis was the mean speed for one hour of observation. Evaluation of such an experiment requires an analysis of covariance procedure for a split plot experiment with a covariate for each unit in the split plot (lanes). Due to the size of the data base and the number of factors and their levels, separate analyses were performed for each lane of travel.

Variance of vehicle speeds, a second speed measure computed for each hour of observation, is not normally amenable for investigation using analysis of covariance techniques because variances are distributed as Chi-Squared variates and not normal variates. However, for large sample sizes, the Chi-Squared distribution is well approximated by the normal distribution. Because speeds were measured for a large number of vehicles during each hour of data collection, it was assumed that variance could be treated as a normal variate and that standard analysis of covariance routines could be used for analyzing variance of speed as well as for its mean.

Excessive speeding was measured by the proportions or numbers of vehicles exceeding certain high speed levels. At very high levels, use of the standard analysis of covariance technique becomes suspect because of the small numbers of vehicles involved. An alternate statistical procedure, attributed to Campbell (14), is available, however, and is not constrained by the small numbers or proportions of affected vehicles. This procedure, adopted for the analysis herein, treats traffic volume not as a covariate but as a factor similar to day of week and lane of travel. Five levels of volume, representing approximately equal numbers of observed vehicles at Ft. Wright, were analyzed; 0-299, 300-599, 600-899, 900-1,200, and more than 1,200 vehicles per lane per hour. While effects of radar can be accurately assessed, the Campbell procedure does not allow analysis of the statistical significance of interactions among the experimental factors. The Campbell procedure is described in Appendix B.

MANUAL SPEED DATA

Data collected with "radar on" and "radar off" were separated and all data for each condition were combined. Using the combined data, the average speed and standard deviation were calculated as well as the percentage of vehicles exceeding 55, 60, 65, and 70 mph. The t-test was used to test the statistical significance of the differences in the mean speeds and the F-test was used to test differences in standard deviations (13).

SPEED DATA WITH AND WITHOUT RADAR DETECTORS

Speeds of vehicles with and without radar detectors were summarized as a function of whether the radar was on or off. For each set of data, the average speed and standard deviation were calculated as well as the percentages of vehicles exceeding 60, 65, 70, and 75 mph. An "analysis of variance" procedure, with appropriate contrasts, was used to compare mean speeds between the four conditions formed by the combinations of the factors of radar on and off and cars with and without detectors. Bartlett's procedure was used to compare the variability of speeds between these four conditions and a contingency table analysis was used to compare the proportion of vehicles exceeding 60, 65, 70, and 75 mph between these four conditions.

SPEED DATA WITH AND WITHOUT POLICE ENFORCEMENT

The data used for evaluating the impact of police enforcement on speeds with "radar on" and "radar off" consisted of three hours of data during each of the conditions. Time periods for data collection were limited because of the availability of enforcement personnel; however, the total sample of vehicles included in each three-hour period was approximately 8,000. These data were combined into four sets representing 1) active enforcement - "radar off", 2) no enforcement - "radar off", 3) active enforcement - "radar on", and 4) no enforcement - "radar on". The combined sets of data were compared statistically by calculating the mean speed, standard deviation, and percentages of vehicles exceeding 65, 70, 75, and 80 mph. The t-test was used to test for statistical differences in mean speeds and the Chi-Squared test was used to determine if differences in the number of vehicles exceeding the speed levels of 65, 70, 75, and 80 mph were different (13).

ACCIDENT DATA

The data were summarized into two location categories and two time categories. The location categories were 1) from the KY 338 interchange to the Ft. Mitchell (US 25) interchange and 2) from the Ft. Mitchell interchange to the Ohio River. The time periods were the three-year period from July 1, 1983 to June 30, 1986 before the start of the unmanned radar and the truck diversion and the one-year period of July 1, 1986 through June 30, 1987. For each category, the total number of accidents per year and the accident rate were calculated along with the percentages of accidents involving trucks, injuries or fatalities, speed as a contributing factor, darkness, and a wet or snowy pavement.

RESULTS

AUTOMATIC SPEED DATA

A comparison of the mean speeds at the Ft. Wright and Florence speed monitoring stations is presented in Tables 4 and 5. Specifically, Table 4 lists the mean speeds at each station with "radar on" and with "radar off" for each lane of traffic under all other conditions, by type of day (weekday and weekend), and by type of light (daylight and darkness). Mean speeds were computed by first regressing average speed on traffic volume for each hour of study via an analysis of covariance and then computing the predicted mean speed at the average level of traffic volume in the resulting regression equation. These "adjusted" mean speeds were next compared using the analysis of covariance, and the P values for these comparisons are listed in Table 5. The results given below are based on these P values.

At the Ft. Wright station, the adjusted mean speeds for both the median and center lanes with "radar on" were lower than the corresponding adjusted mean speeds with "radar off" for each type of condition listed above. None of these differences were determined to be statistically significant based on the results shown in Table 5 where the main effect of radar and the two- and three-factor interactions involving radar and the effects of day and/or light all had P values greater than 0.05. However, for the median lane, the difference in the adjusted mean speeds between "radar off", 62.98, and "radar on", 62.58, was marginally significant ($P = 0.0529$). Although the adjusted mean speeds were not consistently lower in the shoulder lane when radar was on, there was no statistically significant difference between adjusted mean speeds when "radar off" was compared to "radar on" for this lane. As expected, the adjusted mean speeds were significantly lower in darkness compared to daylight ($P < 0.0001$ for all three lanes). Weekend speeds were significantly higher when compared to the weekday ($P < 0.0001$ for the shoulder lane, $P < 0.001$ for the center lane) and the interaction between day and light is significant ($P < 0.0001$ for the median and center lanes).

At the Florence station, the adjusted mean speed with "radar on", 64.50 mph, in the median lane is significantly lower than the corresponding adjusted mean speed with "radar off", 66.36 ($P < 0.0001$); the adjusted mean speed with "radar on", 62.06, in the center lane is significantly lower than the corresponding adjusted mean speed with "radar off", 63.72 ($P < 0.0001$); and the adjusted mean speed with "radar on", 57.15, in the shoulder lane is significantly lower than the corresponding adjusted mean speed with "radar off", 58.61 ($P < 0.0001$). Hence, the use of the unmanned radar installation at Florence produced significantly lower mean speeds with "radar on" when compared to "radar off" for all three lanes of traffic. According to Table 4, the effect of radar varied by day of week, with radar producing a larger reduction in speeds on weekends for all three lanes. The effect of radar also varied by type of light, with radar producing a larger reduction in speeds at night for both center and shoulder lanes.

Adjusted mean speeds at the Florence station were higher than at the Ft. Wright station, which was expected due to the lower speed limit, higher traffic volumes, and restricted roadway geometrics at the Ft. Wright station. The speed limit at Florence was 55 mph as compared to 50 mph for cars and 45 mph for trucks at Ft. Wright. Average ADT's at Florence were in the range of 50,000 to 60,000 as compared to 100,000 to 120,000 at Ft. Wright. In addition, roadway geometrics at Florence were generally straight and level as compared to relatively sharp curves and steep grades at Ft. Wright.

A comparison of the actual and expected number of vehicles above various speeds is shown in Table 6. The actual number of vehicles was the number of vehicles traveling above the given speed with "radar on". This was compared to an expected number of vehicles traveling above a given speed, which was calculated using the data obtained with "radar off" (see illustrative procedure in Appendix B).

The data in Table 6 show what was found to be a statistically significant decrease in vehicles traveling above the high speeds of 65 to 80 mph at both locations. The reduction was more at Florence than at Ft. Wright which would be logical since the spe ds at the Florence station were higher. The traffic volume at the Florence station was about one-half that at Ft. Wright. The high traffic volume combined with the restrictive roadway geometrics at Ft. Wright could result in a greater safety benefit from the reduction in excessive speeding than at Florence even though fewer vehicles were affected. Daily reductions in the number of vehicles exceeding the various speeds are listed. The reductions per day vary from 2,199 exceeding 65 mph at the Florence station to 6 exceeding 80 mph at Ft. Wright.

A comparison of the actual and expected number of vehicles traveling above various speeds is shown in Table 7 as a function of lane. At Florence, the reductions in speed were generally highest for the median lane while the reductions were generally highest for the shoulder lane at Ft. Wright. There were reductions in each lane at both locations, with all the differences determined to be statistically significant.

The differences in actual and expected number of vehicles traveling above various speeds, as a function of day of the week, are presented in Table 8. There was a larger reduction in excessive speeds on the weekend at Florence than on weekdays; no such difference was detected at Ft. Wright. All reductions of Table 8 were statistically significant.

The differences in actual and expected number of vehicles traveling above various speeds, as a function of light condition, are shown in Table 9. At Florence, the reductions during darkness were slightly higher than those during daylight. There were no substantial differences between daylight and darkness at Ft. Wright. All of the differences were statistically significant.

Presented in Table 10 are comparisons of actual and expected numbers of vehicles above various speeds as a function of traffic volume. There were reductions in every category and almost all were statistically significant; however, no trend was detected in which the reductions could be related to traffic volume.

A comparison of the variation of speeds at the two stations is presented in Tables 11 and 12. Specifically, Table 11 lists the adjusted standard deviations of speeds at each station with "radar on" and with "radar off" for each lane of traffic and for various combinations of radar with type of day and type of light. These standard deviations were computed by first regressing the variance of speed on traffic volume for each hour of study via an analysis of covariance; then computing the predicted variance of speed at the average level of traffic volume in the resulting regression equations; and finally converting the predicted variances to predicted standard deviations. These adjusted standard deviations of speeds were compared using the analysis of covariance; the P values for these comparisons are listed in Table 12. A summary of the significant comparisons follows.

At the Ft. Wright station the adjusted standard deviation of speeds with "radar on", 4.97, in the median lane is significantly lower than the corresponding standard deviation with "radar off", 5.08 ($P < 0.0097$); the standard deviation with "radar on", 4.66, in the center lane is significantly lower than the corresponding standard deviation with "radar off", 4.79 ($P < 0.0005$). For the shoulder lane the adjusted standard deviation with "radar on" is significantly lower than the standard deviation with "radar off" for weekdays but not weekends or for daylight but not darkness. For both the center and shoulder lanes the adjusted standard deviation of speeds was significantly higher on weekdays as opposed to weekends and during daylight as opposed to darkness.

At the Florence station, similar results were obtained for the effect of radar in that the adjusted standard deviation of speeds was significantly lower when radar was on compared to when radar was off for both the center and shoulder lanes. For the median lane there was a significant "radar by light" interaction (P = 0.054) that can be explained as follows: with "radar on" in darkness the adjusted standard deviation is 5.67, which is considerably lower than the corresponding figure with "radar off" (6.24); however, there is no effect during daylight (standard deviations of 5.38 and 5.36 when radar is on and off, respectively). The effect of light is different at the Florence station with darkness producing more variable speeds for the median lane, less variable speeds for the shoulder lane, and no significant effect for the center lane. Finally, the adjusted standard deviation of speeds is significantly higher on the weekend when compared to the weekday for the shoulder lane at this station while the opposite is true for this same lane at the Ft. Wright station.

The 85th-percentile speed is a measure commonly used to describe traffic speeds. A summary of the actual and expected 85th-percentile speeds at the Ft. Wright and Florence stations for the various categories is presented in Table 13. The actual speeds with "radar on" were lower than the expected speeds, using the "radar off" data, for every category. The differences, while small, were larger than those found for the mean speeds at the Ft. Wright station. The differences were larger at Florence than at Ft. Wright and were very similar to those found for the mean speeds. No statistical analyses were performed to compare the 85th-percentile speeds.

MANUAL SPEED DATA

The manual data collected at the four locations are summarized in Table 14. The average speed, standard deviation, and the percentage of vehicles exceeding various speeds are presented. Statistical tests indicated that none of the differences in average speed were significant. There was no general trend in the speeds with "radar on" or "radar off" at either the District Office or Jefferson Street locations. Speeds at the Ft. Mitchell location were lower with "radar on". The results show that the sample of speed data collected manually was apparently insufficient to include all the conditions that would identify differences expected by time of day, day of week, light conditions, and traffic volumes.

All speeds increased from the shoulder to the center to the median lane. Speeds decreased as traffic proceeded northbound from the "rest area" location to the "Jefferson Street" location.

SPEED DATA - WITH AND WITHOUT RADAR DETECTORS

The summary of speed data for vehicles with and without a radar detector is presented in Table 15. The data also are summarized with "radar on" and "radar off". All data were collected in the median lane at the Ft. Wright speed monitoring station. The analysis showed that, when the radar was off, the percentage of vehicles with a speed over specified high speeds was higher for vehicles with radar detectors. Conversely, when the radar was on, the percentage of vehicles with speeds over these high speeds was higher for vehicles without a radar detector. It is also interesting to note the reduction in the percentage of vehicles with detectors traveling above these speeds when the radar was on. For example, the percentage of vehicles exceeding 65 mph was about 36 percent for vehicles with radar detectors during "radar off" conditions and this percentage decreased to about 20 percent with "radar on". Conversely, this percentage did not change for vehicles with no radar detector, with 28 percent during "radar off" and 27 percent during "radar on".

A comparison of mean speeds between the four conditions given in Table 15 using a one-way analysis of variance F test, indicated statistically significant differences in the means. This permitted the construction of the following three contrasts of interest: 1) a contrast for testing the difference between the effect of radar for cars with detectors and the effect of radar for cars without detectors (interaction between radar and detectors), which was significant ($P < 0.0001$); 2) a contrast for testing the effect of radar for cars with detectors, which was significant ($t = 3.56$, $P < 0.0001$); and 3) a contrast for testing the effect of radar for cars without detectors, which was not significant ($P > 0.50$). These data show that, while mean speeds decreased significantly for cars with detectors when comparing "radar off" and "radar on" conditions (64.64 mph compared to 62.60 mph), mean speeds did not change significantly for cars without detectors (63.57 mph compared to 63.49 mph). With "radar off", the average speeds of vehicles with detectors were higher than vehicles without detectors (64.64 mph compared to 63.57 mph); and conversely, with "radar on", the average speeds of vehicles without detectors were higher than vehicles with detectors (63.49 mph compared to 62.60 mph).

A statistical analysis of the percentage of vehicles exceeding the various speed levels was performed. For each speed level, Chi-Square tests were performed for the four conditions given in Table 15. When this result was significant, Chi-Square tests were conducted comparing radar on and off for vehicles with and without detectors as well as data for vehicles with and without detectors for the radar on and off. When the data for vehicles with radar detectors were analyzed, it was found that the percentage exceeding 65 mph was reduced by a statistically significant amount with the "radar on" (19.8 percent) compared to "radar off" (36.4 percent). No significant differences were found comparing the data for vehicles without radar detectors when "radar on" and "radar off" conditions were compared. Under "radar off" conditions, the percentage of vehicles exceeding 65 mph (36.4 percent compared to 27.7 percent) and 70 mph (10.6 percent compared to 5.0 percent) was statistically higher for vehicles with radar detectors (the percent of vehicles exceeding 60 mph was statistically (marginally) higher for vehicles with detectors). Under "radar on" conditions, the percentage of vehicles exceeding 60 mph (80.4 percent compared to 71.9 percent) was found to be statistically (marginally) higher for vehicles without a radar detector.

The change in the variability of speeds can be shown in the standard deviations. A comparison between the standard deviation of speeds under the four conditions given in Table 15 was made using Bartlett's statistic ($P < 0.05$). In light of this significant result, F statistics were used to compare the standard deviations between radar on (3.74) and off (4.64) for cars with detectors ($P < 0.01$) and to compare the standard deviations between radar on (4.02) and off (4.21) for cars without detectors ($P < 0.05$). These data show that the variability of speeds was decreased significantly under the "radar on" condition for vehicles with radar detectors as well as for those without detectors. For vehicles with radar detectors, the standard deviation decreased substantially (4.64 compared to 3.74) as a result of radar. When the radar was off the standard deviation of speeds of vehicles with detectors was higher than without detectors (4.64 compared to 4.21); when the radar was on, the standard deviation of speeds of vehicles without detectors was higher than with detectors (4.02 compared to 3.74). These data show that the variability of speeds was decreased under the "radar on" condition, especially for vehicles with radar detectors.

SPEED DATA - WITH AND WITHOUT POLICE ENFORCEMENT

The effect of active enforcement on speeds is shown in Table 16. The data show that both the mean speeds and the percentages of vehicles exceeding various speeds were reduced as a result of active police enforcement. These reductions occurred both with "radar on" and "radar off". The reductions in mean speed and the percentage exceeding 65 mph and 70 mph were determined to be statistically significant.

RADAR DETECTOR DATA

A sample of 318 trucks was inspected by the Division of Motor Vehicle Enforcement during its regular inspection activities at the Scott County weigh station on I 75 between May 15 and June 1, 1987. A visual inspection of the truck cab interiors revealed that 135, or 42.4 percent, of the trucks had radar detectors.

Observations of the number of vehicles with visible detectors were conducted on 14 days between June 2 and August 22, 1987, on I 75 during trips between Lexington and northern Kentucky. A sample of 768 cars between June 2 and July 30 showed that 66, or 8.6 percent, had radar detectors. Another sample between August 4 and August 22 classified the cars into in-state and out-of-state. There was very little difference between in-state and out-of-state with 13.5 percent (55 of 406) in-state cars and 12.9 percent (55 of 426) out-of-state cars having radar detectors. Combining all the data yielded 11.0 percent of cars with detectors.

ACCIDENT ANALYSES

A summary of the analysis of accident records is presented in Table 17. The summary for the 12.3-mile section between the KY 338 interchange and the Ft. Mitchell (US 25) interchange was tabulated separately from the 4.1-mile section between the Ft. Mitchell interchange and the Ohio River. The section between KY 338 and Ft. Mitchell had an average ADT of about 82,000 over the four-year study period compared with about 102,000 for the section between Ft. Mitchell and the Ohio River. During the time covered by the radar experiment, there was basically full radar coverage of the section between Ft. Mitchell and the Ohio River and partial coverage for the other section.

The number of accidents and accident rate were much higher for the section between Ft. Mitchell and the Ohio River. The accident rate for this section during the three years prior to truck diversion and initial radar installations was 245 accidents per 100 MVM. This was above the statewide average of 156 accidents per 100 MVM and a three-year critical rate of 171 accidents per 100 MVM for urban interstates. Critical rates for various types of highways in Kentucky were determined as part of other research (3). In general, the critical rate for a type of highway is calculated using statistical tests to determine whether the accident rate for a specific class of highway is abnormally high compared to a predetermined average for highways with similar characteristics. The statistical tests are based on the commonly accepted assumption that accidents approximate the Poisson distribution.

The accident rate for the section between the KY 338 and Ft. Mitchell interchanges was much lower (a rate of 42 accidents per 100 MVM during the three years prior to truck diversion and radar installations). Although this section of I 75 is classified as an urban interstate, some parts are more representative of a rural interstate. The average rate for rural interstates is 69 accidents per 100 MVM and for similar urban interstates the rate is 156 accidents per 100 MVM.

The data were summarized for a three-year period prior to July 1986 and a one-year period after that date. That date coincided with a diversion of northbound trucks from I 75 onto I 275 and also represents the approximate date when the unmanned radar was started. Both of these factors could have the potential for affecting accidents within the northbound lanes in the July 1986 through June 1987 time period. Also, the impact should be most obvious on the section between Ft. Mitchell and the Ohio River since both factors would apply to the total length of this section. However, only a portion of the section between the KY 338 and Ft. Mitchell interchanges would be affected.

A comparison between the two roadway sections and two time periods showed that the major change was on the section between Ft. Mitchell and the Ohio River. Specifically, the accident rate was reduced during the July 1986 to June 1987 time period. This was primarily the result of a reduction in the number of accidents in the northbound direction, which was shown to be related to a reduction in the number of truck accidents. This would be related to the truck diversion. It also should be noted that there was a reduction in the percentage of speed-related accidents for northbound traffic in this section, which could be related to the unmanned radar.

SUMMARY AND CONCLUSIONS

Following is a summary of the major findings and conclusions from the analyses performed during this study.

1. At the Ft. Wright speed monitoring station, there was no statistical difference in mean speeds with "radar on" and "radar off".
2. At the Florence speed monitoring station, data indicated the mean speeds showed a statistically significant decrease with "radar on".
3. At both speed monitoring stations, there were statistically significant reductions in the numbers of vehicles exceeding speed levels of 65 to 80 mph when "radar on" (actual) and "radar off" (expected) speeds were compared.
4. Unmanned radar was demonstrated to be an effective means of reducing the number of "high-speed" drivers. The reduction per day in numbers of vehicles exceeding the speed limit (55 mph) by 15 mph was determined to be approximately 900 at Florence as compared to approximately 350 vehicles per day exceeding the speed limit (50 mph) by 15 mph at Ft.

Wright.

5. The variability of speeds at the speed monitoring stations (as measured by the standard deviation) decreased with "radar on" as compared to "radar off".

6. The 85th-percentile speeds were lower with "radar on" at the speed monitoring stations. The differences were very small at the Ft. Wright station.

7. The manual data collection did not reveal any statistically significant differences when comparing mean speeds with "radar on" and "radar off". Results indicated that the sampling periods were apparently insufficient to include all conditions that might identify differences that were shown at locations where automatic equipment was used to collect continuous data.

8. About 42 percent of trucks and 11 percent of cars were observed to have radar detectors. There was no substantial difference in the percentage of in-state and out-of-state cars with radar detectors.

9. Speeds of vehicles with and without detectors for "radar on" and "radar off" conditions indicated that the use of radar detectors had a significant effect on vehicle speeds. With "radar on" conditions, the speeds of vehicles with radar detectors decreased significantly compared to the "radar off" conditions, while the speeds of vehicles without detectors were not affected by the radar. These data also indicated that the variability of speeds was decreased under the "radar on" condition, especially for vehicles with radar detectors.

10. Active police enforcement was found to produce a statistically significant reduction in mean speeds and the percentage of vehicles exceeding various speeds.

11. Accidents in the northbound direction on I 75 between Ft. Mitchell and the Ohio River were found to have decreased in the one-year period after July 1986 compared to the three-year period before. This reduction was apparently related to the truck diversion and, possibly, the unmanned radar. There was a reduction in the percentage of truck-related and speed-related accidents for northbound traffic in this section.

RECOMMENDATIONS

The results from analyses of data at the speed monitoring stations demonstrated that the unmanned radar had the significant effect of reducing the number of vehicles traveling at excessive speeds. It should be noted that even though the effect of unmanned radar was dramatic at Florence, it is questionable whether continuation of unmanned radar is justifiable at a location where the accident rate is relatively low. However, data at the Ft. Wright location show that unmanned radar may have a positive effect and reduce speeds at a location where higher speeds have a much greater potential of increasing accidents. For the purposes of evaluation, the data support continuation of the use of unmanned radar throughout the study area at least until a determination is made of the impact on accidents.

To determine whether the speed-reducing effect of unmanned radar has resulted in a reduction in accidents, a longer-term in-depth accident study should be conducted.

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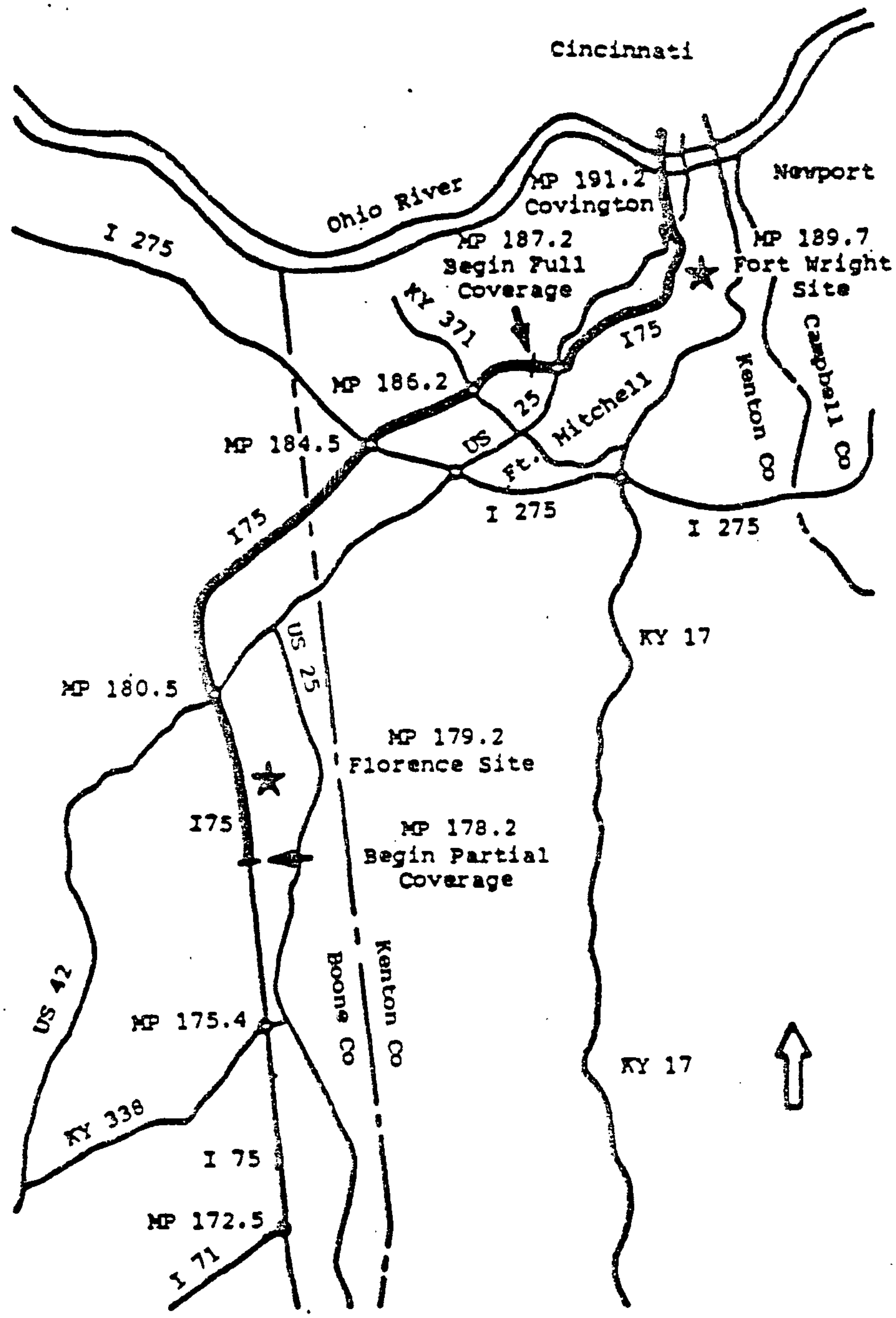

FIGURE 1. MAP SHOWING SIGNIFICANT POINTS IN STUDY AREA

TABLE 1. LOCATION OF UNMANNED UNITS IN PARTIAL AND FULL COVERAGE AREAS

NUMBER	MILEPOINT	LOCATION DESCRIPTION
	178.2	Beginning of Partial Coverage Area
1	179.2	At Existing Speed Monitoring Station
2	180.5*	US 42 Interchange
3	182.9*	Turfway Road Interchange
4	184.5	I 275 Interchange (unit aimed south)
5	184.5	I 275 Interchange (unit aimed north)
6	186.2*	Buttermilk Pike - KY 371 (District Office)
	187.2	Beginning of Full Coverage Area
7	187.7*	Ft. Mitchell - Dixie Highway Interchange (US 25)
8	188.0	Between Ft. Mitchell and Ft. Wright Interchange
9	188.6	Ft. Wright - Kyles Lane Interchange
10	189.2	North of Ft. Wright - Kyles Lane Interchange
11	189.7*	Covington City Limits - New Speed Monitoring Station (unit aimed south)
12	189.7	Covington City Limits - New Speed Monitoring Station (unit aimed north)
13	190.3	Jefferson St. (unit aimed north)
14	190.3	Jefferson St. (unit aimed south)
15	191.2	On Bridge Approach at Ohio River

* Locations where radar units were initially installed in the summer of 1986.

TABLE 2. LOCATION OF DATA COLLECTION SITES

NUMBER	MILEPOINT	LOCATION DESCRIPTION	TYPE
1	176.8	Rest Area	Manual
2	179.2	Speed Monitoring Station	Automatic
3	186.2	Highway District Office	Manual
4	187.7	Ft. Mitchell Interchange	Manual
5	189.7	Speed Monitoring Station	Automatic
6	190.3	Jefferson St. Overpass	Manual

TABLE 3. CALIBRATION OF SPEED DISTRIBUTION MODEL[a]

SPEED INTERVAL (i)	RANGE IN SPEEDS (mph)	MIDPOINT OF SPEED RANGE (MS_i)	a_0	a_1	R^2
1	< 35	33	0.00532975	0.000171737	0.10
2	36-40	38	0.00512458	0.000223322	0.26
3	41-45	43	0.0140188	0.00083977	0.48
4	46-50	48	0.0702431	0.00623933	0.76
5	51-55	53	0.028337	0.0310620	0.92
6	56-60	58	0.195454	0.0290890	0.88
7	61-65	63	0.415943	-0.0153434	0.57

[a]Equation 1.

TABLE 4. ADJUSTED MEAN SPEEDS FROM ANALYSIS OF COVARIANCE[a]

VARIABLE	CATEGORY	LANE: MEDIAN RADAR ON	MEDIAN RADAR OFF	CENTER RADAR ON	CENTER RADAR OFF	SHOULDER RADAR ON	SHOULDER RADAR OFF
FLORENCE							
All	All	64.50	66.36	62.06	63.72	57.15	58.61
Day of Week	Weekday	65.07	66.45	62.52	63.79	57.41	58.58
	Weekend	63.93	66.28	61.60	63.65	56.90	58.64
Light	Daylight	65.42	67.27	63.11	64.45	57.75	58.88
	Darkness	63.58	65.46	61.01	62.99	56.56	58.34
FT. WRIGHT							
All	All	62.82	62.98	57.85	57.88	54.57	54.46
Day of Week	Weekday	62.74	62.91	57.71	57.77	53.58	53.52
	Weekend	62.89	63.05	57.99	58.00	55.56	55.40
Light	Daylight	64.26	64.40	59.01	59.11	55.65	55.48
	Darkness	61.38	61.56	56.69	56.66	53.48	53.44

[a]Mean speeds are adjusted to the average level of traffic volume in the lane.

TABLE 5. P-VALUES FROM ANALYSIS OF COVARIANCE - MEAN SPEEDS[a]

VARIABLE	LANE MEDIAN	LANE CENTER	LANE SHOULDER
FLORENCE			
Covariate			
Volume	0.0001	0.0001	0.0001
Main Effects			
Radar	0.0001	0.0001	0.0001
Day	0.0002	0.0001	0.0356
Light	0.0001	0.0001	0.0001
Two-Factor Interactions			
Radar*Day	0.0048	0.0016	0.0105
Radar*Light	0.9304	0.0083	0.0035
Day*Light	0.0255	0.1490	0.9267
Three-Factor Interaction			
Radar*Day*Light	0.3469	0.2122	0.7898
FT. WRIGHT			
Covariate			
Volume	0.0001	0.0001	0.8246
Main Effects			
Radar	0.0529	0.6649	0.2599
Day	0.0817	0.0010	0.0001
Light	0.0001	0.0001	0.0001
Two-Factor Interactions			
Radar*Day	0.9222	0.7638	0.6041
Radar*Light	0.8478	0.4061	0.4706
Day*Light	0.0001	0.0001	0.0010
Three-Factor Interaction			
Radar*Day*Light	0.2683	0.1594	0.2675

[a]An effect of mean speed is statistically significant for small values of P, generally those less than 0.0500. P-values are based on Type I sum of squares for the covariate and Type III sum of squares elsewhere.

TABLE 6. RADAR EFFECTS ON NUMBER OF VEHICLES ABOVE VARIOUS SPEEDS

LOCATION	SPEED	NUMBER OVER SPEED		PERCENT OVER SPEED		PERCENT REDUCTION DUE TO RADAR	NUMBER OVER SPEED PER HOUR***		REDUCTION PER DAY
		RADAR ON (ACTUAL)*	RADAR OFF (EXPECTED)**	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)		RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	
Florence	80	751	1,265	0.32	0.53	40.5	3.5	5.0	36
	75	2,336	4,396	0.99	1.86	46.9	11.0	20.8	234
	70	11,954	19,828	5.06	8.38	39.7	56.5	93.7	894
	65	55,631	75.023	23.53	31.73	25.8	262.8	354.5	2199
Ft. Wright	80	983	1,240	0.05	0.06	20.6	1.0	1.3	6
	75	5,018	6,223	0.23	0.31	25.8	5.2	6.5	31
	70	44,940	50,663	2.07	2.53	18.2	46.8	52.8	144
	65	252,991	273.301	11.90	13.42	11.3	269.7	284.6	358

* Actual number of vehicles recorded above given speed with "radar on".

** Expected number of vehicles above given speed using data obtained with "radar off".

*** Based on number of hours of data obtained with "radar on" (635 lane-hours at Florence and 2,331 lane-hours at Ft. Wright..

Note: All differences were significant at the 0.05 level of significance.

TABLE 7. RADAR EFFECTS ON NUMBER OF VEHICLES ABOVE VARIOUS SPEEDS AS A FUNCTION OF LANE

			NUMBER OVER SPEED		PERCENT OVER SPEED		
LOCATION	CATEGORY	SPEED	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	PERCENT REDUCTION
Florence	Median Lane	80	290	528	0.63	1.15	45.1
		75	975	1,918	2.13	4.18	49.2
		70	5,049	8,560	11.01	18.67	41.0
		65	21,218	27,593	46.29	60.19	23.1
	Center Lane	80	362	599	0.34	0.56	39.6
		75	1,116	2,100	1.05	1.97	46.9
		70	5,842	9,554	5.49	8.98	38.9
		65	28,551	38,823	26.84	36.50	26.5
	Shoulder Lane	80	99	139	0.12	0.16	28.8
		75	245	378	0.29	0.45	35.2
		70	1,063	1,714	1.26	2.03	38.0
		65	5,862	8,608	6.96	10.22	31.9
Ft. Wright	Median Lane	80	652	758	0.09	0.11	14.0
		75	3,437	4,214	0.48	0.59	18.4
		70	33,540	37,453	4.70	5.25	10.4
		65	191,890	200,978	26.92	28.19	4.5
	Center Lane	80	204	257	0.02	0.03	20.6
		75	1,000	1,226	0.11	0.14	18.4
		70	7,933	9,162	0.88	1.02	13.4
		65	48,657	53,016	5.41	5.90	8.2
	Shoulder Lane	80	127	226	0.02	0.04	43.8
		75	581	789	0.10	0.14	26.4
		70	3,467	4,053	0.61	0.72	14.4
		65	18,444	19,308	3.27	3.42	4.5

Note: All differences were significant at the 0.05 level of significance.

TABLE 8. RADAR EFFECTS ON NUMBER OF VEHICLES ABOVE VARIOUS SPEEDS AS A FUNCTION OF DAY OF WEEK

			NUMBER OVER SPEED		PERCENT OVER SPEED		
LOCATION	CATEGORY	SPEED	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	PERCENT REDUCTION
Florence	Weekday	80	610	1,002	0.34	0.55	39.1
		75	1,909	3,494	1.06	1.93	45.4
		70	9,744	15,489	5.39	8.57	37.1
		65	44,004	57,538	24.36	31.85	23.5
	Weekend	80	141	264	0.25	0.47	46.6
		75	427	901	0.76	1.61	52.6
		70	2,210	4,339	3.96	7.77	49.1
		65	11,627	17,485	20.83	31.32	33.5
Ft. Wright	Weekday	80	689	862	0.04	0.05	20.1
		75	3,513	4,394	0.20	0.26	20.0
		70	32,542	36,644	1.90	2.14	11.2
		65	193,566	204,756	11.33	11.99	5.5
	Weekend	80	294	378	0.06	0.08	22.2
		75	1,505	1,834	0.32	0.39	17.9
		70	12,398	14,025	2.65	3.00	11.7
		65	65,425	68,546	13.99	14.66	4.6

Note: All differences were significant at the 0.05 level of significance.

TABLE 9. RADAR EFFECTS ON NUMBER OF VEHICLES ABOVE VARIOUS SPEEDS AS A FUNCTION OF LIGHT CONDITION

			NUMBER OVER SPEED		PERCENT OVER SPEED		
LOCATION	CATEGORY	SPEED	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	PERCENT REDUCTION
Florence	Daylight	80	538	867	0.33	0.55	37.9
		75	1,725	3,223	1.06	1.93	46.5
		70	9,131	15,050	5.59	8.57	39.3
		65	43,083	57,301	26.40	35.10	24.8
	Dark	80	213	399	0.29	0.55	46.6
		75	611	1,173	0.84	1.60	47.9
		70	2,823	4,779	3.86	6.54	40.9
		65	12,548	17,722	17.20	24.20	29.2
Ft. Wright	Daylight	80	646	835	0.04	0.05	22.6
		75	3,616	4,486	0.22	0.27	19.4
		70	35,166	39,579	2.15	2.42	11.1
		65	206,133	217,200	12.60	13.28	5.1
	Dark	80	337	405	0.06	0.08	16.8
		75	1,402	1,742	0.26	0.32	19.5
		70	9,744	11,089	1.80	2.05	12.1
		65	52,858	56,102	9.79	10.39	5.8

Note: All differences were significant at the 0.05 level of significance.

TABLE 10. RADAR EFFECTS ON NUMBER OF VEHICLES ABOVE VARIOUS SPEEDS AS A FUNCTION OF TRAFFIC VOLUME

			NUMBER OVER SPEED		PERCENT OVER SPEED		
LOCATION	CATEGORY	SPEED	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	PERCENT REDUCTION
Florence	Less than 300 VPH	80	202	393	0.46	0.89	48.6
		75	667	1,243	1.51	2.82	46.3
		70	2,946	4,810	6.69	10.92	38.8
		65	11,366	15,230	25.80	34.57	25.4
	300-599 VPH	80	281	448	0.26	0.42	37.3
		75	849	1,621	0.79	1.51	47.6
		70	4,496	7,571	4.19	7.05	40.6
		65	20,928	28,236	19.51	26.28	25.9
	600-899 VPH	80	234	374	0.31	0.50	37.4
		75	729	1,376	0.98	1.84	47.0
		70	3,960	6,597	5.30	8.84	40.0
		65	20,093	27,501	26.91	36.84	26.9
	900-1,200 VPH	80	34	51	0.33	0.49	33.3*
		75	91	155	0.88	1.50	41.3
		70	552	851	5.35	8.24	35.1
		65	3,244	4,056	31.42	39.29	20.0
Ft. Wright	Less than 300 VPH	80	154	192	0.16	0.20	19.8*
		75	580	756	0.61	0.79	23.3
		70	2,993	3,415	3.15	3.59	12.4
		65	11,599	12,435	12.20	13.08	6.7
	300-599 VPH	80	176	214	0.08	0.10	17.8*
		75	761	948	0.35	0.44	19.7
		70	5,530	6,369	2.57	2.96	13.2
		65	27,283	28,675	12.69	13.34	4.8
	600-899 VPH	80	280	371	0.05	0.07	24.5
		75	1,469	1,784	0.27	0.33	17.6
		70	13,057	14,057	2.41	2.59	7.1
		65	68,404	70,708	12.63	13.05	3.2
	900-1,200 VPH	80	249	293	0.05	0.05	15.0*
		75	1,359	1,664	0.25	0.31	18.3
		70	14,445	15,850	2.67	2.93	8.9
		65	86,790	91,287	16.05	16.88	4.9
	Over 1,200 VPH	80	124	170	0.02	0.02	27.0
		75	849	1,075	0.11	0.14	21.0
		70	8,915	10,978	1.14	1.40	18.8
		65	64,915	70,196	8.29	8.97	7.5

* All differences were significant at the 0.05 level of significance except those noted with an asterisk.

TABLE 11. STANDARD DEVIATION OF SPEED FROM ANALYSIS OF COVARIANCE[a]

VARIABLE	CATEGORY	LANE: MEDIAN		LANE: CENTER		LANE: SHOULDER	
		RADAR ON	RADAR OFF	RADAR ON	RADAR OFF	RADAR ON	RADAR OFF
FLORENCE							
All	All	5.52	5.82	5.38	5.51	5.41	5.58
Day of Week	Weekday	5.57	5.60	5.35	5.47	5.31	5.48
	Weekend	5.48	6.02	5.42	5.55	5.51	5.68
Light	Daylight	5.38	5.36	5.41	5.44	5.55	5.65
	Darkness	5.67	6.24	5.36	5.57	5.28	5.51
FT. WRIGHT							
All	All	4.97	5.08	4.66	4.79	6.02	6.08
Day of Week	Weekday	4.95	5.08	4.71	4.83	6.27	6.39
	Weekend	4.99	5.08	4.61	4.74	5.76	5.76
Light	Daylight	4.82	4.91	4.71	4.80	5.93	6.05
	Darkness	5.12	5.24	4.62	4.77	6.11	6.12

[a]Mean variances of speed are adjusted to the average level of traffic volume in the lane. Standard deviations reported above are square roots of the adjusted mean variances.

TABLE 12. P-VALUES FROM ANALYSIS OF COVARIANCE - MEAN VARIANCE OF SPEED[a]

VARIABLE	LANE: MEDIAN	LANE: CENTER	LANE: SHOULDER
FLORENCE			
Covariate			
Volume	0.0001	0.0001	0.0025
Main Effects			
Radar	0.0683	0.0114	0.0001
Day	0.2860	0.1355	0.0001
Light	0.0037	0.5561	0.0002
Two-Factor Interactions			
Radar*Day	0.1069	0.9690	0.8921
Radar*Light	0.0540	0.0564	0.1172
Day*Light	0.5915	0.7538	0.0009
Three-Factor Interaction			
Radar*Day*Light	0.1571	0.6218	0.6195
FT. WRIGHT			
Covariate			
Volume	0.0001	0.0001	0.0001
Main Effects			
Radar	0.0097	0.0005	0.0456
Day	0.6856	0.0127	0.0013
Light	0.0001	0.2232	0.0001
Two-Factor Interactions			
Radar*Day	0.6341	0.9130	0.0441
Radar*Light	0.5915	0.4107	0.0616
Day*Light	0.0003	0.0284	0.0001
Three-Factor Interactions			
Radar*Day*Light	0.4248	0.1845	0.7211

[a]An effect of mean variance of speed is statistically significant for small values of P, generally those less than 0.0500. P-values are based on Type I sum of squares for the covariate and Type III sum of squares elsewhere.

TABLE 13. RADAR EFFECTS ON 85TH PERCENTILE SPEED

		85TH PERCENTILE SPEED			
		FT. WRIGHT		FLORENCE	
VARIABLE	CATEGORY	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)	RADAR ON (ACTUAL)	RADAR OFF (EXPECTED)
All	All	65.41	65.55	67.31	68.58
Day of Week	Weekday	64.14	64.28	67.47	68.62
	Weekend	64.79	64.93	66.73	68.47
Lane	Median	67.68	67.88	69.44	71.27
	Center	62.21	62.39	67.77	68.91
	Shoulder	59.60	59.63	63.01	64.04
Light Conditions	Daylight	64.46	64.61	67.74	68.88
	Dark	63.69	63.85	65.81	67.61
Traffic Volume (Vehicles per Hour)	Less than 300	64.22	64.45	67.82	69.14
	300-599	64.44	64.61	66.46	67.93
	600-899	64.40	64.50	67.76	68.90
	900-1,200	65.39	65.68	68.15	68.91
	Over 1,200	63.36	63.48	*	*

* There was no data in this traffic volume category.

TABLE 14. SUMMARY OF MANUAL DATA COLLECTION

LOCATION	VARIABLE	SHOULDER LANE		CENTER LANE		MEDIAN LANE	
		RADAR ON	RADAR OFF	RADAR ON	RADAR OFF	RADAR ON	RADAR OFF
Rest Area	Average Speed (mph)	*	57.6	*	62.0	*	69.1
	Standard Deviation	*	4.72	*	4.89	*	4.50
	Percent over 55 mph	*	69.5	*	92.2	*	99.8
	Percent over 60 mph	*	26.0	*	59.7	*	97.8
	Percent over 65 mph	*	4.0	*	20.9	*	79.0
	Percent over 70 mph	*	0.6	*	4.8	*	36.8
District Office	Average Speed (mph)	50.8	50.9	57.8	57.0	61.8	61.9
	Standard Deviation	4.09	4.16	4.40	4.24	4.22	3.96
	Percent over 55 mph	11.5	11.6	69.0	61.2	94.0	94.5
	Percent over 60 mph	2.1	1.9	25.5	16.7	62.4	63.9
	Percent over 65 mph	0.4	0.4	4.6	4.5	17.4	17.5
	Percent over 70 mph	0.0	0.0	0.7	0.4	2.2	1.6
Ft. Mitchell	Average Speed (mph)	49.8	49.9	54.5	55.0	55.9	57.1
	Standard Deviation	4.14	4.13	4.20	4.41	3.92	3.74
	Percent over 55 mph	8.8	9.0	37.0	41.8	54.8	66.4
	Percent over 60 mph	1.3	1.6	7.3	10.7	12.3	17.4
	Percent over 65 mph	0.2	0.3	1.5	2.2	1.3	1.3
	Percent over 70 mph	0.0	0.1	0.3	0.4	0.2	0.2
Jefferson Street	Average Speed (mph)	48.4	48.3	49.8	49.5	55.6	55.7
	Standard Deviation	4.28	4.41	4.19	3.91	3.64	3.99
	Percent over 55 mph	5.3	5.3	7.8	7.0	48.2	51.9
	Percent over 60 mph	0.8	1.1	1.5	1.0	9.3	11.5
	Percent over 65 mph	0.4	0.1	0.7	0.2	0.6	1.6
	Percent over 70 mph	0.0	0.0	0.2	0.2	0.0	0.1

* Data taken outside area covered by radar.

Note: None of the differences between the average speeds were found to be significant at the 0.05 level of significance. Statistical testing was not performed on other speed measures.

TABLE 15. RADAR EFFECTS ON SPEEDS OF VEHICLES WITH AND WITHOUT DETECTORS*

	RADAR OFF		RADAR ON	
	WITH DETECTOR	NO DETECTOR	WITH DETECTOR	NO DETECTOR
Sample Size	132	1,091	121	1,953
Average Speed (MPH)**	64.64	63.57	62.60	63.49
Standard Deviation	4.64	4.21	3.74	4.02
Percent Speeds Over 60 MPH	81.8	79.9	71.9	80.4
Percent Speeds Over 65 MPH	36.4	27.7	19.8	26.7
Percent Speeds Over 70 MPH	10.6	5.0	4.1	4.1
Percent Speeds Over 75 MPH	2.3	1.0	0.0	0.9

* All data taken in median lane at Ft. Wright speed monitoring station.

TABLE 16. RADAR EFFECTS ON SPEEDS WITH AND WITHOUT ACTIVE POLICE ENFORCEMENT

	RADAR OFF		RADAR ON	
	PERCENTAGE	STATISTICAL SIGNIFICANCE*	PERCENTAGE	STATISTICAL SIGNIFICANCE*
Reduction in Mean Speed	5.7	S	6.4	S
Reduction in Percentage Exceeding 65 mph	48	S	65	S
Reduction in Percentage Exceeding 70 mph	53	S	78	S
Reduction in Percentage Exceeding 75 mph	25	NS	43	NS
Reduction in Percentage Exceeding 80 mph	74	NS	81	NS

* Statistical tests were conducted at the 0.05 level of significance. An "S" notation notes a statistical significance. A "NS" notation notes the reduction was not statistically significant.

TABLE 17. ACCIDENT ANALYSIS

	LOCATION			
	KY 338-FT. MITCHELL		FT. MITCHELL-OHIO RIVER	
	7/1/83 - 6/30/86	7/1/86 - 6/30/87	7/1/83- 6/30/86	7/1/86 - 6/30/87
Total Accidents	441	147	1,122	310
Accident/Year				
Total	147	147	374	310
Northbound	82	77	170	121
Southbound	65	70	204	189
Accidents/Mile/Year	120	120	91.2	75.6
Accident Rate(ACC/100 MVM)	42	40	245	204
Percent Truck Accidents				
Total	26.8	23.8	28.9	20.0
Northbound	26.1	23.4	27.6	16.5
Southbound	27.6	24.3	30.3	22.2
Percent Injury or Fatal Accidents				
Total	23.8	25.9	30.7	35.5
Northbound	22.4	23.4	31.2	32.2
Southbound	25.5	28.6	30.5	37.6
Percent Speed Related Accidents				
Total	10.9	6.8	8.0	7.4
Northbound	9.4	9.1	8.0	6.6
Southbound	12.8	4.3	8.1	7.9
Percent During Darkness				
Total	30.6	28.6	33.6	32.3
Northbound	29.0	31.2	26.0	31.4
Southbound	32.7	25.7	40.7	32.8
Percent on Wet or Snowy Pavement				
Total	33.6	22.4	30.6	18.7
Northbound	29.0	23.4	35.2	22.3
Southbound	39.3	21.4	28.5	16.4

APPENDIX A

FEDERAL COMMUNICATIONS COMMISSION RULING AND U.S. CONGRESS LEGISLATION

FEDERAL
COMMUNICATIONS
COMMISSION

Rules and Regulations

VOLUME IV • SEPTEMBER 1987

Part 90—Private Land Mobile Radio Services

Part 94—Private Operational-Fixed Microwave Service ting an application for license on or before July 25, 1985, are grandfathered and their operation is co-primary with the Radiodetermination Satellite Service.

(14) Use of this frequency band is limited to developmental operation and is subject to the provisions of Subpart Q.

(15) Frequencies in this band are available only for one-way paging operations in accordance with § 90.494.

(16) The frequencies available for use at operational-fixed stations in the band 72-76 MHz are listed in § 90.257(a)(1). These frequencies are shared with other services and are available only in accordance with the provisions of § 90.257.

(17) Frequencies in this band will be assigned for low power wireless microphones in accordance with the provisions of § 90.265.

(18) Rules concerning the use of this band for narrowband operations are set forth in § 90.271.

(e) *Limitation on number of frequencies assignable.* Normally only one frequency, or pair of frequencies in the paired frequency mode of operation, will be assigned for mobile service operations by a single applicant in a given area. The assignment of an additional frequency or pair of frequencies will be made only upon a satisfactory showing of need, except that: (See also § 90.253.)

(1) [Reserved]

(2) Frequencies in the 25-50 MHz, 150-170 MHz, and 450-512 MHz bands, and the frequency bands 903-904 MHz, 904-912 MHz 918-926 MHz, and 926-027 MHz may be assigned for the operation of Automatic Vehicle Monitoring (AVM) systems in accordance with § 90.239, notwithstanding this limitation.

(3) The frequency band 33.00-33.01 MHz may be used for developmental operation subject to the provisions of Subpart Q. Any type of emission other than pulsed emission may be used if the bandwidth occupied by the emission is contained within the assigned frequency band.

(f) In addition to the frequencies shown in the frequency table of this section, frequencies in the 421-430 MHz band are available in the Detroit, Cleveland, and Buffalo areas in accordance with the rules in §§ 90.273 through 90.281.

(Secs. 4(i) and 303(r), Communications Act of 1934, as amended, §§ 0.131 and 0.331 of the Commission's Rules and 5 U.S.C. 553 (b)(3)(B) and (d)(3); 47 U.S.C. 154(i) and 303)

[43 FR 54791, Nov. 22, 1978, as amended at 47 FR 39513, Sept. 8, 1982; 47 FR 41044, Sept. 16, 1982; 47 FR 50701, Nov. 9, 1982; 49 FR 20505, May 15, 1984; 49 FR 36377, Sept. 17, 1984; 50 FR 13605, Apr. 5, 1985; 50 FR 39110, Sept. 27, 1985; 50 FR 39680, Sept. 30, 1985; 52 FR 6156, Mar. 2, 1987; 52 FR 29857, Aug. 12, 1987]

Subpart F—Radiolocation Service

§ 90.101 Scope.

The Radiolocation Service accommodates the use of radio methods for determination of direction, distance, speed, or position for purposes other than navigation. Rules as to eligibility for licensing, permissible communications, frequency available, and any special requirements are set forth in the following section, except that the operation of Automatic Vehicle Monitoring (AVM) systems is governed by interim provisions set forth in § 90.239.

§ 90.103 Radiolocation Service.

(a) *Eligibility.* The following persons are eligible for authorizations in the Radiolocation Service to operate stations to determine distance, direction, speed, or position by means of radiolocation devices, for purposes other than navigation:

(1) Any person engaged in a commercial, industrial, scientific, educational, or local government activity

(2) A corporation or association that will furnish radiolocation service to other persons.

(3) A corporation that will furnish a nonprofit radio communication service to its parent corporation, to another subsidiary of the same parent, or to its own subsidiary where the party to be served is regularly engaged in any of the eligibility activities set forth in this paragraph.

(b) *Frequencies available.* The following table indicates frequencies available for assignment to stations in the Radiolocation Service, together with the class of station(s) to which they are normally assigned, and the specific assignment limitations, which are explained in paragraph (c) of this section:

Radiolocation Service Frequency Table

Frequency or band	Class of station(s)	Limitation
Kilohertz		
70 to 90	Radiolocation land or mobile	1
90 to 110	Radiolocation land	2
110 to 130	Radiolocation land or mobile	1
1605 to 1715	do	4, 5, 6, 28, and 29
1715 to 1750	do	5, 6
1750 to 1800	do	5, 6, 7
1900 to 1950	do	6, 25, 26, 27, and 30
1950 to 2000	do	6, 25, 27 and 30
3230 to 3400	do	6, 8
Megahertz		
420 to 450	do	21
2450 to 2500	do	9, 22, 23
2900 to 3100	do	10, 11
3100 to 3300	do	12
3300 to 3500	do	12, 13
3500 to 3700	do	12
5250 to 5350	do	12
5350 to 5460	do	10, 14
5460 to 5470	do	10, 15
5470 to 5600	do	10, 11
5600 to 5650	do	10, 15
8500 to 9000	do	12, 17
9000 to 9200	do	10, 14

Radiolocation Service Frequency Table—Continued

Frequency or band	Class of station(s)	Limitation
9200 to 9300	do	12
9300 to 9500	do	10, 15, 18
9500 to 10.000	do	12
10.000 to 10.500	do	12, 13, 19
10.500 to 10.550	do	20, 22, 24
13.400 to 14.000	do	12
15.700 to 17.700	do	12
24.050 to 24.250	do	12, 22, 24
33.400 to 36.000	do	12

(c) Explanation of assignment limitations appearing in the frequency table of paragraph (b) of this section:

(1) This frequency band is shared with and stations operating in this frequency band in this service are on a secondary basis to stations licensed in the International Fixed Service and the Maritime Mobile Service.

(2) This frequency band is shared with and stations operating in this frequency band in this service are on a secondary basis to the LORAN Navigation System. all operations are limited to radiolocation lands stations in accordance with footnote US104. § 2.106 of this chapter.

(3) [Reserved]

(4) Non-Government radiolocation service in this band is on a secondary basis to stations in the Aeronautical Radionavigation Service operating on 1638 or 1708 kHz.

(5) Station assignments on frequencies in this band will be made subject to the conditions that the maximum output power shall not exceed 375 watts and the maximum authorized bandwidth shall not exceed 2 kHz.

(6) Because of the operation of stations having priority on the same or adjacent frequencies in this or in other countries, frequency assignments in this band may either be unavailable or may be subject to certain technical or operational limitations. Therefore, applications for frequency assignments in this band shall include information concerning the transmitter output power: the type and directional characteristics of the antenna and the minimum hours of operation (GMT).

(7) This band is shared with the Disaster Communications Service (Part 99) and operations are on a secondary basis to that service between local sunset and local sunrise, or at any time during an actual or imminent disaster. Local sunrise and sunset times shall be derived from the 1946 American Nautical Almanac. Each frequency assignment in this band is on an exclusive basis within the daytime primary service area to which assigned. The daytime primary service area is the area where the signal intensities are adequate for radiolocation purposes during the hours from sunrise to sunset from all stations in the radiolocation system of which the station in question is a part; that is, the primary service area of the station coincides with the primary service area of the system. The normal minimum geographical separation between stations of different licensees shall be at least 580 km. (360 mi.) when the stations are operated on the same frequency or on different frequencies separated by less than 3 kHz. Where geographical separation of less than 580 km. (360 mi.) is desired under these circumstances it must be shown that the desired separation will result in protection ratio of at least 20 decibels throughout the daytime primary service area of other stations. Applications in this band are placed on public notice in accordance with § 1.962 of this chapter. Where the number of applicants requesting authority to serve an area exceeds the number of frequencies available for assignment; or where it appears that fewer applicants or licensees than the number before it should be given authority to serve a particular area; or where it appears that an applicant, either directly or indirectly, seeks to use more than 25 kHz of the available spectrum space in this band, the applications may be designated for hearing.

(8) Frequencies in this band may only be assigned to radiolocation stations which are also assigned frequencies in the 1605-1800 kHz band, provided the use of frequencies in this band is necessary for the proper functioning of the particular radiolocation system. Operations in this band are on a secondary basis to stations operating in accordance with the Commission's table of frequency allocations contained in § 2.106 of this chapter.

(9) This band is allocated to the Radiolocation Service on a secondary basis to other fixed or mobile services and most accept any harmful interference that may be experienced from such services or from the industrial, scientific, and medical (ISM) equipment operating in accordance with Part 18 of this chapter. In the 2483.5-2500 MHz band, no applications for new or modification to existing stations to increase the number of transmitters will be accepted. Existing licensees as of July 25, 1985, or on a subsequent date following as a result of submitting an application for license on or before July 25, 1985, are grandfathered and their operation is co-primary with the Radiodetermination Satellite Service.

(10) Speed measuring devices will not be authorized in this band.

(11) This frequency band is shared with and is on a secondary basis to the Maritime Radionavigation Stations (Part 80) and to the Government Radiolocation Service.

(12) This frequency band is shared with and is on a secondary basis to the Government Radiolocation Service.

(13) Operations in this band are limited to survey operations using transmitters with a peak power not to exceed 5 watts into the antenna.

(14) This frequency band is shared with and is on a secondary basis to the Aeronautical Radionavigation Service (Part 87) and to the Government Radiolocation Service.

(15) The non-Government Radiolocation Service in this band is secondary to the Maritime Radionavigation Stations (Part 80), the Aeronautical Radionavigation Service (Part 87) and the Government Radiolocation Service.

(16) This frequency band is shared with and is on a secondary basis to the Maritime Radionavigation Stations (Part 80) and the Government Meteorological Aids Service.

(17) Operation in this frequency band is on a secondary basis to airborne Doppler radars at 8800 MHz.

(18) Radiolocation installations will be coordinated with the Government Meteorological Aids Service, and insofar as practicable, will be adjusted to meet the needs of that service.

(19) Operations in this band are on a secondary basis to the Amateur Radio Service (Part 97). Pulsed emissions are prohibited.

(20) This band is restricted to radiolocation systems using type NON emission with a power not to exceed 40 watts into the antenna.

(21) Non-Government radiolocation stations in the band are secondary to the Government Radiolocation Service, the Amateur Radio Service and the Amateur-Satellite Service. Pulse-ranging radiolocation stations in this band may be authorized along the shorelines of Alaska and the contiguous 48 states. Radiolocation stations using spread spectrum techniques may be authorized in the band 420-435 MHz for operation within the contiguous 48 states and Alaska. Also, stations using spread spectrum techniques shall be limited to a maximum output power of 50 watts, shall be subject to the applicable technical standards in § 90.209 until such time as more definitive standards are adopted by the Commission and shall identify in accordance with § 90.425(c)(3). Authorizations will be granted on a case-by-case basis; however, operations proposed to be located within the zones set forth in § 90.177(e) should not expect to be accommodated.

(22) For frequencies 2455, 10,525, and 24,125 MHz unmodulated continuous wave (AO) emission only shall be employed and a frequency stability of at least .2 percent shall be maintained. Such stations shall be exempt from the requirements of §§ 90.403(c) and (f) and 90.429.

(23) Devices designed to operate as field disturbance sensors on frequencies between 2450 and 2500 MHz with a field strength equal to or less than 50,000 microvolts per meter at 30 meters, on a fundamental frequency, will not be licensed or type accepted for use under this part. Such equipment must comply with the requirements for field disturbance sensors as set forth in Subpart F of Part 15 of this chapter.

(24) Devices designed to operate as field disturbance sensors on frequencies between 10,500 and 10,550 MHz and between 24,050 and 24,250 MHz, with field strength equal to or less than 250,000 microvolts per meter at 30 meters, on the fundamental frequency, will not be licensed or type accepted for use under this part. Such equipment must comply with the requirements for field disturbance sensors as set forth in Subpart F of Part 15 of this chapter.

(25) Station assignments on frequencies in this band will be made subject to the conditions that the maximum output power shall not exceed 375 watts and the maximum authorized bandwidth shall not exceed 1.0 kHz.

(26) Each frequency assignment in this band is on an exclusive basis within the primary service area to which assigned. The primary service area is the area where the signal intensities are adequate for radiolocation purposes from all stations in the radiolocation system of which the station in question is a part; that is, the primary service area of the station coincides with the primary service area of the system. The normal minimum geographical separation between stations of different licensees shall be at lease 1200 mi. (1931 km.) when the stations are operated on the same frequency or on different frequencies separated by less than 1.0 kHz. Where geographical separation of less than 1200 mi. (1931 km.) is requested under these circumstances, it must be shown that the desired separation will result in a protection ratio of at least 20 decibels throughout the primary service area of other stations.

(27) Notwithstanding the bandwidth limitations otherwise set forth in this section of the rules, wideband systems desiring to operate in this band may use such bandwidth as is necessary for proper operation of the system provided that the field strength does not exceed 120 microvolts per meter per square root Hertz (120 uv/m/Hz$^{1/2}$) at 1 mile. Such wideband operations shall be authorized on a secondary basis to stations operating within otherwise applicable technical standards. Applications for wideband systems in this band will be accepted beginning December 15, 1985.

(28) Since the 1605-1705 kHz band has been reallocated for AM broadcasting, no new assignments in the 1605-1705 kHz portion of this band shall be made after September 30, 1985.

(29) Beginning July 1, 1987, licensees of existing systems authorized frequencies in the 1605-1705 kHz portion of this band may request modification of their authorizations to change frequencies to the 1900-2000 kHz band.

(30) Until July 1, 1988, this band will be available only for licensees of existing systems operating in the 1605-1705 kHz portion of the 1605-1715 kHz band requesting modification of their authorizations to change frequencies to this band and for licensees of wideband systems. On July 1, 1988, requests for new station authorizations in this band will be accepted and, if necessary, will be subject to the random selection procedures outlined in § 1.972 of the Commission's Rules.

(d) *Additional frequencies for automatic vehicle monitoring (AVM) systems.* The frequency bands 903-904 MHz, 904-912 MHz, 918-926 MHz, and

926-927 MHz may be assigned for AVM operations in accordance with § 90.239 except that for corporations rendering service to others under paragraph (a)(2) of this section, such operations are limited to the 904-912 MHz and 918-926 MHz bands.

(e) *Other additional frequencies available.* Radiolocation stations in this service may be authorized, on request, to use frequencies allocated exclusively to Federal Government stations, in those instances where the Commission finds, after consultation with the appropriate Government agency or agencies, that such assignment is necessary or required for coordination with Government activities.

[43 FR 54791, Nov. 22, 1978; 44 FR 32218, June 5, 1979, as amended at 45 FR 43418, June 27, 1980; 45 FR 83233, Dec. 18, 1980; 47 FR 34420, Aug. 9, 1982; 49 FR 48710, Dec. 14, 1984; 50 FR 39110, Sept. 27, 1985; 50 FR 46053, Nov. 6, 1985, 50 FR 47748, Nov. 20, 1985; 51 FR 31305, Sept. 2, 1986; 52 FR 29856, Aug. 12, 1987]

Subpart G—Applications and Authorizations

§ 90.111 Scope.

This subpart contains the procedures and requirements for the submission or filing of applications for authority to operate radio facilities under this part. The procedures described as those utilized by the Commission after receiving filed applications.

[51 FR 14996, Apr. 22, 1986]

§ 90.113 Station authorization required.

No radio transmitter shall be operated in the services governed by this part except under and in accordance with a proper authorization granted by the Commission.

§ 90.115 Ineligibility of foreign governments.

No station authorization in the radio services governed by this part shall be granted to or held by a foreign government or its representative.

§ 90.117 Applications for radio station or radio system authorizations.

Persons desiring a radio station or radio system authorization must first submit the appropriate application(s). Prescribed application forms are listed in § 90.119. The Forms may be obtained from the Washington, D.C. office of the Commission, its Gettysburg, Pa. office, or from any of its engineering field offices. (See § 90.145 for information regarding special temporary authorizations.) Applicants for new stations comprising a land mobile radio system as defined in § 90.7 of this Part, or applicants modifying or renewing a station that is a part of a system, may file an application for a system authorization.

[47 FR 57051, Dec. 22, 1982]

§ 90.119 Application forms.

The following application forms shall be used—

(a) Form 574 shall be used to apply:

(1) For new base, fixed, or mobile station authorizations governed by this part.

(2) For system authorizations, where the system meets the requirements of § 90.117.

(i) Application for a radio system may be submitted on a single Form 574.

(ii) If the control station(s) will operate on the same frequency as the mobile station, and if the height of the control station(s) antenna(s) will not exceed 6.1 meters (20 feet) above ground or an existing man-made structure (other than an antenna structure), there is no limit on the number of such stations which may be authorized. Items 1 through 5 of Form 574 shall be completed showing the frequency, the station class, the total number of control stations, the emission, and the output power of the highest powered control station. Applicants for all control stations in the 470-512 MHz band must furnish the information requested in Items 1-11 of Form 574.

(3) For modification or for modification and renewal of an existing authorization. (See § 90.135)

(4) For the Commission's consent to the assignment of an authorization to another person or entity. In addition, the application shall be accompanied by a letter from the assignor setting forth his desire to assign all right, title, and interest in and to such authorization, stating the call sign and location of the station, and that the assignor will submit his current station authorization for cancellation upon completion of the assignment. Form 1046 may be used in lieu of this letter.

(b) With respect to the 806-821 and 851-866 MHz bands, all applications required by this Section to be filed on Form 574 shall be accompanied by Form 574-A.

(c) With respect to the frequencies below 27.5 MHz, all applications required by this Section to be filed on Form 574 shall be accompanied by Form 574-B.

(d) Applications for stations on frequencies above 27.5 MHz in areas where international coordination is required may be accompanied by Form 574-B, but are not required to be. If the applicant files Form 574-B, the information concerning the proposed station that the Commission reports to the coordinating nation will be that provided on the Form. If the applicant does not file Form 574-B, the information concerning the proposed station that the Commission reports to the coordinating nation will be based on assumed technical characteristics determined by the Commission and described in instructions to Form 574. Specifically, the following stations are involved:

(1) Those north of Line A, or east of Line C if the application is for a frequency between 30

als and parking areas at air, train, and bus terminals, the trade name identification of carriers is permitted.

(b) *Technical standards.* (1) The use of 6K00A3E emission will be authorized, however N0N emission may be used for purposes of receiver quieting, but only for a system of stations employing "leaky" cable antennas.

(2) A frequency tolerance of 100 Hz shall be maintained.

(3) For a station employing a cable antenna, the following restrictions apply:

(i) The length of the cable antenna shall not exceed 3.0 km (1.9 miles).

(ii) Transmitter RF output power shall not exceed 50 watts and shall be adjustable downward to enable the user to comply with the specified field strength limit.

(iii) The field strength of the emission on the operating frequency shall not exceed 2 mV/m when measured with a standard field strength meter at a distance of 60 meters (197 feet) from any part of the station.

(4) For a station employing a conventional radiating antenna(s) (ex. vertical monopole, directional array) the following restrictions apply:

(i) The antenna height above ground level shall not exceed 15.0 meters (49.2 feet).

(ii) Only vertical polarization of antennas shall be permitted.

(iii) Transmitter RF output power shall not exceed 10 watts to enable the user to comply with the specified field strength limit.

(iv) The field strength of the emission on the operating frequency shall not exceed 2 mV/m when measured with a standard field strength meter at a distance of 1.50 km (0.93 miles) from the transmitting antenna system.

(5) For co-channel stations operating under different licenses, the following minimum separation distances shall apply:

(i) 0.50 km (0.31 miles) for the case when both stations are using cable antennas.

(ii) 7.50 km (4.66 miles) for the case when one station is using a conventional antenna and the other is using a cable antenna.

(iii) 15.0 km (9.3 miles) for the case when both stations are using conventional antennas.

(6) For a system of co-channel transmitters operating under a single authorization utilizing either cable or conventional antennas, or both, no minimum separation distance is required.

(7) An applicant desiring to locate a station that does not comply with the separation requirements of this section shall coordinate with the affected station.

(8) Each transmitter in a Travelers Information Station shall be equipped with an audio low-pass filter. Such filter shall be installed between the modulation limiter and the modulated stage. At audio frequencies between 3 kHz and 20 kHz this filter shall have an attenuation greater than the attenuation at 1 kHz by at least:

$60 \log_{10}(f/3)$ decibels.

where "f" is the audio frequency in kHz. At audio frequencies above 20 kHz, the attenuation shall be at least 50 decibels greater than the attenuation at 1 kHz.

[43 FR 54791, Nov. 22, 1978; 44 FR 67118, Nov. 23, 1979; 49 FR 48712, Dec. 14, 1984]

§ 90.243 Mobile relay stations.

(a) Mobile relay stations under this part may be authorized only as follows:

(1) On frequencies below 450 MHz, mobile relay stations may be authorized to operate only in the Police, Fire, Local Government, Highway Maintenance, Forestry Conservation, Power, Petroleum, Forest Products, Manufacturers, Telephone Maintenance, and Railroad Radio Services.

Outside the contiguous 48 States mobile relay operations below 450 MHz may also be authorized in the Business and Special Industrial Radio Services.

(2) Mobile relay stations will be authorized on frequencies between 450 MHz and 470 MHz in all of the services governed by this part except for the Radiolocation Service.

(3) Mobile relay stations will be authorized on frequencies between 470 MHz and 512 MHz in all of the services that have been allocated such frequencies.

(b) Special provisions for mobile relay operations:

(1) In the Special Emergency Radio Service, Medical Services systems in the 150-160 MHz band are permitted to be cross-banded for mobile and central station operations with mobile relay stations authorized to operate in the 450-470 MHz band.

(2) In the Business Radio Service, mobile relay stations may be authorized on frequencies below 450 MHz when those frequencies are reserved for low power operation (2 watts or less) or for narrowband operation. (See § 90.271) For systems using low power frequencies the maximum output power shall not exceed 1 watt and the mobile relay antenna system shall not be more than 13 m. (40 ft) above ground.

(3) In the Railroad Radio Service, mobile relay operation shall be on a secondary basis to other co-channel operations.

(4) Except where specifically precluded, a mobile relay station may be authorized to operate on any frequency available for assignment to base stations.

(5) A mobile station associated with mobile relay station(s) may not be authorized to operate on a frequency below 25 MHz.

(c) *Technical requirements for mobile relay stations.*

(1) Each new mobile relay station with an output power of more than one watt, and authorized after January 1, 1972, that is activated by signals below 50 MHz shall deactivate the station

upon cessation of reception of the activating continuous coded tone signal. Licensees may utilize a combination of digital selection and continuous coded tone control where required to insure selection of only the desired mobile relay station.

(2) Mobile relay stations controlled by signals above 50 MHz or authorized prior to January 1, 1972, to operate below 50 MHz are not required to incorporate coded signal or tone control devices unless the transmitters are consistently activated by undesired signals and cause harmful interference to other licensees. If activation by undesired signals causes harmful interference, the Commission will require the installation of tone control equipment within 90 days of a notice to the licensee.

(3) Except in the Railroad Radio Service, each new mobile-relay station authorized after January 1, 1972, shall be equipped for automatic deactivation of the transmitter within 5 seconds after the signals controlling the station cease.

(4) Except in the Railroad Radio Service, each new mobile relay station authorized after January 1, 1972, during periods that it is not controlled from a manned fixed control point, shall have an automatic time delay or clock device that will deactivate the station not more than 3 minutes after its activation by a mobile unit.

(5) In the Railroad Radio Service, each mobile relay station, regardless of the frequency or frequencies of the signals by which it is activated shall be so designated and installed that it will be deactivated automatically when its associated receiver or receivers are not receiving a signal on the frequency or frequencies which normally activate it.

(6) Multiple mobile relay station radio systems shall use wireline or radio stations on fixed frequencies for any necessary interconnect circuits between the mobile relay stations.

[49 FR 40177, Oct. 15, 1984; 50 FR 13606, Apr. 5, 1985; 50 FR 39680, Sept. 30, 1985]

§ 90.245 Fixed relay stations.

Except where specifically provided for, fixed relay stations shall be authorized to operate only on frequencies available for use by operational fixed stations.

§ 90.247 Mobile repeater stations.

A mobile station authorized to operate on a mobile service frequency above 25 MHz may be used as a mobile repeater to extend the communications range of hand-carried units subject to the following:

(a) Mobile repeaters and/or associated hand-carried transmitters may be assigned separate base/mobile frequencies for this use (including, in the Railroad Radio Service, any "base only" frequency in the 450-470 MHz range) in addition to the number of frequencies normally assignable to the licensee.

(b) In the Business and Special Industrial Radio Services on frequencies below 450 MHz, only low-power frequencies (2 watts or less output power) may be assigned for use by mobile repeaters or by hand-carried transmitters whose communications are directed to mobile repeaters, when separate frequencies are assigned for that purpose.

(c) Except as provided in paragraph (d) of this section, hand-carried transmitters whose communications will be automatically relayed by mobile stations shall be limited to a maximum output power of 2.5 watts.

(d) In the Railroad Radio Service, use of mobile repeaters is on a secondary basis to the stations of any other licensee. Hand-carried units used in connection with mobile repeaters in the Railroad Radio Service may operate only above 150 MHz and are limited to a maximum output power of 6 watts. The frequency and maximum power shall be specified in the station authorization.

(e) In the Railroad Radio Service, the output power of a mobile repeater station, when transmitting as a repeater station on the frequency used for communication with its associated pack-carried or hand-carried units, shall not exceed 2 watts except when the same frequency is also used by the same station for direct communication with vehicular mobile units or with one or more base stations.

(f) When automatically retransmitting messages originated by or destined for hand-carried units, each mobile station shall activate the mobile transmitter only with a continuous coded tone, the absence of which will de-activate the mobile transmitter. The continuous coded tone is not required when the mobile unit is equipped with a switch that activates the automatic mode of the mobile unit and an automatic time-delay device that de-activates the transmitter after any uninterrupted transmission period in excess of 3 minutes.

§ 90.249 Control stations.

Control stations associated with land mobile stations under this part shall be authorized to operate subject to the following:

(a) *Frequencies for control stations.* (1) Control stations may be authorized to operate on frequencies available for use by operational fixed stations.

(2) A control station associated with mobile relay station(s) may, at the option of the applicant, be assigned the frequency of the associated mobile station. In the Railroad Radio Service such a control station may be assigned any mobile service frequency available for assignment to mobile stations in that service. Such operation is on a secondary basis to use of the frequency for regular mobile service communications.

(3) Control and fixed stations in the Public Safety and Special Emergency Radio Services may be authorized on a temporary basis to oper-

ate on frequencies available for base and mobile stations between 152 and 450 MHz, where there is an adequate showing that such operations cannot be conducted on frequencies allocated for assignment to operational fixed stations. Such operation will not be authorized initially or renewed for periods in excess of one year. Any such authorization shall be subject to immediate termination if harmful interference is caused to stations in the mobile service, or if the particular frequency is required for mobile service operations in the area concerned.

(b) [Reserved]

(c) A base station which is used intermittently as a control station for one or more associated mobile relay stations of the same licensee shall operate only on the mobile service frequency assigned to the associated mobile relay station when operating as a base station and on the mobile service frequency assigned to the associated mobile station when operating as a control station. Authority for such dual classification and use must be shown on the station authorization. When operating as a control station, the licensee must meet all control station requirements. In the Railroad Radio Service base stations used intermittently as control stations shall operate only on a mobile service frequency which is available for assignment to base stations.

[43 FR 54791, Nov. 22, 1978, as amended at 49 FR 36376, Sept. 17, 1984]

§ 90.250 *Meteor burst communications.*

Meteor burst communications may be authorized for the use of private radio stations subject to the following provisions:

(a) Station operation is limited to the State of Alaska only.

(b) The frequency 44.20 MHz may be used for base station operation and 45.90 MHz for remote station operation on a primary basis. The frequencies 42.40 and 44.10 MHz may be used by base and remote stations, respectively, on a secondary basis to common carrier stations utilizing meteor burst communications. Users shall cooperate among themselves to the extent practicable to promote compatible operation.

(c) The maximum transmitter output power shall not exceed 2000 watts for base stations and 500 watts for remote stations.

(d) Co-channel base stations of different licensees shall be located at least 150 miles apart. A remote station and a base station of different licensees shall be located at least 150 miles apart if the remote units of the different licensees operate on the same frequency. Waiver of this requirement may be granted if affected users agree to a cooperative sharing arrangement.

(e) The authorized emission designator to be used in F1E, F7W, G1E or G7W to allow for Phase Shift Keying (PSK) or Frequency Shift Keying (FSK).

(f) The maximum authorized bandwidth is 20 kHz (20 F1E, F7W, G1E or G7W).

(g) Station identification in accordance with § 90.425 (a) or (b) shall only be required for the base station.

(h) Stations may be required to comply with additional conditions of operation as necessary on a case-by-case basis as specified in the authorization.

(i) Stations employing meteor burst communications shall not cause interference to other stations operating in accordance with the allocation table. New authorizations will be issued subject to the Commission's developmental grant procedure as outlined in Subpart Q of this part. Prior to expiration of the developmental authorization, application Form 574 should be filed for issuance of a permanent authorization.

[48 FR 34043, July 27, 1983. 49 FR 48712, Dec. 14, 1984]

Subpart K—Standards for Special Frequencies or Frequency Bands

§ 90.251 **Scope.**

This subpart sets forth special requirements applicable to the use of certain frequencies (4383.8 kHz) or frequency bands (72-76, 216-220, 450-470, and 1427-1435 MHz).

[48 FR 9274, Mar. 4, 1983]

§ 90.253 **Use of frequency 5167.5 kHz.**

The frequency 5167.5 kHz may be used by any station authorized under this part to communicate with any other station in the State of Alaska for emergency communications. The maximum power permitted is 150 watts peak envelope power (PEP). All stations operating on this frequency must be located in or within 50 nautical miles (92.6 km) of the State of Alaska. This frequency may also be used by stations authorized in the Alaska-private fixed service for calling and listening, but only for establishing communication before switching to another frequency.

[49 FR 32201, Aug. 13, 1984]

§ 90.255 **[Reserved]**

§ 90.257 **Assignment and use of frequencies in the band 72-76 MHz.**

(a) The following criteria shall govern the authorization and use of frequencies within the band 72-76 MHz by fixed stations. (For call box operations see § 90.241).

(1) The following frequencies in the band 72-76 MHz may be used for fixed operations:

MHz. 72.02, 72.04, 72.06, 72.08,[1] 72.10, 72.12, 72.14, 72.16,[1] 72.18, 72.20, 72.22, 72.24,[1] 72.26, 72.28, 72.30, 72.32,[1] 72.34, 72.36, 72.38, 72.40,[1] 72.42, 72.46, 72.50, 72.54, 72.58, 72.62, 72.64, 72.66, 72.68

[1] These frequencies are shared, on a secondary basis, by the Radio Control Radio Service until (5 years after the effective date of the rule change).

Commission, shall, within 10 days from such receipt or such other period as may be specified, send a written answer to the office of the Commission originating the original notice. If an answer cannot be sent, or an acknowledgement made within such period, acknowledgement and answer shall be made at the earliest practicable date with a satisfactory explanation of the delay. The answer to each notice shall be complete in itself and shall not be abbreviated by reference to other communications or answers to other notices. The reply shall set forth the steps taken to prevent a recurrence of improper operation.

Subpart O—Transmitter Control

§ 90.460 Scope.

This subpart sets forth the provisions relating to permissible methods of transmitter control and interconnection (see the definition in § 90.7) of radio systems authorized under this part. The rules become effective for new systems on October 17, 1978. Licensees of existing systems shall bring their facilities into compliance with the provisions of this subpart by January 1, 1984.

[44 FR 67124, Nov. 23, 1979]

§ 90.461 Direct and remote control of transmitters.

(a) *In general.* Radio transmitters may be operated and controlled directly (as when the operating position for the transmitter and the transmitter being operated are at the same location), or remotely (as when the transmitter being operated and the position from which it is being operated are at different locations).

(b) *Control of transmitters at remote locations.* Radio transmitters at remote locations may be operated and controlled through the use of wire line or radio links; or through dial-up circuits, as provided in paragraph (c) of this section. Such control links or circuits may be either those of the licensee or they may be provided by common carriers authorized by law to furnish such service.

(c) *Dial-up circuits.* Dial-up circuits may be provided by wire line telephone companies under appropriate tariffs, and they may be used by licensees for purposes of transmitter control, provided:

(1) The dial-up circuits serve only to link licensed transmitter control points and the transmitters being controlled.

(2) The dial-up circuits are so designed that the transmitters being controlled cannot be operated from any fixed position other than the licensed control points for those transmitters.

(3) Equipment used to provide the transmitter/dial-up-circuit interface is designed to preclude associated mobile units of the licensee from reaching any point(s) served by the wire line telephone facilities other than the control point(s) of the station(s) controlled.

(4) Any direct electrical connection to the telephone network shall comply with applicable tariffs and with Part 68 of the Commission's rules (See § 90.5(h)).

(5) Interconnection, within the meaning of §§ 90.7 and 90.477 through 90.483, may not take place at a control point which connects to its associated transmitter(s) through dial-up circuits; nor may such dial-up transmitter control circuits be used in conjunction with (or shared by) interconnection equipment.

[43 FR 54791, Nov. 22, 1978, as amended at 44 FR 67124, Nov. 23, 1979]

§ 90.463 Transmitter control points.

(a) A control operator is required to be stationed at the operating position of a transmitter control point. A control operator is any person designated by the licensee to exercise supervision and control over the operation and use of the licensee's facilities. The control operator may be the licensee, himself; or an employee of the licensee; or the agent of the licensee, appointed by the licensee to act as the control operator; or a third-party contractor, engaged by the licensee to serve as the control operator: *Provided, however,* In no case, through appointment or designation of any person to serve as control operator, may the licensee delegate any of the duties and responsibilities the licensee may have in his capacity as licensee.

(b) Each station or licensed system of communication shall normally have a control point, or control points, at which the control operator or operators are stationed and at or from which the licensee may exercise supervision and control over the authorized facilities, as required by the provisions of § 90.461. *Provided, however,* Control point requirements may vary from one system to another, depending upon the nature of the radio operation; the way and by whom the facilities are employed; and other factors, as set out in other rule sections under this subpart.

(c) A transmitter control point may be located at a fixed position in a system of communication at or from which the control operator exercises supervision and control over the operation and use of the licensed facilities. Each fixed transmitter control point shall have equipment and facilities to permit the control operator:

(1) To determine when the transmitter or transmitters controlled are either radiating "RF" energy, or when the transmitter circuits have been placed in a condition to produce such radiation. This may be accomplished either through the use of a carrier operated device which provides a visual indication when the transmitter(s) are radiating or a pilot lamp or meter which provides a visual indication when the transmitter circuits have been placed in a condition to produce radiation. Further, where a local transmitter is used to activate a remote transmitter or transmitters in the licensee's system of communication, a single pilot lamp or meter may be employed to in-

dicate the activation of both the local and the remote transmitter(s).

(2) To turn the carrier of the transmitter on and off at will, or to close the system down completely, when circumstances warrant such action.

(d) The licensee's transmitting facilities may be operated from dispatch points, the fixed control point shall have equipment to permit the control operator to either disconnect the dispatch point circuits from the transmitter(s) or to render the transmitter(s) inoperative from any dispatch point being supervised.

(e) Where the system is interconnected with public communication facilities, as provided at §§ 90.477 through 90.483, and where those rules so require, the fixed control point shall be equipped to permit the control operator:

(1) To monitor co-channel facilities of other licensees sharing an assigned channel or channels with the licensee in the licensee's area of operation; and,

(2) To terminate any transmission(s) or communication(s) between points in the public communications system and the private communications system.

(f) In urban areas, the location of fixed transmitter control points will be specified, "same as transmitter," unless the control point is at a street address which is different from that of the transmitter(s) controlled. In rural areas, the location of fixed control points will be specified, "same as transmitter," unless the control point is more than 500 feet from the transmitter(s) controlled. In the latter case, the approximate location of the control point will be specified in distance and direction from the transmitter(s) controlled in terms of feet and geographical quadrant, respectively. It would be assumed that the location of a fixed control point is the same as the location of the transmitter(s) controlled, unless the applicant includes a request for a different location described in appropriate terms as indicated herein.

(g) [Reserved]

(h) Mobile transmitters shall be assumed to be under the immediate control of the mobile operator; provided, however, overall supervision and control of the operation and use of a communication system may be the responsibility of a fixed control point operator. In general, mobile transmitters shall be equipped to permit the operator to determine when they are radiating "RF" energy or when the transmitter circuits have been placed in a condition to produce such radiation. This may be accomplished either through the use of a carrier operated device or of a pilot lamp or meter which will provide a visual indication when the transmitter is radiating or has been placed in a condition to produce radiation provided, however, that hand-carried or pack-carried transmitters and transmitters installed on motorcycles need not be so equipped.

[43 FR 54791, Nov. 22, 1978; 44 FR 32220, June 5, 1979; 44 FR 34134, June 14, 1979, as amended at 44 FR 67125, Nov. 23, 1979; 48 FR 29517, June 27, 1983]

§ 90.465 Control of systems of communication.

(a) Depending on design considerations, control of a system of communication may be exercised in varying ways. In SF simplex, base/mobile operations, control may be exercised by the control operator at the fixed control point. In mobile relay systems, where there is an associated control point or control station, control may be exercised by the operator at the control point or control station. In mobile-only systems, control may be exercised by the mobile operator. In communication systems involving multiple base stations or fixed relays control of the system may result from a combination of factors and considerations, including control by a fixed control point operator at some point within the system of communication or control by the mobile station operator of the licensee.

(b) In internal systems, as defined at § 90.7 control may be maintained by conforming the system to the requirements of §§ 90.471 through 90.475.

(c) In interconnected systems, as defined at § 90.7 control may be maintained by conforming operation and system design to that permitted at §§ 90.477 through 90.483.

§ 90.467 Dispatch points.

Dispatch points meeting the requirements of this section need not be specifically authorized: provided, however, that the licensee of any radio station operated from a dispatch point or points shall assume full responsibility for the use and operation of the authorized facilities in compliance with all applicable provisions of law or rule and shall comply with the policy:

(a) A dispatch point may be linked to the transmitter(s) being operated by private or leased wire line of fixed radio circuits, provided the requirements of § 90.463 are met.

(b) No telephone position in the public, switched, telephone network will be treated as a dispatch point within the meaning or intent of this section.

(c) Operation of transmitting facilities from dispatch points is permitted only when the control operator at a fixed control point in the system is on duty and at no other time.

§ 90.469 Unattended operation.

(a) Subject to the provisions of §§ 90.243, 90.245, and 90.247, mobile relay, fixed relay, and mobile repeater stations are authorized for unattended operation; and the transmitter control point requirements set out at §§ 90.463 through 90.465 shall not apply.

(b) Self-activated transmitters may be authorized for unattended operation where they are activated by either electrical or mechanical devices, provided the licensee adopts reasonable means to guard against malfunctions and harmful interference to other users.

INTERNAL TRANSMITTER CONTROL SYSTEMS

§ 90.471 Points of operation in internal transmitter control systems.

The transmitting facilities of the licensee may be operated from fixed positions located on premises controlled by the licensee. The fixed position may be part of a private telephone exchange or it may be any position in a closed or limited access communications facility intended to be used by employees of the licensee for internal communications and transmitter control purposes. Operating positions in internal transmitter control systems are not synonymous with dispatch points (See § 90.467) nor with telephone positions which are part of the public, switched telephone network; and the scheme of regulation is to be considered and treated as being different. See §§ 90.485 through 90.489.

[44 FR 67125, Nov. 23, 1979]

§ 90.473 Operation of internal transmitter control systems through licensed fixed control points.

An internal transmitter control system may be operated under the control and supervision of a control operator stationed at a fixed control point in the system. In such a case, the control point must be equipped to permit the control operator to monitor all traffic to and from fixed positions and mobile stations or paging units of the licensee; and the system shall be so designed to permit the control operator to either disconnect any operating position in the internal system from the transmitter control circuit or to close the system down entirely at will.

[44 FR 67125, Nov. 23, 1979]

§ 90.475 Operation of internal transmitter control systems in specially equipped systems.

(a) An internal transmitter control system need not be designed to meet the requirements of § 90.473 if it meets the following requirements:

(1) All operating positions must be located on premises controlled by the licensee.

(2) An internal transmitter control system may be used in conjunction with other approved methods of transmitter control and interconnection so long as the internal transmitter control system, itself, is neither accessed from telephone positions in the public switched telephone network, nor used dial-up circuits in the public switched telephone network. Licensees with complex communications systems involving fixed systems whose base stations are controlled by such systems may automatically access these base stations through the microwave or operational fixed systems from positions in the PSTN, so long as the base stations and mobile units meet the requirements of § 90.483 and if a separate circuit is provided for each mode of transmitter operation (*i.e.*, conventional, dial-up or internal).

(3) The system must be designed so that upon completion of a transmission, the base station transmitter(s) will close down automatically within 3 seconds.

(4) To guard against malfunctions, the system must also be designed so that the base station(s) will be deactivated by an automatic timing device when a modulated signal is not transmitted for a period of three (3) consecutive minutes.

(5) The system must include automatic monitoring equipment, installed at the base station transmitter site(s), which will prevent the activation of the system when signals of other co-channel stations are present.

[43 FR 54791, Nov. 22, 1978, as amended at 44 FR 67125, Nov. 23, 1979; 47 FR 17521, Apr. 23, 1982]

INTERCONNECTED SYSTEMS

§ 90.476 Interconnection of fixed stations and certain mobile stations.

(a) Fixed stations and mobile stations used to provide the functions of fixed stations pursuant to the provisions of paragraphs (c)(4) and (c)(36) of § 90.75 and § 90.267 are not subject to the interconnection provisions of § 90.477 and § 90.483 and may be interconnected with the facilities of common carriers.

(b) Mobile stations used to provide the functions of base and mobile relay stations pursuant to the provisions of paragraphs (c)(4) and (c)(36) of § 90.75 and § 90.267 are not subject to the provisions of paragraph (d)(3) of § 90.477 and may be interconnected with the facilities of common carriers subject to the provisions of paragraphs (d)(1), (d)(2) and (e) of § 90.477 and § 90.483.

[44 FR 67125, Nov. 23, 1979; 50 FR 15152, Apr. 17, 1985]

§ 90.477 Interconnected systems.

(a) Applicants for new land stations to be interconnected with the public switched telephone network must indicate on their applications (class of station code) that their stations will be interconnected. Licensees of land stations that are not interconnected may interconnect their stations with the public switched telephone network only after modifying their license. See § 90.135. In all cases a detailed description of how interconnection is accomplished must be maintained by licensees as part of their station records. See § 90.433.

(b) In the frequency ranges 806-821 MHz, 851-866 MHz, 896-901 MHz, and 935-940 MHZ, interconnection with the public switched telephone network is authorized under the following conditions:

99TH CONGRESS
2D SESSION

H. R. 5484

To strengthen Federal efforts to encourage foreign cooperation in eradicating illicit drug crops and in halting international drug traffic, to improve enforcement of Federal drug laws and enhance interdiction of illicit drug shipments, to provide strong Federal leadership in establishing effective drug abuse prevention and education programs, to expand Federal support for drug abuse treatment and rehabilitation efforts, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

SEPTEMBER 8, 1986

Mr. WRIGHT (for himself, Mr. MICHEL, Mr. RANGEL, Mr. GILMAN, Mr. FOLEY, Mr. LOTT, Mr. GEPHARDT, Mr. LEWIS of California, Ms. OAKAR, Mr. KEMP, Mr. FASCELL, Mr. ROSTENKOWSKI, Mr. JONES of Tennessee, Mr. ST GERMAIN, Mr. RODINO, Mr. HOWARD, Mr. HAWKINS, Mr. ASPIN, Mr. DINGELL, Mr. FORD of Michigan, Mr. BROOKS, Mr. JONES of Oklahoma, Mr. HUGHES, Mr. ENGLISH, Mr. AKAKA, Mr. ALEXANDER, Mr. ANDREWS, Mr. ANNUNZIO, Mr. ANTHONY, Mr. ATKINS, Mr. AUCOIN, Mr. BARNARD, Mr. BENNETT, Mr. BEVILL, Mr. BIAGGI, Mr. BLAZ, Mr. BLILEY, Mr. BOEHLERT, Mr. BOLAND, Mr. BONER of Tennessee, Mr. BONKER, Mr. BORSKI, Mr. BOUCHER, Mr. BREAUX, Mr. BROOMFIELD, Mr. BROWN of California, Mr. BRUCE, Mr. BRYANT, Mrs. BURTON of California, Mr. CALLAHAN, Mr. CAMPBELL, Mr. CARR, Mr. CHAPMAN, Mr. CHAPPELL, Mr. CHENEY, Mr. CLINGER, Mr. COELHO, Mr. COLEMAN of Missouri, Mr. COLEMAN of Texas, Mrs. COLLINS, Mr. COMBEST, Mr. COOPER, Mr. COUGHLIN, Mr. COURTER, Mr. COYNE, Mr. DANIEL, Mr. DARDEN, Mr. DASCHLE, Mr. DAUB, Mr. DAVIS, Mr. DELLUMS, Mr. DERRICK, Mr. DEWINE, Mr. DICKINSON, Mr. DIOGUARDI, Mr. DIXON, Mr. DONNELLY, Mr. DORGAN of North Dakota, Mr. DORNAN of California, Mr. DOWNEY of New York, Mr. DUNCAN, Mr. DURBIN, Mr. DWYER of New Jersey, Mr.

SEC. 12016. RADAR DEMONSTRATION PROJECT.

(a) PROJECT DESCRIPTION.—Notwithstanding any other provision of law, the Secretary, in cooperation with State and local law enforcement officials, shall conduct a demonstration project to assess the benefits of continuous use of unmanned radar equipment on highway safety on a section of highway with a high rate of motor vehicle accidents. Such project shall be conducted in northern Kentucky on a hilly section of Interstate Route I–75 between Fort Mitchell and the Brent Spence Bridge over the Ohio River during the 24-month period beginning on the date of the enactment of this title.

(b) REPORTS.—

(1) INTERIM REPORT.—Not later than 18 months after the date of the enactment of this title, the Secretary shall transmit to Congress an interim report on the results of the demonstration project conducted under subsection (a), together with any recommendations on whether or not to extend the duration of such demonstration project and whether or not to expand the scope of such project.

(2) FINAL REPORT.—Not later than 60 days after completion of the demonstration project conducted under subsection (a), the Secretary shall transmit to Congress a final report on the results of such project, together with any such recommendations.

APPENDIX B

STATISTICAL ANALYSIS OF PROPORTIONS OF VEHICLES EXCEEDING SPECIFIED SPEED LEVELS

Statistical analysis of the proportions of vehicles exceeding specified speed levels was patterned after analysis originally used by Campbell in his 1968 evaluation of the injury-reduction effects of seat belts in automobile crashes (14). Campbell was aware that factors other than seat-belt usage affected the likelihood that drivers would sustain injuries in crashes. Such factors, identifiable within his data base, included type of accident (single vehicle, car vs. car, and car vs. truck), part of car struck (front, side, rear, and unspecified), and travel speed (0-29 mph, 30-49 mph, and 50 or more mph). Direct comparisons between the proportions of crashes resulting in injury between belted and unbelted drivers were limited to the elemental analysis units, each comprising a unique combination of type of accident, part of car struck, and travel speed. For aggregations, adjustments were made to assure proportional representation among the elemental analysis units for both belted and unbelted drivers. Essentially, within each elemental unit, the proportion of injury crashes for unbelted drivers was applied to the number of crashes for belted drivers to obtain the number of injury crashes in the belted driver sample that would be "expected" had the driver not been belted. Aggregated comparisons were between the expected sums and the actual sums for belted drivers.

The Campbell procedure was adopted for use herein because of its simplicity and its intuitive appeal. Essentially, data collected under "radar off" conditions was adjusted so that the proportion of total observations occurring within each elemental analysis unit was identical to that occurring under "radar on" conditions. Each speed measure, so adjusted, is considered to be the expected value in the absence of radar: it is compared with the actual value measured with "radar on" to identify the most likely effects of the radar.

Table B1 illustrates computations for the number of vehicles exceeding 65 miles per hour at Florence. The first line of data represents that collected in the median lane during daylight hours of weekdays under the lowest volume condition. The proportion of vehicles exceeding 65 miles per hour with "radar off" is 0.647 (5,571/8,611). If radar has no effect, the expected number of vehicles exceeding 65 mph in the sample observed with "radar on" is 5,572, the product of the number of vehicles observed with "radar on" (8,613) and the above proportion (0.647). Thus, for this elemental analysis unit, the effect of radar was to reduce the number of vehicles exceeding 65 mph by 1,062, from 5,572 to 4,510.

To determine the composite effect of radar, it is necessary to aggregate data tabulated for each of the elemental analysis units. The proportion of observations within each elemental unit for the "radar on" condition was used as the representative condition. Again referring to Table B1 for illustrative purposes, the composite effect of radar at Florence was to reduce the number of vehicles exceeding 65 miles per hour during a representative period of 635 lane hours, about 212 clock hours, from 75,023 to 55,631, a reduction of about 26 percent. Therefore, 55,631 is the actual number of vehicles exceeding 65 mph that was observed, and 75,023 is the expected number obtained by summing over the 35 elemental analysis units.

Effects of radar were evaluated not only for the entire data set, as illustrated above, but also for subsets by day of week, lane of travel, light condition, and volume level. In this way, conditions possibly enhancing or diminishing the effects of radar may be identified.

Effects of radar on vehicle speeds were generally tested for their statistical significance. The level of significance for hypothesis testing was set at 0.05. As illustrated in Figure B2, a Chi-Squared test was used for testing the significance of differences in the proportions of vehicles exceeding stated speed levels (14, 15).

TABLE B1. ILLUSTRATION OF COMPUTATION OF EXPECTED CONDITIONS

				RADAR OFF			RADAR ON			RADAR OFF
DAY	LANE	LIGHT	VOL	NO. OF HOURS	ACTUAL NO. OF VEHICLES	ACTUAL NO. OF VEHICLES EXCEEDING 65 MPH	NO. OF HOURS	ACTUAL NO. OF VEHICLES	ACTUAL NO. OF VEHICLES EXCEEDING 65 MPH	EXPECTED NO. OF VEHICLES EXCEEDING 65 MPH
1	1	1	1	39	8611	5571	37	8613	4510	5572
1	1	1	2	30	12077	7655	43	16933	8394	10733
1	1	2	1	67	4408	2239	82	6355	2739	3228
1	1	2	2	5	1672	948	2	659	293	374
1	2	1	2	16	9073	3332	12	6952	2212	2553
1	2	1	3	50	35073	14038	66	48199	14519	19292
1	2	1	4	3	2773	1234	3	2915	914	1297
1	2	2	1	42	7438	2357	47	8374	1804	2654
1	2	2	2	23	9146	2926	31	12996	3137	4158
1	2	2	3	7	4705	1354	6	3870	871	1114
1	3	1	2	65	32793	3592	78	39409	3160	4317
1	3	1	3	4	2458	345	3	1962	216	275
1	3	2	1	50	10726	781	53	11776	468	857
1	3	2	2	22	8771	840	31	11637	767	1114
2	1	1	1	16	2124	1521	8	1065	581	763
2	1	1	2	21	8727	5226	9	3480	1217	2084
2	1	1	3	7	5088	3229	5	3832	1781	2432
2	1	1	4	2	1883	994	2	1916	841	1011
2	1	2	1	41	2741	1252	22	1880	432	859
2	1	2	2	5	2076	1001	1	472	183	228
2	1	2	3	2	1407	685	1	636	247	310
2	2	1	1	3	608	238	2	459	172	180
2	2	1	2	10	4458	2034	4	1785	640	814
2	2	1	3	20	15253	5582	11	8172	1686	2991
2	2	1	4	13	13685	4597	4	4489	1273	1508
2	2	2	1	30	5111	1745	13	2079	442	710
2	2	2	2	9	3760	985	7	2948	318	772
2	2	2	3	6	4023	1021	3	2135	347	542
2	2	2	4	3	2996	714	1	1004	216	239
2	3	1	1	5	1068	173	3	689	72	112
2	3	1	2	27	13574	1614	14	7294	498	867
2	3	1	3	14	9615	927	7	5187	397	500
2	3	2	1	34	6017	643	16	2770	146	296
2	3	2	2	12	5039	391	7	2864	109	222
2	3	2	3	2	1290	90	1	665	29	46
TOTALS				705	260267	81874	635	236471	55631	75023

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Vol (vplph):
1 < 300
2 300-599
3 600-399
4 900-1,200
5 > 1,200

TABLE B2. ILLUSTRATION OF STATISTICAL TESTING, VEHICLES EXCEEDING 65 MPH (ALL DATA AT FLORENCE)

				RADAR OFF		RADAR ON		RADAR OFF	
DAY	LANE	LIGHT	VOL	NO. OF VEH	ACTUAL NO. OF VEHICLES EXCEEDING 65 MPH	NO. OF VEH	ACTUAL NO. OF VEHICLES EXCEEDING 65 MPH	EXPECTED NO. OF VEHICLES EXCEEDING 65 MPH	CHI SQUARED DENOMINATOR
1	1	1	1	8611	5571	8613	4510	5572	3935
1	1	1	2	12077	7655	16933	8394	10733	9440
1	1	2	1	4408	2239	6355	2739	3228	3878
1	1	2	2	1672	948	659	293	374	226
1	2	1	2	9073	3332	6952	2212	2553	2853
1	2	1	3	35073	14038	48199	14519	19292	27470
1	2	1	4	2773	1234	2915	914	1297	1477
1	2	2	1	7438	2357	8374	1804	2654	3854
1	2	2	2	9146	2926	12996	3137	4158	6845
1	2	2	3	4705	1354	3870	871	1114	1446
1	3	1	2	32793	3592	39409	3160	4317	8463
1	3	1	3	2458	345	1962	216	275	426
1	3	2	1	10726	781	11776	468	857	1668
1	3	2	2	8771	840	11637	767	1114	2345
2	1	1	1	2124	1521	1065	581	763	325
2	1	1	2	8727	5226	3480	1217	2084	1169
2	1	1	3	5088	3229	3832	1781	2432	1558
2	1	1	4	1883	994	1916	841	1011	963
2	1	2	1	2741	1252	1880	432	859	786
2	1	2	2	2076	1001	472	183	228	145
2	1	2	3	1407	685	636	247	310	231
2	2	1	1	608	238	459	172	180	192
2	2	1	2	4458	2034	1785	640	814	620
2	2	1	3	15253	5582	8172	1686	2991	2912
2	2	1	4	13635	4597	4489	1273	1508	1330
2	2	2	1	5111	1745	2079	442	710	658
2	2	2	2	3760	985	2948	318	772	1017
2	2	2	3	4023	1021	2135	347	542	619
2	2	2	4	2996	714	1004	216	239	243
2	3	1	1	1068	173	689	72	112	154
2	3	1	2	13574	1614	7294	498	867	1175
2	3	1	3	9615	927	5187	397	500	696
2	3	2	1	6017	643	2770	146	296	386
2	3	2	2	5039	391	2864	109	222	321
2	3	2	3	1290	90	665	29	46	65
TOTAL				260267	81874	236471	55631	75024	89891

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Vol (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE B2. ILLUSTRATION OF STATISTICAL TESTING, VEHICLES EXCEEDING 65 MPH (ALL DATA AT FLORENCE) (CONTINUED)

x_a, n_a = actual number of vehicles exceeding 65 mph and actual number of observed vehicles with "radar off"

x_b, n_b = actual number of vehicles exceeding 65 mph and actual number of observed vehicles with "radar on"

x_b' = expected number of vehicles exceeding 65 mph with "radar off" (adjusted to reflect "radar on" counting frequencies)

$$\text{Chi Squared} = \frac{[sum(x_b - sum(x_b'))]^2}{sum[(x_a/n_a*n_b)*(1-x_a/n_a)*(1+n_b/n_a)]}$$

$$= \frac{[55,631 - 75,024]^2}{89,891} = 4,184$$

ls = level of significance = 0.05

Chi $Squared_{1-ls}$ = 3.84 (From chi-squared table with one degree of freedom)

Since Chi Squared > Chi $Squared_{1-ls}$, conclude that the proportion of vehicles exceeding 65 mph without radar exceeds the proportion of vehicles exceeding 65 mph with radar at a level of significance of 0.05.

APPENDIX C

SUMMARY TABLES SHOWING MEAN SPEEDS, 85TH PERCENTILE, STANDARD DEVIATION, AND NUMBER OF VEHICLES EXCEEDING VARIOUS SPEED LEVELS

TABLE C1. COMPARISON OF MEAN SPEEDS
(AUTOMATIC DATA AT FT. WRIGHT)

DAY	LANE	LIGHT	VOLUME	RADAR OFF NO. OF HOURS	RADAR OFF NO. OF VEHICLES	RADAR OFF MEAN SPEED	RADAR ON NO. OF HOURS	RADAR ON NO. OF VEHICLES	RADAR ON MEAN SPEED
1	1	1	1	0	0	-	2	355	66.099
1	1	1	2	2	1,180	63.648	4	2,090	64.151
1	1	1	3	74	59,669	64.256	100	78,738	64.131
1	1	1	4	98	102,910	63.650	164	172,126	63.337
1	1	1	5	70	114,908	59.129	123	196,679	59.750
1	1	2	1	108	8,792	63.231	165	14,286	62.991
1	1	2	2	64	28,274	63.324	93	39,943	62.996
1	1	2	3	28	19,922	62.634	46	32,202	62.437
1	1	2	4	5	5,221	61.708	4	4,094	61.872
1	1	2	5	15	22,765	61.303	19	28,027	61.188
1	2	1	2	0	0	-	2	911	60.656
1	2	1	3	3	2,480	58.351	4	3,430	57.853
1	2	1	4	99	111,034	58.525	127	141,476	58.603
1	2	1	5	140	198,726	56.688	260	370,882	56.723
1	2	2	1	90	15,714	58.142	130	24,251	58.087
1	2	2	2	36	16,597	58.628	64	30,621	58.364
1	2	2	3	48	36,660	57.738	71	54,278	57.409
1	2	2	4	26	26,567	57.177	40	39,995	57.145
1	2	2	5	17	24,265	56.615	21	29,795	56.575
1	3	1	1	2	423	56.097	3	606	56.845
1	3	1	2	7	3,931	54.692	18	9,474	54.908
1	3	1	3	164	127,341	54.564	283	219,290	54.507
1	3	1	4	23	23,541	53.856	49	50,468	53.967
1	3	1	5	22	33,001	48.711	30	47,059	49.373
1	3	2	1	93	17,674	51.682	152	26,899	51.750
1	3	2	2	81	36,638	54.463	137	60,150	54.089
1	3	2	3	13	8,864	54.269	21	14,142	54.235
1	3	2	4	15	15,681	53.335	16	16,729	53.347
1	3	2	5	0	0	-	1	1,295	51.514
2	1	1	1	14	2,471	66.543	11	1,906	65.629
2	1	1	2	19	9,203	65.983	18	8,541	65.537
2	1	1	3	42	32,270	64.487	37	28,629	64.475
2	1	1	4	57	59,260	63.505	40	40,306	63.625
2	1	1	5	27	35,427	62.644	26	33,898	62.299
2	1	2	1	71	7,719	63.559	64	6,826	63.437
2	1	2	2	35	15,488	62.455	29	12,192	62.256
2	1	2	3	11	7,965	61.380	13	8,554	61.819
2	1	2	4	3	3,097	61.466	4	3,868	61.232
2	1	2	5	0	0	-	2	2,647	60.376
2	2	1	2	15	6,476	60.377	11	4,704	60.163
2	2	1	3	19	14,804	60.478	19	14,714	59.793
2	2	1	4	56	61,137	58.917	48	52,524	58.833
2	2	1	5	67	89,037	58.356	54	72,598	58.175
2	2	2	1	40	7,639	58.244	36	7,436	58.420
2	2	2	2	35	14,575	58.095	34	14,687	58.197
2	2	2	3	30	22,629	57.159	23	17,230	57.243
2	2	2	4	11	11,052	56.039	16	16,061	56.398
2	2	2	5	1	1,253	55.989	3	3,899	55.596
2	3	1	1	7	1,591	57.525	8	1,910	57.442
2	3	1	2	29	14,248	56.814	31	15,216	56.986
2	3	1	3	91	65,085	56.394	90	65,170	56.503
2	3	1	4	1	931	56.464	3	3,002	56.235
2	3	1	5	1	1,254	53.738	0	0	-
2	3	2	1	55	8,470	54.630	64	10,981	54.855
2	3	2	2	44	18,760	54.826	40	17,332	54.815
2	3	2	3	3	1,996	53.917	8	5,390	54.622

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C2. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 65 MPH (AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 65 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 65 MPH
1	1	1	1	0	0	-	2	355	55.211
1	1	1	2	2	1,180	32.119	4	2,090	37.751
1	1	1	3	74	59,669	39.444	100	78,738	38.307
1	1	1	4	98	102,910	34.095	164	172,126	31.689
1	1	1	5	70	114,908	16.111	123	196,679	15.900
1	1	2	1	108	8,792	32.803	165	14,286	30.470
1	1	2	2	64	28,274	30.961	93	39,943	29.222
1	1	2	3	28	19,922	25.891	46	32,202	24.377
1	1	2	4	5	5,221	19.556	4	4,094	19.248
1	1	2	5	15	22,765	16.253	19	28,027	14.725
1	2	1	2	0	0	-	2	911	15.258
1	2	1	3	3	2,480	6.371	4	3,430	7.114
1	2	1	4	99	111,034	6.638	127	141,476	6.755
1	2	1	5	140	198,726	4.987	260	370,882	4.476
1	2	2	1	90	15,714	9.030	130	24,251	7.987
1	2	2	2	36	16,597	7.718	64	30,621	6.740
1	2	2	3	48	36,660	5.330	71	54,278	4.536
1	2	2	4	26	26,567	4.265	40	39,995	3.863
1	2	2	5	17	24,265	3.128	21	29,795	2.796
1	3	1	1	2	423	7.565	3	606	7.756
1	3	1	2	7	3,931	3.409	18	9,474	4.296
1	3	1	3	164	127,341	3.758	283	219,290	3.587
1	3	1	4	23	23,541	2.935	49	50,468	2.130
1	3	1	5	22	33,001	0.567	30	47,059	0.436
1	3	2	1	93	17,674	2.535	152	26,899	2.521
1	3	2	2	81	36,638	3.376	137	60,150	3.061
1	3	2	3	13	8,864	2.550	21	14,142	2.758
1	3	2	4	15	15,681	1.715	16	16,729	1.536
1	3	2	5	0	0	-	1	1,295	0.849
2	1	1	1	14	2,471	58.155	11	1,906	50.262
2	1	1	2	19	9,203	53.624	18	8,541	50.650
2	1	1	3	42	32,270	41.305	37	28,629	41.332
2	1	1	4	57	59,260	33.905	40	40,306	34.035
2	1	1	5	27	35,427	27.191	26	33,898	22.780
2	1	2	1	71	7,719	35.017	64	6,826	33.680
2	1	2	2	35	15,488	25.426	29	12,192	24.729
2	1	2	3	11	7,965	18.318	13	8,554	20.715
2	1	2	4	3	3,097	17.469	4	3,868	17.813
2	1	2	5	0	0	-	2	2,647	11.976
2	2	1	2	15	6,476	15.889	11	4,704	14.435
2	2	1	3	19	14,804	13.854	19	14,714	10.833
2	2	1	4	56	61,137	7.877	48	52,524	7.553
2	2	1	5	67	89,037	6.753	54	72,598	5.603
2	2	2	1	40	7,639	9.438	36	7,436	8.755
2	2	2	2	35	14,575	6.840	34	14,687	6.945
2	2	2	3	30	22,629	4.424	23	17,230	4.684
2	2	2	4	11	11,052	2.443	16	16,061	3.375
2	2	2	5	1	1,253	3.591	3	3,899	2.257
2	3	1	1	7	1,591	8.297	8	1,910	8.639
2	3	1	2	29	14,248	5.959	31	15,216	6.138
2	3	1	3	91	65,085	5.036	90	65,170	5.051
2	3	1	4	1	931	2.148	3	3,002	3.598
2	3	1	5	1	1,254	1.834	0	0	-
2	3	2	1	55	8,470	4.298	64	10,981	4.653
2	3	2	2	44	18,760	3.353	40	17,332	3.093
2	3	2	3	3	1,996	2.305	8	5,390	2.430

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C3. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 70 MPH (AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 70 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 70 MPH
1	1	1	1	0	0	-	2	355	20.282
1	1	1	2	2	1,180	7.712	4	2,090	9.665
1	1	1	3	74	59,669	7.775	100	78,738	7.525
1	1	1	4	98	102,910	5.951	164	172,126	5.287
1	1	1	5	70	114,908	2.396	123	196,679	2.069
1	1	2	1	108	8,792	9.418	165	14,286	8.274
1	1	2	2	64	28,274	6.370	93	39,943	5.430
1	1	2	3	28	19,922	4.573	46	32,202	3.975
1	1	2	4	5	5,221	3.026	4	4,094	2.760
1	1	2	5	15	22,765	1.841	19	28,027	1.549
1	2	1	2	0	0	-	2	911	3.842
1	2	1	3	3	2,480	0.806	4	3,430	1.108
1	2	1	4	99	111,034	1.065	127	141,476	1.081
1	2	1	5	140	198,726	0.850	260	370,882	0.701
1	2	2	1	90	15,714	1.992	130	24,251	1.621
1	2	2	2	36	16,597	1.440	64	30,621	1.238
1	2	2	3	48	36,660	0.854	71	54,278	0.755
1	2	2	4	26	26,567	0.662	40	39,995	0.613
1	2	2	5	17	24,265	0.482	21	29,795	0.359
1	3	1	1	2	423	1.418	3	606	1.155
1	3	1	2	7	3,931	0.763	18	9,474	0.982
1	3	1	3	164	127,341	0.806	283	219,290	0.670
1	3	1	4	23	23,541	0.582	49	50,468	0.365
1	3	1	5	22	33,001	0.082	30	47,059	0.085
1	3	2	1	93	17,674	0.583	152	26,899	0.424
1	3	2	2	81	36,638	0.756	137	60,150	0.572
1	3	2	3	13	8,864	0.553	21	14,142	0.566
1	3	2	4	15	15,681	0.293	16	16,729	0.203
1	3	2	5	0	0	-	1	1,295	-
2	1	1	1	14	2,471	21.489	11	1,906	17.471
2	1	1	2	19	9,203	16.234	18	8,541	13.628
2	1	1	3	42	32,270	9.191	37	28,629	8.589
2	1	1	4	57	59,260	6.277	40	40,306	5.930
2	1	1	5	27	35,427	4.604	26	33,898	3.065
2	1	2	1	71	7,719	10.364	64	6,826	9.903
2	1	2	2	35	15,488	5.107	29	12,192	4.823
2	1	2	3	11	7,965	3.277	13	8,554	3.718
2	1	2	4	3	3,097	2.196	4	3,868	2.559
2	1	2	5	0	0	-	2	2,647	1.322
2	2	1	2	15	6,476	3.567	11	4,704	2.636
2	2	1	3	19	14,804	2.797	19	14,714	2.005
2	2	1	4	56	61,137	1.268	43	52,524	1.199
2	2	1	5	67	89,037	1.153	54	72,598	0.849
2	2	2	1	40	7,639	2.173	36	7,436	1.910
2	2	2	2	35	14,575	1.413	34	14,687	1.273
2	2	2	3	30	22,629	0.787	23	17,230	0.789
2	2	2	4	11	11,052	0.461	15	16,061	0.567
2	2	2	5	1	1,253	0.399	3	3,899	0.231
2	3	1	1	7	1,591	1.823	8	1,910	1.990
2	3	1	2	29	14,248	1.235	31	15,216	1.104
2	3	1	3	91	65,085	0.976	90	65,170	0.956
2	3	1	4	1	931	0.430	3	3,002	0.966
2	3	1	5	1	1,254	0.319	0	0	-
2	3	2	1	55	8,470	0.980	64	10,981	0.984
2	3	2	2	44	18,760	0.709	40	17,332	0.646
2	3	2	3	3	1,996	0.601	8	5,390	0.445

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C4. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 75 MPH (AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 75 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 75 MPH
1	1	1	1	0	0	-	2	355	2.535
1	1	1	2	2	1,180	0.678	4	2,090	1.435
1	1	1	3	74	59,669	0.833	100	78,738	0.705
1	1	1	4	98	102,910	0.585	164	172,126	0.465
1	1	1	5	70	114,908	0.216	123	196,679	0.179
1	1	2	1	108	8,792	2.172	165	14,286	1.505
1	1	2	2	64	28,274	0.902	93	39,943	0.701
1	1	2	3	28	19,922	0.527	46	32,202	0.413
1	1	2	4	5	5,221	0.326	4	4,094	0.391
1	1	2	5	15	22,765	0.119	19	28,027	0.107
1	2	1	2	0	0	-	2	911	0.659
1	2	1	3	3	2,480	0.121	4	3,430	0.117
1	2	1	4	99	111,034	0.142	127	141,476	0.128
1	2	1	5	140	198,726	0.098	260	370,882	0.079
1	2	2	1	90	15,714	0.369	130	24,251	0.326
1	2	2	2	36	16,597	0.217	64	30,621	0.163
1	2	2	3	48	36,660	0.125	71	54,278	0.116
1	2	2	4	26	26,567	0.094	40	39,995	0.090
1	2	2	5	17	24,265	0.041	21	29,795	0.017
1	3	1	1	2	423	0.473	3	606	0.165
1	3	1	2	7	3,931	0.229	18	9,474	0.179
1	3	1	3	164	127,341	0.158	283	219,290	0.109
1	3	1	4	23	23,541	0.085	49	50,468	0.052
1	3	1	5	22	33,001	0.009	30	47,059	0.015
1	3	2	1	93	17,674	0.170	152	26,899	0.093
1	3	2	2	81	36,638	0.145	137	60,150	0.098
1	3	2	3	13	8,864	0.056	21	14,142	0.078
1	3	2	4	15	15,681	0.026	16	16,729	0.030
1	3	2	5	0	0	-	1	1,295	-
2	1	1	1	14	2,471	4.775	11	1,906	3.095
2	1	1	2	19	9,203	2.238	18	8,541	1.932
2	1	1	3	42	32,270	1.016	37	28,629	0.870
2	1	1	4	57	59,260	0.660	40	40,306	0.486
2	1	1	5	27	35,427	0.353	26	33,898	0.260
2	1	2	1	71	7,719	2.125	64	6,826	2.197
2	1	2	2	35	15,488	0.710	29	12,192	0.615
2	1	2	3	11	7,965	0.339	13	8,554	0.351
2	1	2	4	3	3,097	0.161	4	3,868	0.310
2	1	2	5	0	0	0	2	2,647	0.113
2	2	1	2	15	6,476	0.463	11	4,704	0.340
2	2	1	3	19	14,804	0.399	19	14,714	0.306
2	2	1	4	56	61,137	0.134	48	52,524	0.131
2	2	1	5	67	89,037	0.162	54	72,598	0.098
2	2	2	1	40	7,639	0.537	36	7,436	0.309
2	2	2	2	35	14,575	0.274	34	14,687	0.191
2	2	2	3	30	22,629	0.146	23	17,230	0.110
2	2	2	4	11	11,052	0.054	16	16,061	0.100
2	2	2	5	1	1,253	-	3	3,899	0.051
2	3	1	1	7	1,591	0.126	8	1,910	0.209
2	3	1	2	29	14,248	0.232	31	15,216	0.184
2	3	1	3	91	65,085	0.194	90	65,170	0.183
2	3	1	4	1	931	0.215	3	3,002	0.033
2	3	1	5	1	1,254	-	0	0	-
2	3	2	1	55	8,470	0.272	64	10,981	0.219
2	3	2	2	44	18,760	0.133	40	17,332	0.075
2	3	2	3	3	1,996	0.050	8	5,390	0.056

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C5. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 80 MPH (AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 80 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 80 MPH
1	1	1	1	0	0	-	2	355	0.000
1	1	1	2	2	1,180	0.085	4	2,090	0.431
1	1	1	3	74	59,669	0.146	100	78,738	0.135
1	1	1	4	98	102,910	0.102	164	172,126	0.079
1	1	1	5	70	114,908	0.032	123	196,679	0.025
1	1	2	1	108	8,792	0.523	165	14,286	0.420
1	1	2	2	64	28,274	0.170	93	39,943	0.170
1	1	2	3	28	19,922	0.115	46	32,202	0.109
1	1	2	4	5	5,221	0.057	4	4,094	0.049
1	1	2	5	15	22,765	0.013	19	28,027	0.014
1	2	1	2	0	0	-	2	911	0.110
1	2	1	3	3	2,480	-	4	3,430	0.029
1	2	1	4	99	111,034	0.030	127	141,476	0.025
1	2	1	5	140	198,726	0.018	260	370,882	0.013
1	2	2	1	90	15,714	0.095	130	24,251	0.087
1	2	2	2	36	16,597	0.054	64	30,621	0.039
1	2	2	3	48	36,660	0.030	71	54,278	0.020
1	2	2	4	26	26,567	0.004	40	39,995	0.033
1	2	2	5	17	24,265	0.008	21	29,795	0.003
1	3	1	1	2	423	0.236	3	606	-
1	3	1	2	7	3,931	0.025	18	9,474	0.032
1	3	1	3	164	127,341	0.043	283	219,290	0.021
1	3	1	4	23	23,541	0.025	49	50,468	0.012
1	3	1	5	22	33,001	-	30	47,059	0.002
1	3	2	1	93	17,674	0.034	152	26,899	0.022
1	3	2	2	81	36,638	0.052	137	60,150	0.018
1	3	2	3	13	8,864	0.011	21	14,142	0.007
1	3	2	4	15	15,681	-	16	16,729	0.006
1	3	2	5	0	0	-	1	1,295	-
2	1	1	1	14	2,471	0.931	11	1,906	0.735
2	1	1	2	19	9,203	0.478	18	8,541	0.375
2	1	1	3	42	32,270	0.149	37	28,629	0.126
2	1	1	4	57	59,260	0.093	40	40,306	0.092
2	1	1	5	27	35,427	0.045	26	33,898	0.030
2	1	2	1	71	7,719	0.570	64	6,826	0.513
2	1	2	2	35	15,488	0.149	29	12,192	0.131
2	1	2	3	11	7,965	0.050	13	8,554	0.012
2	1	2	4	3	3,097	0.032	4	3,868	0.052
2	1	2	5	0	0	-	2	2,647	-
2	2	1	2	15	6,476	0.124	11	4,704	0.085
2	2	1	3	19	14,804	0.074	19	14,714	0.043
2	2	1	4	56	61,137	0.029	48	52,524	0.027
2	2	1	5	67	89,037	0.027	54	72,598	0.011
2	2	2	1	40	7,639	0.209	36	7,436	0.121
2	2	2	2	35	14,575	0.082	34	14,687	0.068
2	2	2	3	30	22,629	0.049	23	17,230	0.023
2	2	2	4	11	11,052	0.009	16	16,061	0.012
2	2	2	5	1	1,253	-	3	3,899	0.051
2	3	1	1	7	1,591	-	8	1,910	0.052
2	3	1	2	29	14,248	0.077	31	15,216	0.059
2	3	1	3	91	65,085	0.061	90	65,170	0.048
2	3	1	4	1	931	0.107	3	3,002	-
2	3	1	5	1	1,254	-	0	0	-
2	3	2	1	55	8,470	0.106	64	10,981	0.073
2	3	2	2	44	18,760	0.032	40	17,332	0.012
2	3	2	3	3	1,996	-	8	5,390	-

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C6. COMPARISON OF 85TH PERCENTILE SPEEDS
(AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	85TH %TILE SPEED	NO. OF HOURS	NO. OF VEHICLES	85TH %TILE SPEED
1	1	1	1	0	0	-	2	355	74.524
1	1	1	2	2	1,180	71.433	4	2,090	71.593
1	1	1	3	74	59,669	71.224	100	78,738	71.219
1	1	1	4	98	102,910	71.056	164	172,126	71.000
1	1	1	5	70	114,908	70.871	123	196,679	70.745
1	1	2	1	108	8,792	71.991	165	14,286	71.840
1	1	2	2	64	28,274	71.287	93	39,943	71.133
1	1	2	3	28	19,922	71.062	46	32,202	70.963
1	1	2	4	5	5,221	70.805	4	4,094	70.726
1	1	2	5	15	22,765	70.620	19	28,027	66.837
1	2	1	2	0	0	-	2	911	70.962
1	2	1	3	3	2,480	66.477	4	3,430	66.786
1	2	1	4	99	111,034	66.600	127	141,476	66.565
1	2	1	5	140	198,726	66.605	260	370,882	66.486
1	2	2	1	90	15,714	67.455	130	24,251	67.140
1	2	2	2	36	16,597	66.858	64	30,621	66.715
1	2	2	3	48	36,660	66.625	71	54,278	66.481
1	2	2	4	26	26,567	66.527	40	39,995	66.358
1	2	2	5	17	24,265	61.504	21	29,795	61.456
1	3	1	1	2	423	66.957	3	606	67.000
1	3	1	2	7	3,931	61.992	18	9,474	66.867
1	3	1	3	164	127,341	62.164	283	219,290	62.095
1	3	1	4	23	23,541	61.933	49	50,468	61.638
1	3	1	5	22	33,001	57.659	30	47,059	57.476
1	3	2	1	93	17,674	62.220	152	26,899	62.067
1	3	2	2	81	36,638	62.049	137	60,150	61.953
1	3	2	3	13	8,864	61.609	21	14,142	61.736
1	3	2	4	15	15,681	61.486	16	16,729	61.299
1	3	2	5	0	0	-	1	1,295	60.588
2	1	1	1	14	2,471	76.193	11	1,906	75.803
2	1	1	2	19	9,203	75.737	18	8,541	71.817
2	1	1	3	42	32,270	71.423	37	28,629	71.304
2	1	1	4	57	59,260	71.129	40	40,306	71.048
2	1	1	5	27	35,427	71.009	26	33,898	70.766
2	1	2	1	71	7,719	72.057	64	6,826	72.036
2	1	2	2	35	15,488	71.226	29	12,192	71.180
2	1	2	3	11	7,965	71.031	13	8,554	71.042
2	1	2	4	3	3,097	70.592	4	3,868	70.712
2	1	2	5	0	0	-	2	2,647	66.647
2	2	1	2	15	6,476	71.318	11	4,704	67.600
2	2	1	3	19	14,804	67.309	19	14,714	66.986
2	2	1	4	56	61,137	66.719	48	52,524	66.677
2	2	1	5	67	89,037	66.684	54	72,598	66.472
2	2	2	1	40	7,639	67.447	36	7,436	67.147
2	2	2	2	35	14,575	66.852	34	14,687	66.812
2	2	2	3	30	22,629	66.590	23	17,230	66.583
2	2	2	4	11	11,052	61.590	16	16,061	61.712
2	2	2	5	1	1,253	61.418	3	3,899	61.305
2	3	1	1	7	1,591	67.053	8	1,910	67.294
2	3	1	2	29	14,248	66.946	31	15,216	66.880
2	3	1	3	91	65,085	66.841	90	65,170	66.817
2	3	1	4	1	931	65.640	3	3,002	66.336
2	3	1	5	1	1,254	-	0	0	-
2	3	2	1	55	8,470	62.372	64	10,981	67.158
2	3	2	2	44	18,760	61.911	40	17,332	61.881
2	3	2	3	3	1,996	61.373	8	5,390	61.613

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C7. COMPARISON OF STANDARD DEVIATION OF SPEEDS
(AUTOMATIC DATA AT FT. WRIGHT)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	STD DEV	NO. OF HOURS	NO. OF VEHICLES	STD DEV
1	1	1	1	0	0	-	2	355	5.219
1	1	1	2	2	1,180	4.735	4	2,090	5.120
1	1	1	3	74	59,669	4.733	100	78,738	4.742
1	1	1	4	98	102,910	4.736	164	172,126	4.752
1	1	1	5	70	114,908	6.666	123	196,679	6.237
1	1	2	1	108	8,792	5.773	165	14,286	5.513
1	1	2	2	64	28,274	4.840	93	39,943	4.865
1	1	2	3	28	19,922	4.772	46	32,202	4.700
1	1	2	4	5	5,221	4.676	4	4,094	4.489
1	1	2	5	15	22,765	4.562	19	28,027	4.338
1	2	1	2	0	0	-	2	911	5.106
1	2	1	3	3	2,480	4.641	4	3,430	5.183
1	2	1	4	99	111,034	4.557	127	141,476	4.588
1	2	1	5	140	198,726	5.715	260	370,882	5.536
1	2	2	1	90	15,714	5.535	130	24,251	5.187
1	2	2	2	36	16,597	4.751	64	30,621	4.654
1	2	2	3	48	36,660	4.562	71	54,278	4.571
1	2	2	4	26	26,567	4.516	40	39,995	4.482
1	2	2	5	17	24,265	4.481	21	29,795	4.298
1	3	1	1	2	423	6.814	3	606	5.995
1	3	1	2	7	3,931	6.186	18	9,474	6.506
1	3	1	3	164	127,341	6.246	283	219,290	6.150
1	3	1	4	23	23,541	6.197	49	50,468	5.798
1	3	1	5	22	33,001	6.482	30	47,059	6.151
1	3	2	1	93	17,674	7.105	152	26,899	7.036
1	3	2	2	81	36,638	6.246	137	60,150	6.317
1	3	2	3	13	8,864	5.887	21	14,142	5.988
1	3	2	4	15	15,681	5.851	16	16,729	5.731
1	3	2	5	0	0	-	1	1,295	5.674
2	1	1	1	14	2,471	5.514	11	1,906	5.500
2	1	1	2	19	9,203	4.927	18	8,541	4.926
2	1	1	3	42	32,270	4.821	37	28,629	4.713
2	1	1	4	57	59,260	4.969	40	40,306	4.718
2	1	1	5	27	35,427	4.969	26	33,898	4.523
2	1	2	1	71	7,719	5.720	64	6,826	5.686
2	1	2	2	35	15,488	4.953	29	12,192	5.046
2	1	2	3	11	7,965	4.890	13	8,554	4.815
2	1	2	4	3	3,097	4.493	4	3,868	4.867
2	1	2	5	0	0	-	2	2,647	4.530
2	2	1	2	15	6,476	5.512	11	4,704	5.024
2	2	1	3	19	14,804	4.770	19	14,714	4.679
2	2	1	4	56	61,137	4.597	48	52,524	4.579
2	2	1	5	67	89,037	4.767	54	72,598	4.474
2	2	2	1	40	7,639	5.541	36	7,436	5.170
2	2	2	2	35	14,575	4.874	34	14,687	4.800
2	2	2	3	30	22,629	4.638	23	17,230	4.674
2	2	2	4	11	11,052	4.654	16	16,061	4.657
2	2	2	5	1	1,253	4.529	3	3,899	4.468
2	3	1	1	7	1,591	5.928	8	1,910	5.959
2	3	1	2	29	14,248	5.723	31	15,216	5.644
2	3	1	3	91	65,085	5.676	90	65,170	5.553
2	3	1	4	1	931	4.903	3	3,002	5.059
2	3	1	5	1	1,254	5.477	0	0	-
2	3	2	1	55	8,470	6.543	64	10,981	6.563
2	3	2	2	44	18,760	5.931	40	17,332	5.867
2	3	2	3	3	1,996	5.746	8	5,390	5.632

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C8. COMPARISON OF MEAN SPEEDS
(AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	MEAN SPEED	NO. OF HOURS	NO. OF VEHICLES	MEAN SPEED
1	1	1	1	39	8,611	67.274	37	8,613	65.789
1	1	1	2	30	12,077	67.037	43	16,933	65.488
1	1	1	3	0	0	-	1	617	65.600
1	1	2	1	67	4,408	65.715	82	6,355	64.533
1	1	2	2	5	1,672	66.500	2	659	65.000
1	2	1	2	16	9,073	63.987	12	6,952	63.475
1	2	1	3	50	35,073	64.480	66	48,199	63.217
1	2	1	4	3	2,773	65.067	3	2,915	63.433
1	2	2	1	42	7,438	63.188	47	8,374	61.474
1	2	2	2	23	9,146	63.335	31	12,996	62.168
1	2	2	3	7	4,705	63.057	6	3,870	62.117
1	3	1	2	65	32,793	59.032	78	39,409	58.171
1	3	1	3	4	2,458	59.975	3	1,962	59.267
1	3	2	1	50	10,726	57.818	53	11,776	56.102
1	3	2	2	22	8,771	58.691	31	11,637	57.532
2	1	1	1	16	2,124	68.212	8	1,065	65.875
2	1	1	2	21	8,727	66.605	9	3,480	64.000
2	1	1	3	7	5,088	66.771	5	3,832	65.140
2	1	1	4	2	1,883	65.650	2	1,916	64.850
2	1	2	1	41	2,741	65.366	22	1,880	62.709
2	1	2	2	5	2,076	65.160	1	472	63.900
2	1	2	3	2	1,407	65.400	1	636	64.400
2	2	1	1	3	608	64.500	2	459	64.000
2	2	1	2	10	4,458	65.060	4	1,785	63.925
2	2	1	3	20	15,253	64.100	11	8,172	61.809
2	2	1	4	13	13,685	63.715	4	4,489	63.050
2	2	1	5	0	0	-	3	3,731	62.433
2	2	2	1	30	5,111	63.520	13	2,079	60.877
2	2	2	2	9	3,760	62.178	7	2,948	59.586
2	2	2	3	6	4,023	62.200	3	2,135	60.700
2	2	2	4	3	2,996	62.333	1	1,004	61.700
2	3	1	1	5	1,068	59.460	3	689	58.300
2	3	1	2	27	13,574	59.296	14	7,294	57.536
2	3	1	3	14	9,615	58.757	7	5,187	58.114
2	3	2	1	34	6,017	58.379	16	2,770	56.075
2	3	2	2	12	5,039	57.450	7	2,864	55.771
2	3	2	3	2	1,290	57.950	1	665	57.300

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C9. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 65 MPH (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 65 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 65 MPH
1	1	1	1	39	8,611	64.696	37	8,613	52.363
1	1	1	2	30	12,077	63.385	43	16,933	49.572
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	50.794	82	6,355	43.100
1	1	2	2	5	1,672	56.699	2	659	44.461
1	2	1	2	16	9,073	36.724	12	6,952	31.818
1	2	1	3	50	35,073	40.025	66	48,199	30.123
1	2	1	4	3	2,773	44.501	3	2,915	31.355
1	2	2	1	42	7,438	31.689	47	8,374	21.543
1	2	2	2	23	9,146	31.992	31	12,996	24.138
1	2	2	3	7	4,705	28.778	6	3,870	22.506
1	3	1	2	65	32,793	10.954	78	39,409	8.018
1	3	1	3	4	2,458	14.036	3	1,962	11.009
1	3	2	1	50	10,726	7.281	53	11,776	3.974
1	3	2	2	22	8,771	9.577	31	11,637	6.591
2	1	1	1	16	2,124	71.610	8	1,065	54.554
2	1	1	2	21	8,727	59.883	9	3,480	34.971
2	1	1	3	7	5,088	63.463	5	3,832	46.477
2	1	1	4	2	1,883	52.788	2	1,916	43.894
2	1	2	1	41	2,741	45.677	22	1,880	22.979
2	1	2	2	5	2,076	48.218	1	472	38.771
2	1	2	3	2	1,407	48.685	1	636	38.836
2	2	1	1	3	608	39.145	2	459	37.473
2	2	1	2	10	4,458	45.626	4	1,785	35.854
2	2	1	3	20	15,253	36.596	11	8,172	20.631
2	2	1	4	13	13,685	33.592	4	4,489	28.358
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	34.142	13	2,079	21.260
2	2	2	2	9	3,760	26.197	7	2,948	10.787
2	2	2	3	6	4,023	25.379	3	2,135	16.253
2	2	2	4	3	2,996	23.832	1	1,004	21.514
2	3	1	1	5	1,068	16.199	3	689	10.450
2	3	1	2	27	13,574	11.890	14	7,294	6.828
2	3	1	3	14	9,615	9.641	7	5,187	7.654
2	3	2	1	34	6,017	10.686	16	2,770	5.271
2	3	2	2	12	5,039	7.759	7	2,864	3.806
2	3	2	3	2	1,290	6.977	1	665	4.361

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C10. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 70 MPH (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 70 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 70 MPH
1	1	1	1	39	8,611	21.461	37	8,613	13.932
1	1	1	2	30	12,077	20.378	43	16,933	11.658
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	16.742	82	6,355	12.195
1	1	2	2	5	1,672	15.849	2	659	10.470
1	2	1	2	16	9,073	8.365	12	6,952	7.365
1	2	1	3	50	35,073	9.802	66	48,199	6.096
1	2	1	4	3	2,773	10.746	3	2,915	5.489
1	2	2	1	42	7,438	9.344	47	8,374	5.266
1	2	2	2	23	9,146	8.266	31	12,996	5.186
1	2	2	3	7	4,705	6.291	6	3,870	3.902
1	3	1	2	65	32,793	2.110	78	39,409	1.467
1	3	1	3	4	2,458	3.824	3	1,962	2.090
1	3	2	1	50	10,726	1.510	53	11,776	.807
1	3	2	2	22	8,771	1.870	31	11,637	1.169
2	1	1	1	16	2,124	27.966	8	1,065	14.836
2	1	1	2	21	8,727	17.303	9	3,480	6.609
2	1	1	3	7	5,088	15.586	5	3,832	8.612
2	1	1	4	2	1,883	9.772	2	1,916	7.307
2	1	2	1	41	2,741	14.995	22	1,880	4.521
2	1	2	2	5	2,076	11.802	1	472	6.992
2	1	2	3	2	1,407	11.087	1	636	8.648
2	2	1	1	3	608	12.007	2	459	9.150
2	2	1	2	10	4,458	12.808	4	1,785	8.011
2	2	1	3	20	15,253	8.215	11	8,172	3.647
2	2	1	4	13	13,685	6.686	4	4,489	4.812
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	10.272	13	2,079	5.051
2	2	2	2	9	3,760	6.702	7	2,948	1.967
2	2	2	3	6	4,023	5.518	3	2,135	3.185
2	2	2	4	3	2,996	5.007	1	1,004	3.586
2	3	1	1	5	1,068	2.903	3	689	2.032
2	3	1	2	27	13,574	2.416	14	7,294	1.097
2	3	1	3	14	9,615	1.706	7	5,187	1.484
2	3	2	1	34	6,017	2.476	16	2,770	1.119
2	3	2	2	12	5,039	1.766	7	2,864	.314
2	3	2	3	2	1,290	1.240	1	665	.301

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C11. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 75 MPH (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 75 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 75 MPH
1	1	1	1	39	8,611	5.028	37	8,613	2.868
1	1	1	2	30	12,077	4.372	43	16,933	1.990
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	4.741	82	6,355	3.021
1	1	2	2	5	1,672	3.768	2	659	1.973
1	2	1	2	16	9,073	1.841	12	6,952	1.266
1	2	1	3	50	35,073	2.130	66	48,199	1.137
1	2	1	4	3	2,773	2.164	3	2,915	.755
1	2	2	1	42	7,438	2.514	47	8,374	1.230
1	2	2	2	23	9,146	1.848	31	12,996	1.062
1	2	2	3	7	4,705	1.063	6	3,870	.775
1	3	1	2	65	32,793	.467	78	39,409	.335
1	3	1	3	4	2,458	.936	3	1,962	.510
1	3	2	1	50	10,726	.392	53	11,776	.144
1	3	2	2	22	8,771	.319	31	11,637	.275
2	1	1	1	16	2,124	7.062	8	1,065	4.695
2	1	1	2	21	8,727	3.231	9	3,480	1.092
2	1	1	3	7	5,088	2.437	5	3,832	1.331
2	1	1	4	2	1,883	1.434	2	1,916	.992
2	1	2	1	41	2,741	4.524	22	1,880	.904
2	1	2	2	5	2,076	2.601	1	472	.636
2	1	2	3	2	1,407	1.990	1	636	1.258
2	2	1	1	3	608	4.441	2	459	1.961
2	2	1	2	10	4,458	2.759	4	1,785	1.681
2	2	1	3	20	15,253	1.632	11	8,172	.661
2	2	1	4	13	13,685	1.242	4	4,489	1.025
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	2.544	13	2,079	1.058
2	2	2	2	9	3,760	1.543	7	2,948	.475
2	2	2	3	6	4,023	1.143	3	2,135	.375
2	2	2	4	3	2,996	.868	1	1,004	.398
2	3	1	1	5	1,068	.468	3	689	.581
2	3	1	2	27	13,574	.479	14	7,294	.288
2	3	1	3	14	9,615	.468	7	5,187	.366
2	3	2	1	34	6,017	.565	16	2,770	.217
2	3	2	2	12	5,039	.437	7	2,864	.105
2	3	2	3	2	1,290	.310	1	665	.150

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C12. COMPARISON OF PERCENTAGE OF VEHICLES EXCEEDING 80 MPH (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 80 MPH	NO. OF HOURS	NO. OF VEHICLES	PERCENT EXCEED 80 MPH
1	1	1	1	39	8,611	1.243	37	8,613	.720
1	1	1	2	30	12,077	1.068	43	16,933	.567
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	1.838	82	6,355	1.117
1	1	2	2	5	1,672	1.196	2	659	1.062
1	2	1	2	16	9,073	.408	12	6,952	.360
1	2	1	3	50	35,073	.570	66	48,199	.367
1	2	1	4	3	2,773	.721	3	2,915	.480
1	2	2	1	42	7,438	.820	47	8,374	.322
1	2	2	2	23	9,146	.601	31	12,996	.369
1	2	2	3	7	4,705	.298	6	3,870	.181
1	3	1	2	65	32,793	.174	78	39,409	.127
1	3	1	3	4	2,458	.407	3	1,962	.102
1	3	2	1	50	10,726	.177	53	11,776	.093
1	3	2	2	22	8,771	.080	31	11,637	.112
2	1	1	1	16	2,124	1.789	8	1,065	1.315
2	1	1	2	21	8,727	.768	9	3,480	.489
2	1	1	3	7	5,088	.649	5	3,832	.339
2	1	1	4	2	1,883	.637	2	1,916	.209
2	1	2	1	41	2,741	1.459	22	1,880	.160
2	1	2	2	5	2,076	.434	1	472	.212
2	1	2	3	2	1,407	.426	1	636	.314
2	2	1	1	3	608	1.316	2	459	.654
2	2	1	2	10	4,458	.763	4	1,785	.392
2	2	1	3	20	15,253	.492	11	8,172	.257
2	2	1	4	13	13,685	.329	4	4,489	.356
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	.998	13	2,079	.337
2	2	2	2	9	3,760	.479	7	2,948	.237
2	2	2	3	6	4,023	.199	3	2,135	.141
2	2	2	4	3	2,996	.267	1	1,004	.000
2	3	1	1	5	1,068	.094	3	689	.145
2	3	1	2	27	13,574	.177	14	7,294	.110
2	3	1	3	14	9,615	.135	7	5,187	.154
2	3	2	1	34	6,017	.199	16	2,770	.108
2	3	2	2	12	5,039	.198	7	2,864	.070
2	3	2	3	2	1,290	.078	1	665	.150

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C13. COMPARISON OF 85TH PERCENTILE SPEEDS (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	85TH %TILE SPEED	NO. OF HOURS	NO. OF VEHICLES	85TH %TILE SPEED
1	1	1	1	39	8,611	76.477	37	8,613	71.790
1	1	1	2	30	12,077	76.338	43	16,933	71.526
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	76.877	82	6,355	71.935
1	1	2	2	5	1,672	75.617	2	659	71.205
1	2	1	2	16	9,073	71.437	12	6,952	71.462
1	2	1	3	50	35,073	71.617	66	48,199	71.262
1	2	1	4	3	2,773	71.516	3	2,915	70.962
1	2	2	1	42	7,438	72.051	47	8,374	71.563
1	2	2	2	23	9,146	71.718	31	12,996	71.338
1	2	2	3	7	4,705	71.313	6	3,870	70.944
1	3	1	2	65	32,793	67.069	78	39,409	66.776
1	3	1	3	4	2,458	67.278	3	1,962	66.933
1	3	2	1	50	10,726	66.671	53	11,776	66.382
1	3	2	2	22	8,771	66.949	31	11,637	66.704
2	1	1	1	16	2,124	76.352	8	1,065	71.690
2	1	1	2	21	8,727	75.995	9	3,480	71.089
2	1	1	3	7	5,088	75.778	5	3,832	71.085
2	1	1	4	2	1,883	71.045	2	1,916	70.892
2	1	2	1	41	2,741	72.313	22	1,880	71.009
2	1	2	2	5	2,076	71.184	1	472	70.600
2	1	2	3	2	1,407	71.161	1	636	71.042
2	2	1	1	3	608	71.610	2	459	71.038
2	2	1	2	10	4,458	71.823	4	1,785	71.288
2	2	1	3	20	15,253	71.415	11	8,172	71.019
2	2	1	4	13	13,685	71.180	4	4,489	70.951
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	72.001	13	2,079	71.355
2	2	2	2	9	3,760	71.588	7	2,948	66.712
2	2	2	3	6	4,023	71.212	3	2,135	70.950
2	2	2	4	3	2,996	70.933	1	1,004	70.583
2	3	1	1	5	1,068	70.273	3	689	66.887
2	3	1	2	27	13,574	67.200	14	7,294	66.669
2	3	1	3	14	9,615	66.880	7	5,187	66.608
2	3	2	1	34	6,017	67.233	16	2,770	66.534
2	3	2	2	12	5,039	66.812	7	2,864	66.103
2	3	2	3	2	1,290	66.005	1	665	65.515

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200

TABLE C14. COMPARISON OF STANDARD DEVIATIONS OF SPEED (AUTOMATIC DATA AT FLORENCE)

				RADAR OFF			RADAR ON		
DAY	LANE	LIGHT	VOLUME	NO. OF HOURS	NO. OF VEHICLES	STD DEV	NO. OF HOURS	NO. OF VEHICLES	STD DEV
1	1	1	1	39	8,611	5.041	37	8,613	5.121
1	1	1	2	30	12,077	5.043	43	16,933	4.851
1	1	1	3	0	0	-	1	617	
1	1	2	1	67	4,408	5.957	82	6,355	5.761
1	1	2	2	5	1,672	4.896	2	659	5.067
1	2	1	2	16	9,073	5.272	12	6,952	5.172
1	2	1	3	50	35,073	5.251	66	48,199	5.148
1	2	1	4	3	2,773	5.041	3	2,915	4.888
1	2	2	1	42	7,438	6.173	47	8,374	5.697
1	2	2	2	23	9,146	5.630	31	12,996	5.384
1	2	2	3	7	4,705	5.116	6	3,870	5.109
1	3	1	2	65	32,793	5.578	78	39,409	5.440
1	3	1	3	4	2,458	5.738	3	1,962	5.377
1	3	2	1	50	10,726	5.524	53	11,776	5.227
1	3	2	2	22	8,771	5.406	31	11,637	5.328
2	1	1	1	16	2,124	5.293	8	1,065	5.192
2	1	1	2	21	8,727	4.975	9	3,480	4.819
2	1	1	3	7	5,088	4.556	5	3,832	4.549
2	1	1	4	2	1,883	4.556	2	1,916	4.446
2	1	2	1	41	2,741	6.244	22	1,880	5.233
2	1	2	2	5	2,076	5.265	1	472	4.936
2	1	2	3	2	1,407	4.955	1	636	4.876
2	2	1	1	3	608	6.210	2	459	5.422
2	2	1	2	10	4,458	5.485	4	1,785	5.282
2	2	1	3	20	15,253	5.205	11	8,172	5.182
2	2	1	4	13	13,685	4.997	4	4,489	4.985
2	2	1	5	0	0	-	3	3,731	
2	2	2	1	30	5,111	6.049	13	2,079	5.919
2	2	2	2	9	3,760	5.951	7	2,948	5.363
2	2	2	3	6	4,023	5.556	3	2,135	5.293
2	2	2	4	3	2,996	5.190	1	1,004	5.042
2	3	1	1	5	1,068	6.097	3	689	5.776
2	3	1	2	27	13,574	5.611	14	7,294	5.546
2	3	1	3	14	9,615	5.446	7	5,187	5.465
2	3	2	1	34	6,017	5.884	16	2,770	5.720
2	3	2	2	12	5,039	5.941	7	2,864	5.475
2	3	2	3	2	1,290	5.490	1	665	4.924

Day:
1 Weekday
2 Weekend

Lane:
1 Median
2 Center
3 Shoulder

Light:
1 Daylight
2 Darkness

Volume (vplph):
1 < 300
2 300-599
3 600-899
4 900-1,200
5 > 1,200