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Life-Cycle Cost Effectiveness and Safety Evaluation Involving Tennessee Bureau of Investigation Vehicles

Curtis Lee Sturgill
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Curtis Lee Sturgill entitled "Life-Cycle Cost Effectiveness and Safety Evaluation Involving Tennessee Bureau of Investigation Vehicles." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Health and Human Sciences.

Robert H. Kirk, Major Professor

We have read this dissertation and recommend its acceptance:

William M. Bass, Bill C. Wallace, Robert J. Pursley

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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LIFE-CYCLE COST EFFECTIVENESS AND SAFETY EVALUATION INVOLVING TENNESSEE BUREAU OF INVESTIGATION VEHICLES

A Dissertation
Presented for the
Doctor of Education
Degree
The University of Tennessee, Knoxville

Curtis Lee Sturgill

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A final word goes to my son, Christopher, whose very being focuses the world and in doing so keeps facets of my life in their proper perspective.

ABSTRACT

The purpose of this study was to identify and analyze the life-cycle effectiveness and safety factors involved in operating Tennessee Bureau of Investigation (TBI) motor vehicles from zero miles through life-cycle. The major concerns were to provide a balance of economic and safety factors for determining when vehicles should be replaced.

The data were collected from TBI files, Department of Transportation (DOT) records, and the National Automobile Dealers Associations Guide (NADA).

The analysis consisted of entering the data into a computer where they were cross tabulated to determine the correlation between operational costs and mileage.

The major findings of the research were that economic savings could be achieved if TBI vehicles were traded at 85,000 miles as opposed to trading same vehicle at seventy thousand miles and that operating TBI vehicles past seventy thousand miles did not create safety hazards. A nomograph was utilized for determining when vehicles should be replaced.

The three major conclusions were based on the findings:

1. TBI vehicles, if traded at 85,000 miles instead of 70,000 miles would create economic savings for the organization;
2. The operation of TBI vehicles past seventy

thousand miles does not create safety hazards; and miles apparently have no bearing in terms of safety:

3. If the procedure for determining the life-cycle or replacement of TBI vehicles was instituted, economic savings could be recognized.

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CHAPTER I

1. INTRODUCTION

The Tennessee Bureau Of Investigation (T.B.I.) had previously been operating passenger motor vehicles for seventy thousand miles before trade-in. The vehicles are currently being operated in excess of one hundred and twenty thousand miles before trade-in.

The problem materializes in the form of possible safety factors occurring in these vehicles with the extended accumulation of miles. Will this excess mileage cause vehicles to become mechanically unsafe? With the possibility of vehicles becoming unsafe mechanically the real probability exists that safety hazards will become apparent in the form of accidental death, injury or property damage.

When vehicles were being driven for seventy thousand miles the life-cycle was approximately three years. This meant a T.B.I. agent would be expected to operate the same vehicle during this period of time. With the recent accumulated mileage for vehicles, past seventy thousand miles, the same agent would be expected to drive the same vehicle for approximately five years. Deterioration on said vehicle could have an influence on its safety worthiness.

The automobile has rapidly gained acceptance as an essential tool for T.B.I. agents. Just as pen and pad are tools used by the agent, so does the automobile represent an essential tool. The agents are required to be very mobile because crime events occur at various locations of the assigned areas of responsibilities. Not only are crime scenes at different locations, but interviews and interrogations are most often only accessible by the agent using an automobile to reach his/her destination. An additional factor is that every law enforcement agency in the United States utilizes, to some extent, motor vehicles for delivery of police services. With delivery of these police services the T.B.I. and other law enforcement agencies must be concerned with cost-effectiveness and safety factors related to the use of these motor vehicles. A further concern is forecasting the budget requirements for the T.B.I. or any police agency related to the purchase and maintenance of the vehicles. A final factor is providing for the safety of its agents and maintaining a fleet of motor vehicles which are safe and kept at a constant ready-state.

Vehicular accidents among law enforcement officers are of importance in public health and safety. The importance is, first, accidents are the fourth leading cause of death in the United States with motor vehicles constituting the majority of persons killed or injured (1:3). The motor vehicle accident data compiled from T.B.I. files shows: A) no deaths due to automobile accidents, B) three injuries to T.B.I. agents due to automobile accidents, C) T.B.I. agents have had approximately 120 motor vehicles accidents during the last ten years. Secondly, because the T.B.I. utilized the motor vehicles to a large degree in delivery of services, the potential for motor vehicle accidents represents an occupational health and safety problem.

2. NEED FOR THE STUDY

The T.B.I., when setting policy, has been concerned with those factors that adversely affect the psychological and physiological health of its agents. The attitude that an accident just happens has long since lost its acceptance in the bureau. The position is now that accidents can be prevented. Automobile accidents within the T.B.I. or any police agency can be prevented if proper research is conducted and the resulting recommendations of that research are implemented to change behavior and improve the safety integrity of the vehicles used by the agents. These accidents cause, not only injury to agents, but a loss of personhours and restricted availability of motor vehicles. The aforementioned have created an overall reduction in the potential efficiency of the T.B.I. Every law enforcement agency in the United States has suffered damages from motor vehicle accidental death, injury or property damage. Due to other inherent demands of the profession, the T.B.I. and other law enforcement agencies had the tendency to place less emphasis on vehicular safety and injury reduction and more emphasis on other aspects of the technical aspects of investigations and enforcement.

The results of an investigation such as this may be used by the T.B.I. and other police agencies in setting policy concerning operation of vehicles in excess of seventy thousand miles. With an emphasis on budget preparation and policy making, there has been concern that scientific research on the consequence of operating state police vehicles past seventy thousand miles has not been conducted in any of the fifty states. No recorded major study has been conducted by any known large metropolitan police department. The above conclusions are in accordance with a rather thorough review of the literature concerning this problem.

The T.B.I. management needs more information to assist in determining economic savings, budget settings and policy making, when dealing with vehicle purchases. The director of the T.B.I., Arzo Carson, and the Special Agent in Charge of Administration, Robert Pearce, expressed an interest and need for this research. These operating officials stated the results could be used by the T.B.I. when planning the budget. Also, results could be used by the administration in the setting of policies related to the potential safe life of vehicles used by the bureau.

3. PURPOSE OF THE STUDY

The purpose of this study was to identify and analyze the life-cycle cost effectiveness, economic savings and safety hazards involved in operating 1980 LTD Ford T.B.I. motor vehicles from zero miles through life-cycle of vehicles.

4. STATEMENT OF THE PROBLEM

The major problem of this study was to analyze the cost-effectiveness, life-cycle and safety evaluations of T.B.I. vehicles when the mileage exceeded previous standards. Specifically, the study sought to answer the following questions:

1. What are the economic savings when operating T.B.I. vehicles past seventy thousand miles as opposed to trading same vehicles when seventy thousand miles is reached?
2. Would operating T.B.I. vehicles past previous standards of seventy thousand miles create safety hazards?
3. When should vehicles be replaced for economic savings?
4. In reference to safety factors, at which mileage points should vehicles be replaced?

5. DELIMITATIONS OF THE STUDY

This study was delimited to the following:

1. The study was delimited to an investigation of 1980 Ford LTD's used by the T.B.I.

2. The study was delimited to the use of official T.B.I. records.

3. The study was delimited to the book value or trade-in value of the vehicles according to the National Automobile Dealers Association Guide.

4. The study was delimited to the fluctuating gasoline cost from 1980 through 1985.

6. LIMITATIONS

A limiting factor may have been that agents stopped unscheduled maintenance between 95,000 and 100,000 miles.

7. ASSUMPTIONS

In undertaking this study, the following assumptions were made:

1. The mileage, maintenance and accident records maintained for T.B.I. vehicles were accurate.

2. Resale value was determined by accuracy of records kept by Finance and Administration in accordance with set depreciated value or book value.

8. DEFINITIONS OF TERMS

For the purpose of this study the following definitions were used:

Cost-Effectiveness: The term refers to economic savings in relation to expenses incurred while operating T.B.I. vehicles past previous standard of seventy thousand miles.

Life-Cycle: The term refers to operating time of vehicles; from period of time vehicles were placed in service until trade-in of same vehicles.

Previous Standard: The term refers to the seventy thousand miles which was the trade-in point for T.B.I. vehicles prior to the purchase of 1980 Ford LTD's.

Safety Hazards: The term refers to accidents incurred by T.B.I. vehicles during the life cycle of those vehicles used by T.B.I. agent during the period 1980 through 1985.

Safety Limits: The term refers to accidental deaths, injury or property damage incurred during the life cycle of the vehicle.

Deadlining: The term refers to removing vehicles from service.

Nomogram: A graphic representation that consists of several lines marked off to scale and arranged in such a way that by using a straightedge to connect known values on two lines an unknown value can be read at the point of intersection with another line.

9. SUMMARY

The purpose of this chapter was to identify the problem and the subproblems of operating T.B.I. vehicles past seventy thousand miles. A need for the study existed because prior studies had not been conducted which contributed results related to the problem of this investigation. Importance of the study, delimitations and assumptions were explained and shown to be valid in their relationship within the scope of the research. How would operating T.B.I. vehicles past previous standards of seventy thousand miles affect the cost-effectiveness and safety evaluation? That question was the basis for the research study.

The following organization of study will give a review of the literature in relationship to the problems stated in this chapter. In Chapter II a review of the literature related to the purpose of this study was gleaned. Chapter III details the methodology utilized in conducting this study. Chapter IV is an analysis of the data which was collected and treated. Chapter V shows the summary, findings, conclusions, and recommendations. In Chapter VI a study in retrospect and a personal comment is given.

CHAPTER II

REVIEW OF THE LITERATURE

The policy of the T.B.I. has previously been to trade automobiles when the mileage was between seventy and eighty thousand miles. For the years beginning in 1980 through 1985, the T.B.I. did not trade their 1980 LTD Ford vehicles although other vehicles were used and traded. This extra operation time added an average of twenty-five to sixty thousand miles to the life of vehicles. The following questions become apparent. Does this extra operating time and mileage create safety hazards and does the extra operation time and mileage save money when considering cost of new automobiles and cost of maintenance?

The review of the literature pertaining to this study were summarized in two categories: They were: (1) A review of the evaluation of studies dealing with fleet cost effectiveness and safety and (2) Fleet safety maintenance.

1. REVIEW OF LITERATURE ON COST-EFFECTIVENESS AND SAFETY

A computer search in the field of Transportation Research Information Service established a list of studies which have been conducted by individuals, state governments, state highway patrol organizations, law enforcement organizations and fleet managers dealing with this problem.

This list included studies dealing with maintenance of fleet vehicles, life cycle, savings, operating costs and benefit cost analysis. The factor of extra mileage was added to extracted studies related to the statement of the problem.

No similar studies, as described in the statement of the problem for this research topic, were found for either the T.B.I., Tennessee Highway Patrol (THP) or other State of Tennessee Department fleets or private fleet owners. When conducting the search of the literature, studies dealing with seat belts and air bags were eliminated.

2. STUDIES RELATING TO COST-EFFECTIVENESS

A small number of studies relating to this study have been conducted by other researchers.

Research conducted by C.A. Nash used statistical data dealing with overhead expenses and the size of fleets (2:225). The findings revealed two ways in which new road schemes may influence capital expenditure on vehicles. First, by improving utilization of existing vehicles. Second, by generating additional road traffic, road schemes which may lead to an increase in the life cycle of fleet vehicles. The study argued that the then employed treatment of vehicle depreciation and interest changes were not productive. The data for cost failed to allow correctly for either of the first and second items aforementioned. There were errors in the logic in which the capital stock of vehicles was valued and even that certain overheads were ignored even when organizations changed their fleet sizes. The author further charged that empirical evidence supporting the current separating of depreciation into overhead and running cost components.

The author suggested that an alternative method of calculating vehicle capital costs based on the concept of annual capital charges, and making explicit the assumptions with respect to vehicle utilization, was advocated (2:226-242). The study did not deal with state police organizations but a general overview of capital cost of vehicles in road utilization.

Following the research of C.A. Nash in 1974, R.T. Ruess conducted a study using techniques of life cycle costs to analyze some of the decision problems of police fleet management (3:221). The study addressed questions of: (1) Cost effects when purchasing different sizes of patrol cars, (2) direct ownership of vehicles by departments, (3) compared contracting maintenance work with in-house repairs, (4) cost of alternative utilization on fleet costs, (5) how often vehicles should be replaced, and (6) disposition of vehicles. The techniques used to compare costs of alternative systems were described on life cycle cost (3:221).

A further study by R.T. Ruess provided assistance to

Police Fleet Administrators in selecting an economically efficient vehicle program (4:290). The study suggested a general method for evaluating and comparing the costs and benefits of a Personal Patrol Car Program (PCP) and a Multiple-Shift, Pool Car Program (MSP). The life-cycle cost of a PCP with an MSP were compared (4:298).

Another study by J.S. Thomas produced a guide in an attempt to aid managers in evaluating the performance of government fleet management and maintenance functions (5:25). The guide, presented five key performance questions which dealt with fleet management and maintenance functions. The questions addressed were: Do the operating agencies have sufficient automotive equipment available to complete the needed work on schedule? Are there many vehicles out of service for maintenance? Is your automotive fleet too old? Does your government have too many or too few vehicles? Is vehicle maintenance being performed efficiently? The author suggested that because the answers to these questions were interrelated in terms of fleet availability, they should have been considered collectively in planning an improvement program (5:25).

This guide, which was prepared by J.S. Thomas for the National Center for Productivity and Quality of Working Life, could be of use by police organizations in planning fleet management and maintenance functions.

In any organization managers are concerned with financial data on their agency. Author S.J. Morin, in a report, summarized the financial and operating data submitted annually to the Urban Mass Transportation Administration (UTMA) by the nation's public transit operators (6:8). Two sections were contained within the report dealing with industry aggregate statistics and a detailed financial operating data on individual transit agencies. The report contained statistics compiled on transit industry (6:10). This report related to fleet management.

D.A. Cox focused on vehicle unladen weight and operating efficiency of a transport fleet (7:11). It was estimated that ten percent savings in fuel consumption could have been obtained by governing top speed to between 65 and 70 miles per hour. This study used the procedure of samplings and analysis of sump oil and the introduction of a small fleet standard section for monitoring vehicle conditions at depots (7:12).

Author K.P. Jonas conducted another project which detailed the technical basis or strategy for performance of cost-benefit analysis of motor vehicle inspections using data collected by the participating states (8:126). The research was designed to answer the question posed by the evaluation objective: Namely, "does diagnostic inspection save the motorist money by reducing his aggregate repair costs and improving his gas mileage?" This study further dealt with repair, maintenance cost evaluations and the fuel economy evaluation in relation to maintenance cost (8:126).

During a conference held in London, England, a paper was presented which dealt with levels of cost in planning journeys for fleet vehicles. Items discussed were road transport fleet cost and an assessment of trip lengths. W.E. Norman gave most of the details and the topic was mainly directed toward the use of the computer in road transport planning (9:1).

3. STUDIES RELATED TO SAFETY FACTORS

The following are prior studies relating to factors involving safety on State and National levels. The studies related directly to the statement of problem researched in this proposal.

Authors K.L. Campbell and A.C. Wolfe conducted a study in which data were collected from a fleet monitoring program. The data were taken from a national sample and dealt with mileage, accidents, and brake maintenance. The fleets and vehicles were selected from manufacturers' sales lists for the production period January, 1974 through January, 1976, using probability-based sampling techniques. The preliminary results indicated that the adjusted accident rate was slightly lower (19%) for the post-standard vehicles. However, brake system maintenance on the post-standard vehicles occurred more frequently (35%). The results were shown not to be statistically significant (10:227).

Other studies dealing with vehicle management were conducted outside the United States. One such study by D.M. Cooper and A. Kins was conducted in the United Kingdom (11:183). The computer based information system involved records kept by drivers, mechanics and work shop staff. The data were intended to help transport managers create an environment for disciplined record keeping and to standardize information. This study results estimated that the wide spread use of the system could produce savings for British Government Fleets of at least five million dollars in operating and maintenance costs (11:183).

In research by Martin W. Johnson, results were used to produce guidelines for determining the preventability of accidents (12:9). A good accident record keeping system was considered essential to fleet safety programs. A review board to analyze accidents and actions to be taken against drivers was suggested. Johnson also discussed how careless handling of police cars could affect operating cost (12:12).

In a later study by Martin W. Johnson, a survey was used to sample forty-eight state agencies and eighteen municipal departments (13:4). The data came from driver training for police recruits, content of program, accident reports, and disciplinary practices. The author discussed how a police driving safety program could be outlined (13:8).

In 1982, B.P. Orland submitted an article to the

National Safety Council in which he discussed the influence of state accident rates on automobile fleets (14:8). He explained how a simple equation, developed by the North Atlantic Division of the United States Army Corps of Engineers, could be applied to the influence of state accident rates on automobile fleets. The equation was explained in the following manner. The district accident rate was divided by the overall state accident rate and then multiplied by the percentage of driving done in each state by district drivers. The figures for each state were then added together to arrive at the comparability factor (CF) for the whole district. The CF equation was not only useful, but highly cost effective (14:10). Since cost effectiveness is an important part of this research proposal, the research by B.P. Orland could be of importance not only to this study but also to managers interested in cost effectiveness for their organizations.

In a report by J.E. Paquette, he described the drive-train operating systems and maintenance or repair history of 1,472 vehicles which were randomly selected from 14 fleets (15:6).

The analysis of data for line-haul vehicles indicated that while approximately 7 percent of the repair orders concerned the drive-train, almost 13 percent of the total dollars was consumed by repairs in this category. Almost 16 percent of the parts dollars was consumed by drive-train repairs, as compared with approximately 10 percent of the labor dollars. There was a higher overall drive-train cost per mile for pickup and delivery vehicles as compared to line-haul vehicles due to the nature of the stop and go pickup and delivery operation. Although fewer repair orders were submitted on the pickup and delivery units, they represent a larger percentage of total input for their particular application (15:6). Although this study was conducted in 1971, the results are still of use to fleet managers who must deal with pickup and deliveries.

J.B. Schnell used the maintenance and operation cost of three fleets of buses as the basis for a study of maintenance cost and specifications for manufacturers (16:78). Factors such as diesel powered vehicles and small vehicles were taken into consideration and discussed. His study showed cost per mile when comparing small vehicles and large vehicles in savings tests which were analyzed for results (16:79).

The purpose of a study by Dr. Larry Scott Miller, was to determine the role of selected factors of police officer involvement in motor vehicle accidents within the State of Tennessee (16:6). The four major factors of concern were police demographic characteristics, police administrative policies, police motor vehicle conditions and police stress.

Police officers were involved in more on duty motor vehicle accidents when they believed their police vehicles were not properly maintained and/or unsafe. The study showed certain demographic characteristics of Tennessee police officers created an environment susceptible for police officer involvement in motor vehicle accidents. The existence (or non-existence) of certain police administrative policies of Tennessee Law Enforcement agencies contributed to police officer involvement in on-duty motor vehicle accidents (16:72). This study, by Miller showed that if Tennessee Law Enforcement agencies have existing policies concerning the environment of operating motor vehicles, the accident rate could be controlled.

A.C. Lewis and E.J. Lewis developed a guide which was designed to supply the information needed to select police patrol car tires to suit particular needs and to maintain the tires for maximum safety, tire life and performance (17:45). The study dealt with automobile tires and the bias encountered when purchasing belted tires and ply tires. Also covered was stress on tires when cornering and traction of tires in reference to wear resistance (17:72).

4. SCOPE OF LITERATURE

The theory of life-cycle cost-effectiveness and safety evaluation of fleet vehicles has been studied by many researches. Many of these studies seemed to have dealt with specific aspects of the motor vehicles. Some of these aspects were tires, brakes, seat belts and bumpers. Authors A.C. Lewis and E.J. Lewis, as early as 1978, conducted research on selecting tires to meet particular police needs and how to maintain these tires for maximum safety, tire life and performance (17:45). J.J. Collard submitted a report on tire safety a year before the Lewis study (18:44). Collard dealt mostly with high speed hazards of steel belted radial tires on police cars. He recommended using tires which had been tested and certified by manufactures for speeds of at least 125 miles per hour (18:44).

5. SUMMARY

After a review of the literature the above listed studies are considered among the most relevant in relation to the research purposed by this writer. Several of these studies found common denominators of cost-effectiveness in evaluating the performance of fleet vehicles. Some examples cited were improving utilization of existing vehicles and generating additional road traffic. This led to an increase in the life-cycle of fleet vehicles. In the final analysis it is concluded that there is a paucity of research directly relating to their investigation.

CHAPTER III

METHODOLOGY

1. INTRODUCTION

This chapter is designed to address the specific methodology employed in addressing the research problem and its related subproblems. Also included are the procedures for collecting and treating the data.

Automobile accidental injuries involving police officers is ranked first among police injuries. These motor vehicle accidents not only cause bodily injury, but also create problems in performance of police agencies. Police budgets reflect repair and replacement due to these accidents. Also lost working hours and absence of the vehicle (because of an accident) creates a reduction in T.B.I. agents effectiveness and performance of their duties.

There are studies which indicate that particular police demographic characteristics, some administrative policies, condition of automobile and stress were the leading causes of automobile accidents involving police officers. There has been a study conducted on the aforementioned factors involving, police officer involvement in motor vehicle accidents within the state of Tennessee. A comprehensive study has not been conducted which would address factors of life-cycle cost-effectiveness and safety evaluation involving T.B.I. motor vehicles after operating said vehicle past seventy thousand miles. Therefore, this study was designed to address the factors of cost-effectiveness and safety. T.B.I. vehicles are operating presently at varying lengths of service with regard for these factors but without sufficient data for such an operation.

2. DATA COLLECTION

THE STUDY POPULATION

The data used were on the operation of 30 LTD Ford T.B.I. vehicles between 1980 and 1985. The data were collected from the T.B.I. in the form of computer print-outs, from the Department of Transportation (DOT) in the form of microfish and T.B.I. Motor Vehicle Maintenance Reports (MVMR) (see Appendix C). The trade-in values were determined by use of the National Automobile Dealers Associations (NADA) Used Car Guide (19:117). The data collected from the NADA was the trade-in value of newly purchased 1980 LTD Fords. Also included was the trade-in value of same vehicles at the end of the life-cycle. Mileage on the speedometer at the time of trade-in was also used in conjunction with the NADA book to determine the salvage value. The MVMR's showed vehicle accidents, vehicle maintenance, gasoline consumption, oil consumption and dollar prices for these entries. These data were collected only after vehicles had been disposed of by T.B.I. The collected data were transferred to a paper accountant spreadsheet which had been organized with categories of accidents, repairs and parts, preventative maintenance, gasoline, and trade-in values. The data on the paper accountant spreadsheet was entered into a computer to be tabulated and analyzed.

The data was compiled in the following manner: each month T.B.I. agents are required to list all expenses acquired by their assigned T.B.I. vehicle on a T.B.I. Motor Vehicle Maintenance Report (MVMR). These expenses have spaces provided on the MVMR. There is a space for number of gallons of gasoline purchased and cost of purchased gasoline. A space for oil and oil cost is shown. Lub and number of times, tire repairs, parts and repairs each have individual spaces provided. Also, a column for parts and repairs including cost is shown. The last row of spaces on the MVMR show the mileage on vehicle and date purchases were made. When print-outs were unavailable and the MVMR were missing the data were available on microfish at the Department of Transportation (DOT).

The data on the MVMR were verified by individual purchase tickets. These purchase tickets were filled out each time by individual agents when purchases were made. The purchase tickets along with signed receipt work orders were kept in individual automobile packets at the T.B.I. headquarters in Nashville, Tennessee. These individual automobile packets were started with cost at time automobiles were purchased and continued until automobiles were deadlined and disposed of by the T.B.I. Data to verify these individual automobile packets were collected from print-outs, MVMR's, individual purchase tickets and work orders.

The MVMR's were collected from the T.B.I. warehouse at T.B.I. headquarters. The individual purchase tickets for gasoline and oil were collected from the T.B.I. storage warehouse and missing data for gasoline and oil consumptions were available on microfish at the D.O.T. office. The individual automobile packet data was collected from T.B.I. Assistant Director, Robert Pearce. The print-outs were made available by the T.B.I. Administrative Secretary. After all above mentioned data were collected, the data were sorted according to each individual vehicle. A separate packet for each automobile was organized by separating collected data and placing the data into the individual packets. These data were transcribed onto an accountant form paper spreadsheet designed for each automobile in the study group. Each vehicle had a separate spreadsheet onto which data were placed. After each individual sheet was completed, the data were entered into a computer.

The data were collected by this writer in person and hand carried to the computer site where data was tabulated and analyzed. The data were collected in prescribed method for scientific study in that the data was not changed in any manner from the computer files through the tabulation and analysis process.

3. DATA TABULATION

After collection, the data were entered into the computer where it was cross tabulated, identifying the characteristics of cost of operating vehicles (cost-effectiveness) up to and over seventy thousand miles. For example, trade-in value, number of accidents (safety factors) and maintenance costs were tabulated. Comparison and distribution of accidents, trade-in values and maintenance cost were analyzed and shown on bar and line graphs. Data analysis involved the use of a computerized software package called Lotus 1-2-3, which is an automated spreadsheet. This automated spreadsheet displayed the information in the form of entries in a two dimensional table, 20 rows by 27 columns. The data contained on these spreadsheets were analyzed by the computer and an analysis was shown on the monitor screen and given on a print-out in the form of a hardcopy. This print-out was shown in the form of line and bar graphs. The bar graph for each individual vehicle was shown in Appendix B. The variables shown on line and bar graphs show the relationship between the miles and costs. The graphs were used to access the differences between maintenance costs, trade-in value and number of accidents.

The average mileage was calculated for the vehicle prior to and after 1980 through 1985. Maintenance costs prior to and after seventy thousand miles for vehicles after 1980 were row-ordered in comparison to average miles and maintenance fees.

4. PROCEDURE FOR TREATING DATA

After the data were collected and tabulated, they were analyzed. The data were crosstabulated in order to identify what the characteristics of vehicles operated over seventy thousand miles were, for example, the number of accidents, trade-in value, and maintenance costs. Comparison and distribution of accidents, trade-in values and maintenance cost were analyzed.

The data were grouped by characteristics of maintenance costs, trade-in value and number of accidents. The data were collected from the T.B.I., DOT and MVMR's for the time period, from 1980 through 1985. The data were then hand sorted into individual vehicle packets. This study group of 30 LTD Ford vehicles was analyzed to determine relationship between the variables.

Data analysis involved the use of a computerized software package called an Automated Spreadsheet. The Automated Spreadsheet chosen for this project was Lotus

1-2-3 created by Lotus Development Corporation as it functions on the IBM PC/XT.

An automated spreadsheet displays information in the form of entries in a two dimensional table. This table displays in the form of rows and columns, and looks like a paper spreadsheet used by accountants.

In 1-2-3 the columns were referred to by letters A, B, C, etc. and the rows were indicated by numbers 1, 2, 3 etc. The following types of information were entered onto a spreadsheet:

A. Labels - Report titles, column headings and the meaning of particular rows. Labels are sometimes called text or characters.

B. Values - A value is simply a number which you enter.

C. Formulas - A formula performs a calculation on the number presented in a row-column location.

The automated spreadsheet designed for this study consisted of column headings and mileage figures in 5,000 mile increments starting with 5,000 and continuing to 140,000. The rows consisted of the costs for five categories, gasoline, accidents, preventive maintenance, repairs, and trade-in values for each of the thirty-one vehicles.

After creation of the spreadsheet, the data were arranged into a form most useful for describing the costs per mile for any and all of the categories and into a form most suitable for presentation in tabular or graph form.

Following the input of the data, the determination of the cost per mile indicators were performed.

Relationships were shown by using graphs to depict the possible relationship between groups. Graphs were used to show the possible descriptive differences in maintenance cost, trade-in value and number of accidents for the two groups.

The rate of increase was a critical factor in a study of this type. The total rate of increase refers to the gradual rise in operation cost with time and use. If the rate of increase were a positive number, or a continual rise, then a useful life based on economic principles was estimated for the automobile. If, however, the rate were zero or negative, the automobile should be operated until it fails. With this in mind, computer computations to make this determination were used to determine the rate of increase. The procedure was used to determine the rate of increase for several intervals of miles and to determine if rate is positive, zero or negative. The procedure used applied only to positive rates of increase. The scale shown in Appendix A describes the replacement cycle for items that wear out. The nomograph gives a graphic representation which consists of several lines that have been marked to scale. By using a straightedge and connecting the rate of increasing operating cost (c) to the initial cost (a-s) an unknown value can be read at the point of intersection at life of the vehicle (n). The nomograph (Appendix A) was used in Chapter IV to analyze the data by use of the Cost for a Given Cycle of Replacement formula:

$$\frac{(\text{replacement cycle} - 1) \times (\text{rate of increasing cost})}{2}$$

+ (straight line depreciation).

The calculations of the formula were described as: A equaled the initial cost of vehicle which was $7,150. S equaled salvage value of vehicle which was $3,340 at 95,000 miles. C equaled rate of increasing operating cost and n were predictable life-cycle of the vehicle during each period.

4. SUMMARY

This chapter gave the specific methodology employed in addressing the research problem and its related subproblems. The procedure for collecting the data from T.B.I. files, DOT microfish and MVMR reports was covered. The study population was shown as a fleet of 30 LTD Ford's utilized by the T.B.I. from the period 1980 through 1985. The procedure for data tabulation through the use of a computer was presented as the method for treatment of the data by use of Lotus. Chapter IV will utilize this methodology in an analysis of the data.

CHAPTER IV

ANALYSIS OF DATA

1. INTRODUCTION

The purpose of the study was not to determine the overall cost of operating a fleet of cars but to determine the point at which any given car should be removed from service because of operating cost. This researcher collected the data which equals amounts for gas and maintenance for thirty vehicles. The data were representative of totals for 5,000 mile periods. The periods were considered autonomous because the analyzed differences on the basis of successive periods. The data were analyzed by categories as follows: gas usage, gas cost, scheduled maintenance, unscheduled maintenance, accidents (See Table 1).

2. COST OF OWNERSHIP

With the use of the computer, this researcher accumulated and determined means by periods with respect to the number of vehicles remaining in service at any particular period. The researcher determined that due to the decrease in fleet size to 11 at period 20 or 100,000 miles data became unreliable, so 19 periods

Table 1. Cost Of Ownership

Year →			1980			1981				1982					1983						1984			
Vehicle ID Category Mileage -	5000	10000	15000	20000	25000	30000	35000	40000	45000	50000	55000	60000	65000	70000	75000	80000	85000	90000	95000	100000	105000	110000	115000	averages
Average Fuel usage (gallons)	328.37	331.17	328.49	333.06	330.58	329.86	341.14	343.48	334.34	341.72	345.56	344.41	340.86	344.96	341.96	347.71	357.43	360.36	376.64	378.95	439.93	403.43	457.63	355.7423
Miles per Gallon	15.23	15.10	15.22	15.01	15.12	15.16	14.66	14.56	14.95	14.63	14.47	14.52	14.67	14.49	14.62	14.38	13.99	13.87	13.28	13.19	11.37	12.39	10.93	14.16565
Average fuel cost	$354.64	$357.66	$354.77	$359.70	$357.03	$356.25	$368.43	$370.95	$361.09	$369.06	$373.21	$371.97	$368.13	$372.56	$369.32	$375.53	$386.03	$389.19	$406.78	$409.27	$475.13	$435.70	$494.24	$384.20
Average maintenance costs	$38.87	$45.04	$71.29	$65.01	$92.13	$68.03	$95.44	$105.01	$109.54	$152.18	$98.74	$123.63	$151.12	$164.21	$173.11	$157.96	$188.67	$152.70	$105.53	$72.25	$76.45	$79.23	$31.50	$105.11
Average all cost	$393.50	$402.70	$426.07	$424.71	$449.16	$424.28	$463.88	$475.96	$470.63	$521.24	$471.95	$495.60	$519.25	$536.77	$542.43	$533.49	$574.69	$541.89	$512.30	$481.52	$551.58	$514.93	$525.74	$489.32
Difference of successive period	$393.50	$9.20	$23.36	($1.35)	$24.45	($24.88)	$39.60	$12.08	($5.33)	$50.60	($49.29)	$23.65	$23.65	$17.52	$5.66	($8.94)	$41.21	($32.80)	($29.59)	($30.78)	$70.06	($36.65)	$10.81	$22.86
Number of vehicles remaining	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	28	24	18	16	11	6	2		
Increasing cost rate																			30.11					
Average Trade-in Value	$7,150.00					$5,950.00				$4,950.00					$4,350.00				$3,340.00		$3,500.00		$2,700.00	
Straight line dep		$2,225.00	$1,483.33	$1,112.50	$890.00	$741.67	$635.71	$556.25	$494.44	$445.00	$404.55	$370.83	$342.31	$317.86	$296.67	$278.13	$261.76	$247.22	$234.21	$222.50	$211.90	$202.27	$193.48	
Total ownership cost		$2,240.00	$1,513.33	$1,157.50	$950.00	$816.67	$725.71	$661.25	$614.44	$580.00	$554.55	$535.83	$522.31	$512.86	$506.67	$503.13	$501.76	$502.22	$504.21	$507.50	$511.90	$517.27	$523.48	

or 95,000 miles was used for calculations of averages. From these averages the cost was determined for each period. Then the differences of total cost per period were calculated. From these differences, the average rate of increase was derived. That average rate of increase was calculated as the sum of the differences of total cost per period divided by number of periods.

The replacement cycle of any vehicle was defined as the number of periods of ownership to a given period. For example, the replacement cycle of a vehicle at 95,000 miles was 19 periods.

The straight line depreciation was derived by the difference between average starting value and ending value divided by the given number of periods up to that point.

The formulated version of the nomograph was: the cost of owning the equipment at any given period equals the replacement cycle - 1 multiplied by the rate of increasing cost with the result divided by 2 with that added to straight line depreciation.

Applying the aforementioned values to the formulated version of the nomograph for each of the 19 periods in the replacement cycle, the cost of ownership for each given period was derived.

Calculating the ownership cost for each period resulted in a trend of a decreasing nature to a period where that trend became increasing. Refer to Table 1 for total ownership cost. This minimum cost point showed that keeping the vehicle longer resulted in higher cost and replacing the vehicle before would also result in a higher cost of ownership.

This study through the use of data collection among the defined categories combined with the summation of that collected data and the calculation of the means of those sums was used to estimate differences for successive periods. Those differences for successive periods were used to calculate rate of increasing cost. The given replacement cycle of 19 periods along with the rate of increasing cost of $30.11 and straight line depreciation in the formula version of the nomograph resulted in a minimum cost point of 17 periods or 85,000 miles.

3. RATE OF INCREASE

The rate of increase was a major factor in the analysis of data. The rate of increase refers to the gradual rise in operating cost with time and use. If the rate of increase is a positive number or a contiual rise, then a useful life can be estimated for the unit. With the analysis of data, a positive rate of increase of $30.11 was determined.

An analysis of data resulted in the information shown in Figure 1. Figure 1 is a summary of the total ownership costs to the T.B.I. for operating their 1980 LTD Fords for the period February 1, 1980 through June 30, 1985.

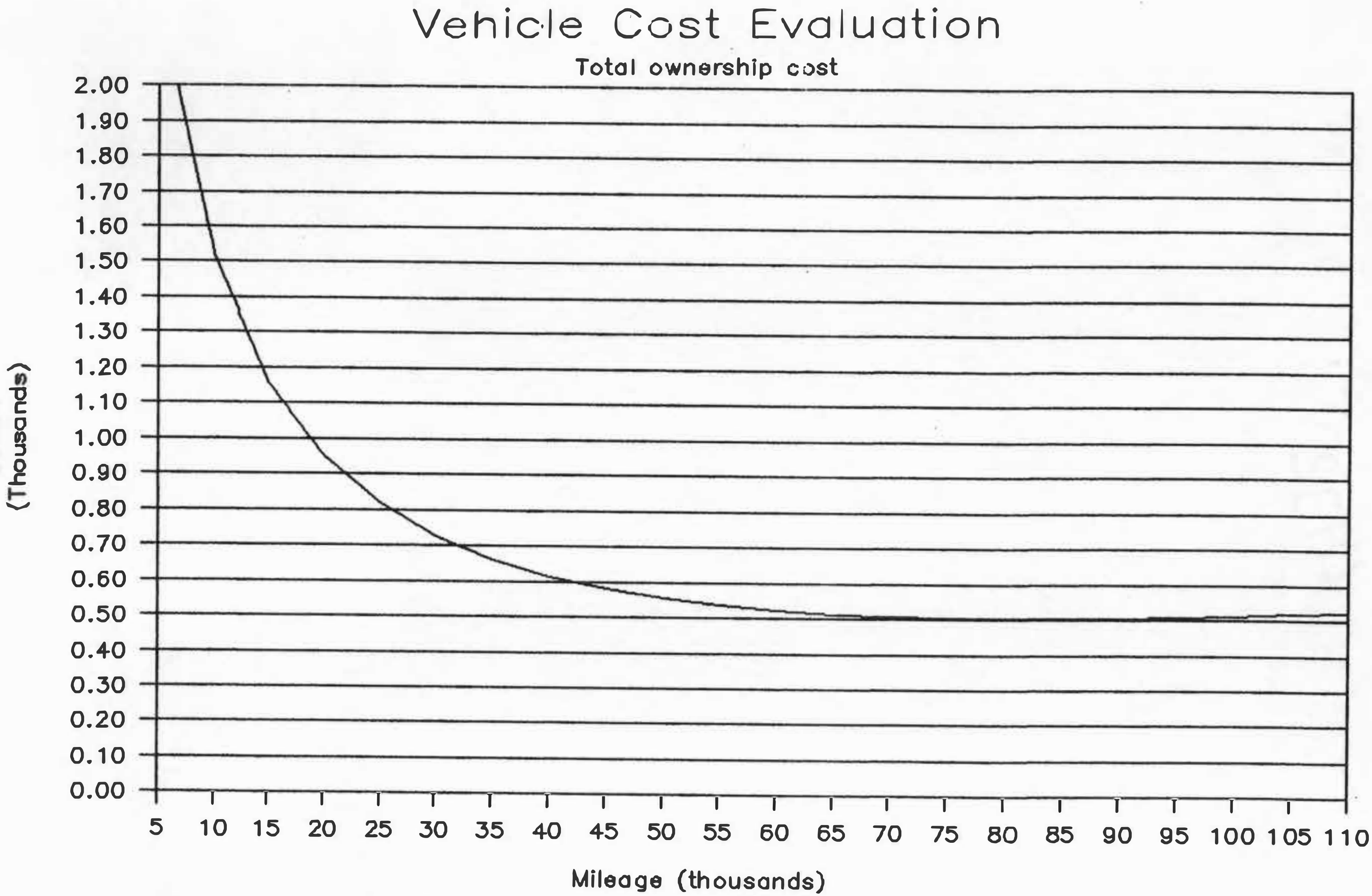


Figure 1. Total Ownership Cost Per Number of Miles for Vehicles in Service

There appears to be a gradual decline in ownership costs of $500 at approximately 65,000 miles then a leveling off until a rise in costs of approximately $510 starts again at 95,000 miles. (See Table 1 for exact cost of ownership amounts for any given period.)

4. FUEL USAGE

Figure 2 shows the total average miles per gallon that the T.B.I. 1980 LTD motor vehicles achieved for the period from February 1, 1980 through June 30, 1985. Figure 2 also reveals a steady decline in miles per gallon (15 mpg) at about 25,000 miles and then a significant decline begins at 85,000 miles with an MPG of 14. The most drastic decline (11.25 mpg) occurs at approximately 105,000 miles.

In Figure 3, the total average fuel usage for the Ford LTD's is shown. The line graph shows a steady but consistent rise in the use of fuel. At 85,000 miles about 350 gallons per vehicle per period were used and climbed rapidly thereafter to a high of about 450 gallons per vehicle per period at 105,000 miles. From the graph, the researcher summarized that the vehicles were using more fuel at 85,000 miles than at 5,000 miles. This was consistent with the data contained in Figure 2 which showed the vehicles were achieving fewer miles per gallon at 85,000 miles than the vehicles had been achieving at

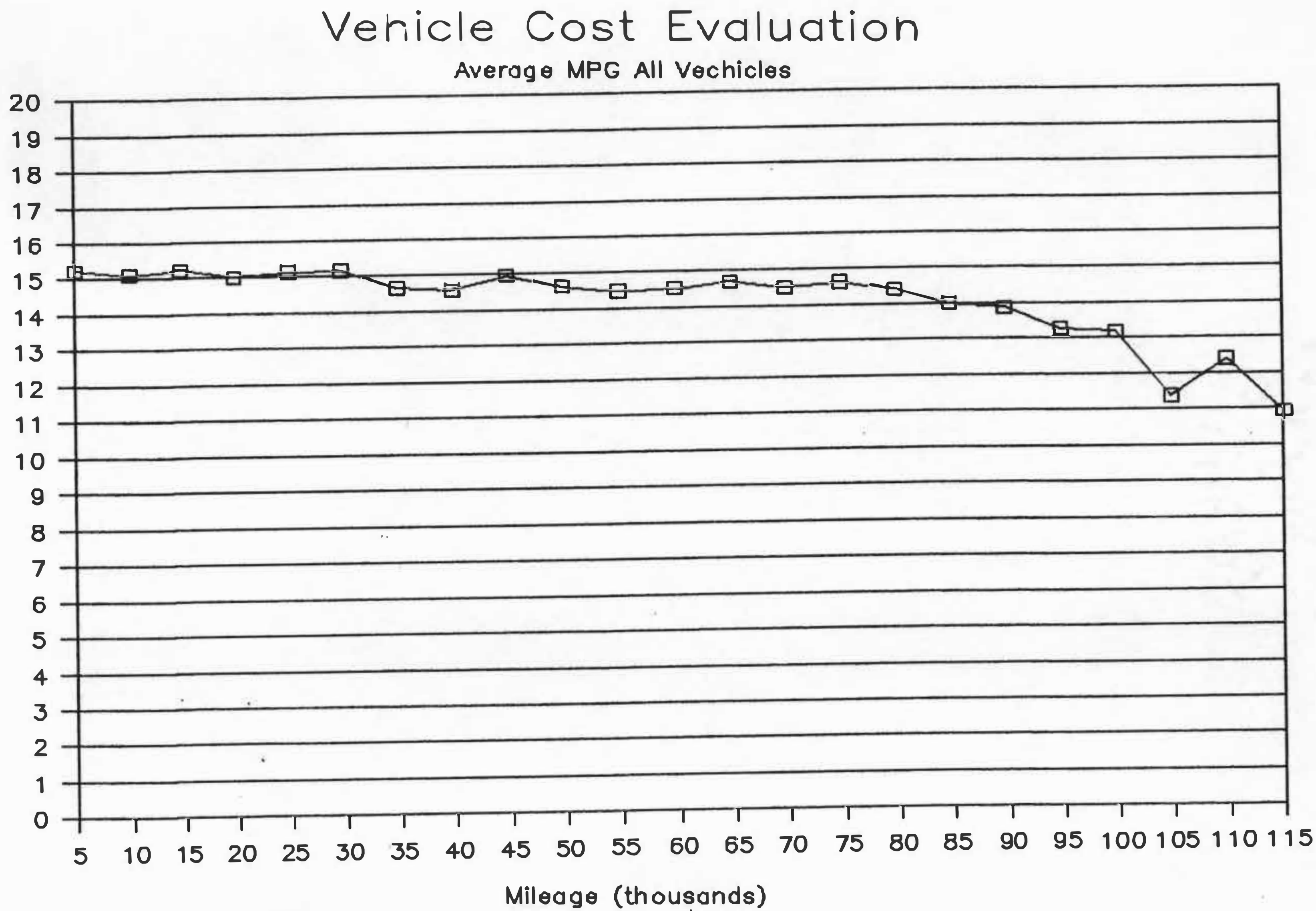


Figure 2. Average MPG Per Number of Miles for Vehicles in Service

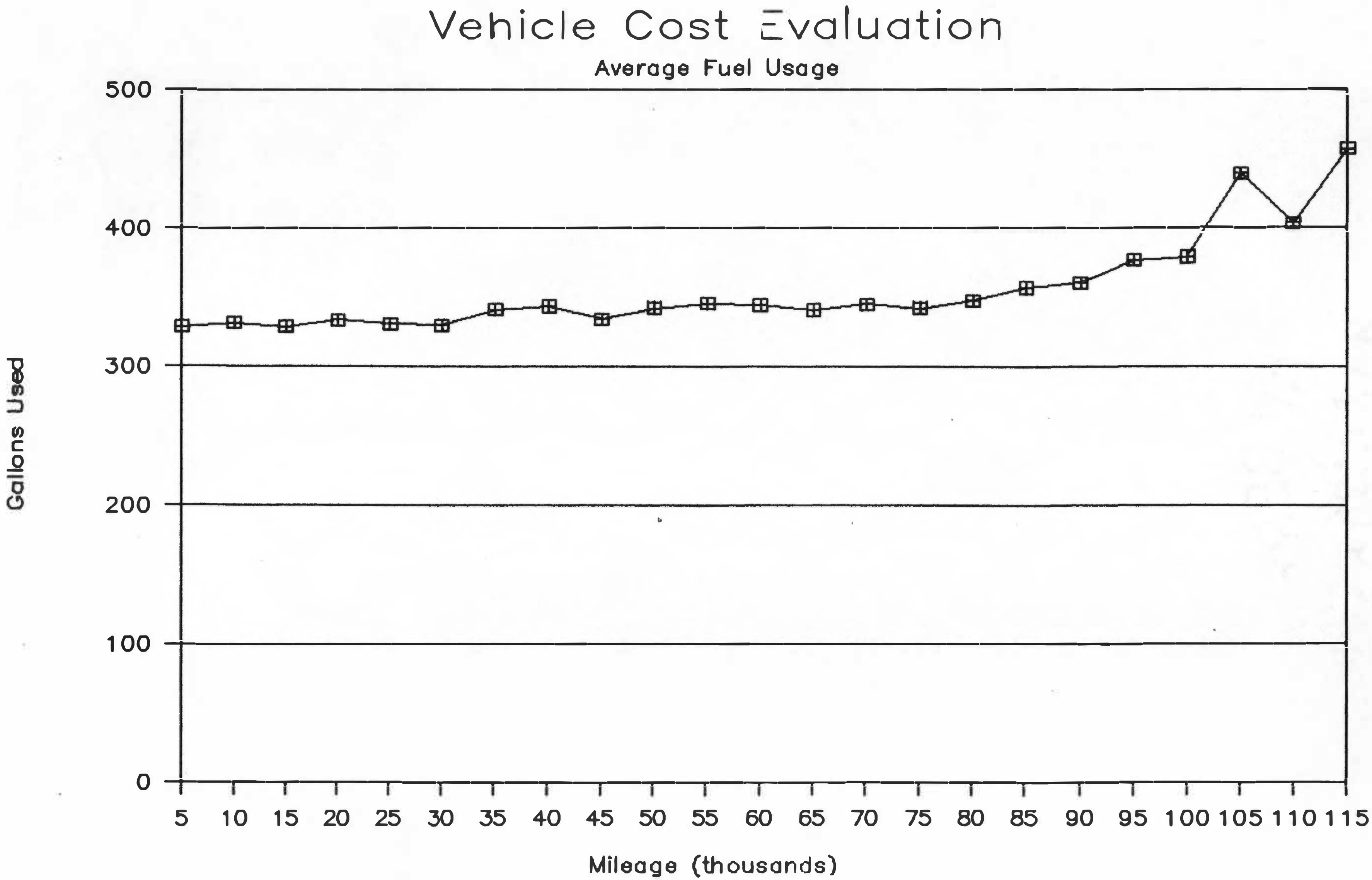


Figure 3. Average Fuel Usage Per Number of Miles for Vehicles in Service

miles. Therefore, it was shown that the vehicles were using more fuel at 85,000 miles but not acquiring as many miles per gallon. The relation between miles per gallon and fuel usage shows that in reference to the economic factor the vehicles were achieving fewer miles per gallon but were costing more to operate.

5. MAINTENANCE COST

Figure 4 shows the total maintenance cost for operating the T.B.I. 1980 Ford LTD's during the period February 1, 1980 through June 30, 1985. The study reveals a rise in costs to approximately 85,000 miles or $190 per vehicle per period and then a sudden and continuous drop of cost for scheduled and unscheduled maintenance to approximately 100,000 miles or $70 per vehicle per period.

The total maintenance cost includes both scheduled and unscheduled maintenance. The scheduled maintenance consisted of all fluids except gasoline. These included oil consumption and cost, lubrications, antifreeze, windshield wiper fluid, number of tires and cost and tire repairs. The unscheduled maintenance consisted of any repair or part used not listed in the scheduled maintenance category. Those unscheduled items consisted of batteries, blown engines, sway bars, broken parts and any repair not covered by scheduled maintenance.

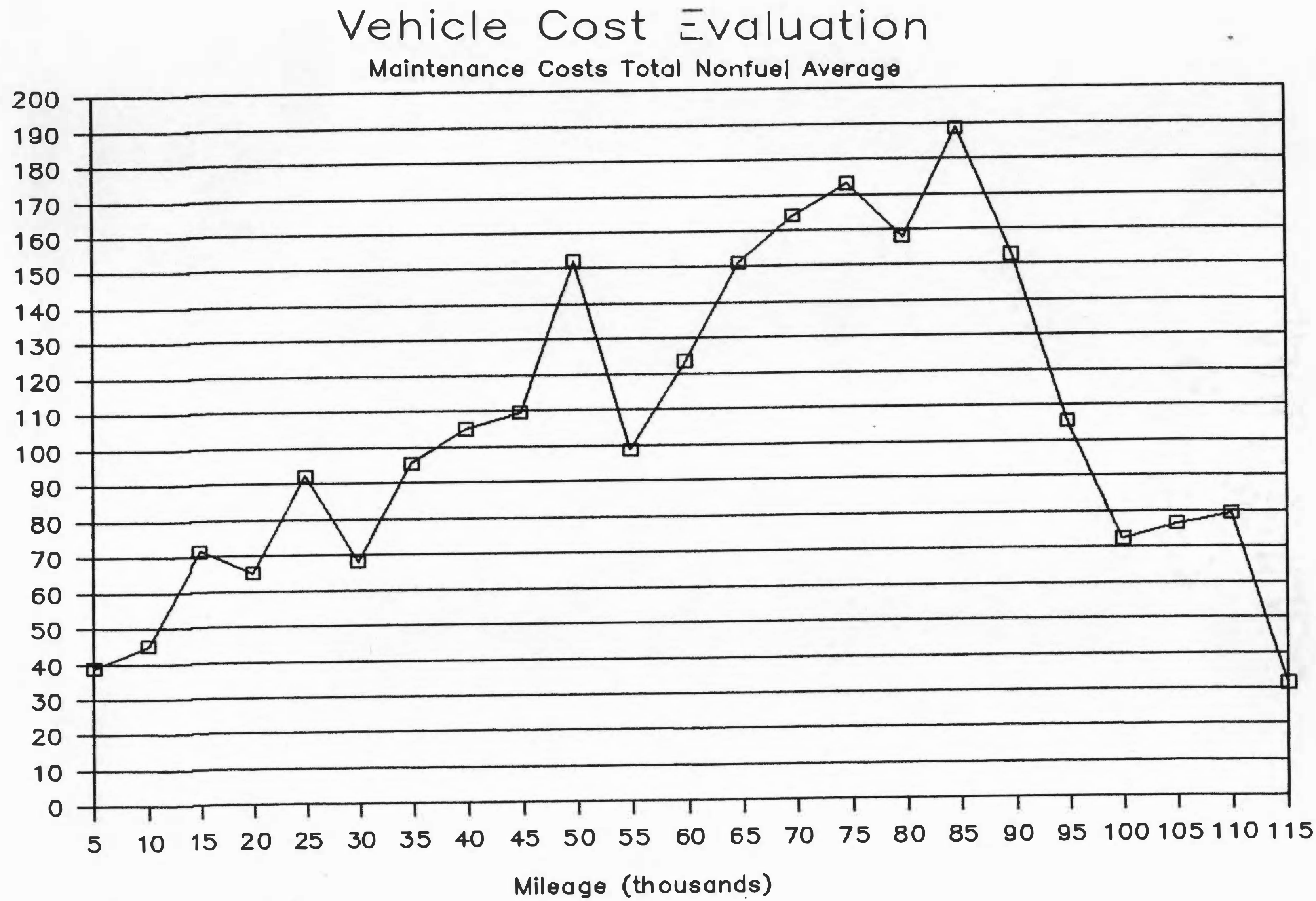


Figure 4. Total Maintenance Costs Per Number of Miles for Vehicles in Service

Figure 4 shows that there was a gradual rise in the cost of scheduled and unscheduled maintenance costs until approximately 85,000 miles, then a drastic drop in cost to approximately 100,000 miles. This drop in cost was due to the trading of vehicles and agents knowledge that vehicles were going to be traded. Therefore, the agents stopped major repairs to vehicles.

Figure 5 shows the total average of scheduled maintenance cost of vehicles for the period February 1, 1980 through June 30, 1985. Scheduled maintenance was that maintenance which was performed on a regular basis. For example, oil changes and lubrication of vehicles were routine scheduled maintenance.

The line graph in Figure 5 shows a rise and fall of cost of scheduled maintenance to a period of 105,000 miles and a cost of $0.001 per vehicle per mile. At approximately 95,000 miles there was a drop in cost per vehicle per mile to approximately $0.004, at which point there was a drastic fall in scheduled maintenance.

Figure 6 shows the cost per mile of scheduled maintenance on the T.B.I. 1980 LTD's from February 1, 1980 through June 30, 1985. The results for cost per mile is similar to the cost of average scheduled maintenance. The difference was the scales which were costs (cents) on the cost per mile graph and cost (dollars) on the average scheduled maintenance graph. Figure 6 shows an uneven pattern of cost per mile until 85,000 miles at which point

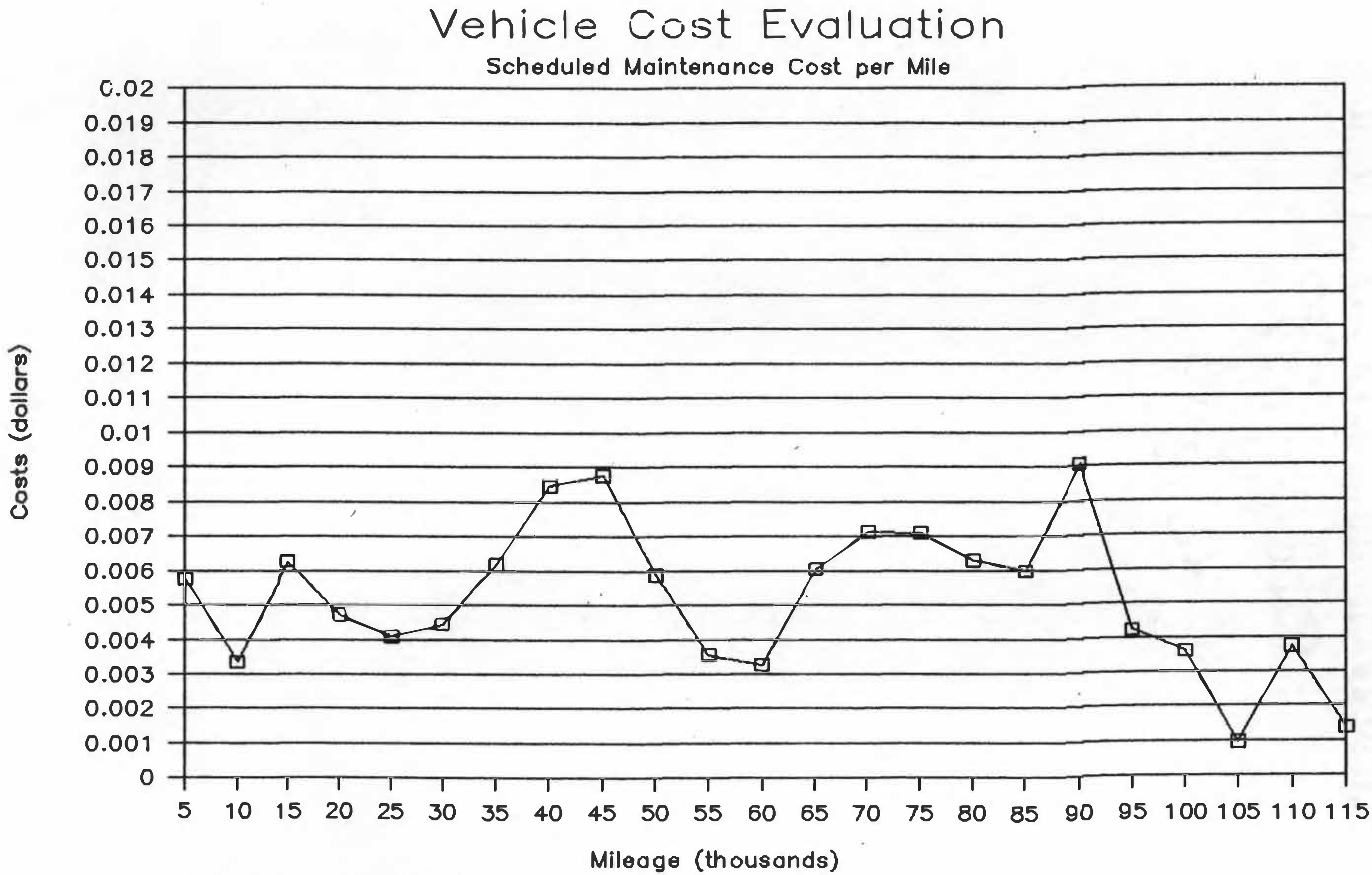


Figure 5. Scheduled Maintenance Cost per Mile per Number of Miles for Vehicles in Service

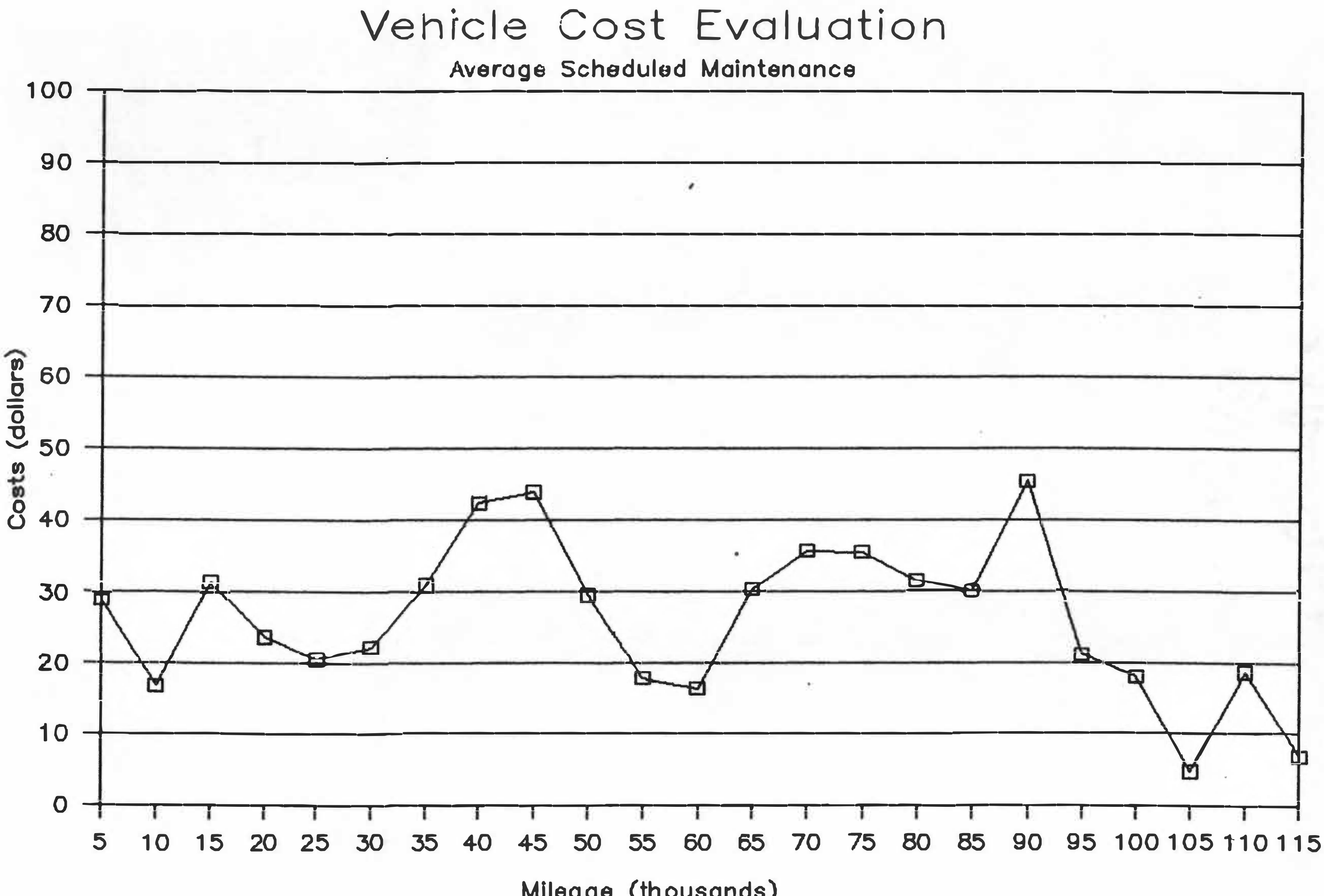


Figure 6. Average Scheduled Maintenance per Number of Miles for Vehicles in Service

the cost was approximately $0.006 per mile. At approximately 85,000 miles, there was a rise to 90,000 miles at a cost of $0.009 per mile and then a drastic drop to $0.001 per mile at 105,000 miles. This sudden decline was due to trading of some of the vehicles and knowledge of agents that vehicles were soon to be traded. When scheduled maintenance was stopped the cost per mile for operating the vehicles dropped drastically.

Figure 7 shows the average maintenance costs for unscheduled repairs to the 1980 LTD Fords operated by the T.B.I. from February 1, 1980 through June 30, 1985. There was a rise in cost of unscheduled repairs up to 85,000 miles at a cost of approximately $160 per vehicle per period. At approximately 85,000 miles there was a sudden drop in cost per miles to approximately 100,000 miles at which time the cost per vehicle per period was $52.

The breakdown for the average maintenance cost for unscheduled repairs was in keeping with the analysis of determining at what mileage point would be most probable for trade-in of the vehicles.

The data presented in Figure 8 were consistent with the data presented in Figure 7 in determining cost per mile in relation to unscheduled maintenance cost. When unscheduled repairs became necessary there was an increase in cost per mile to operate the fleet.

Vehicle accidents incurred by the T.B.I. agents

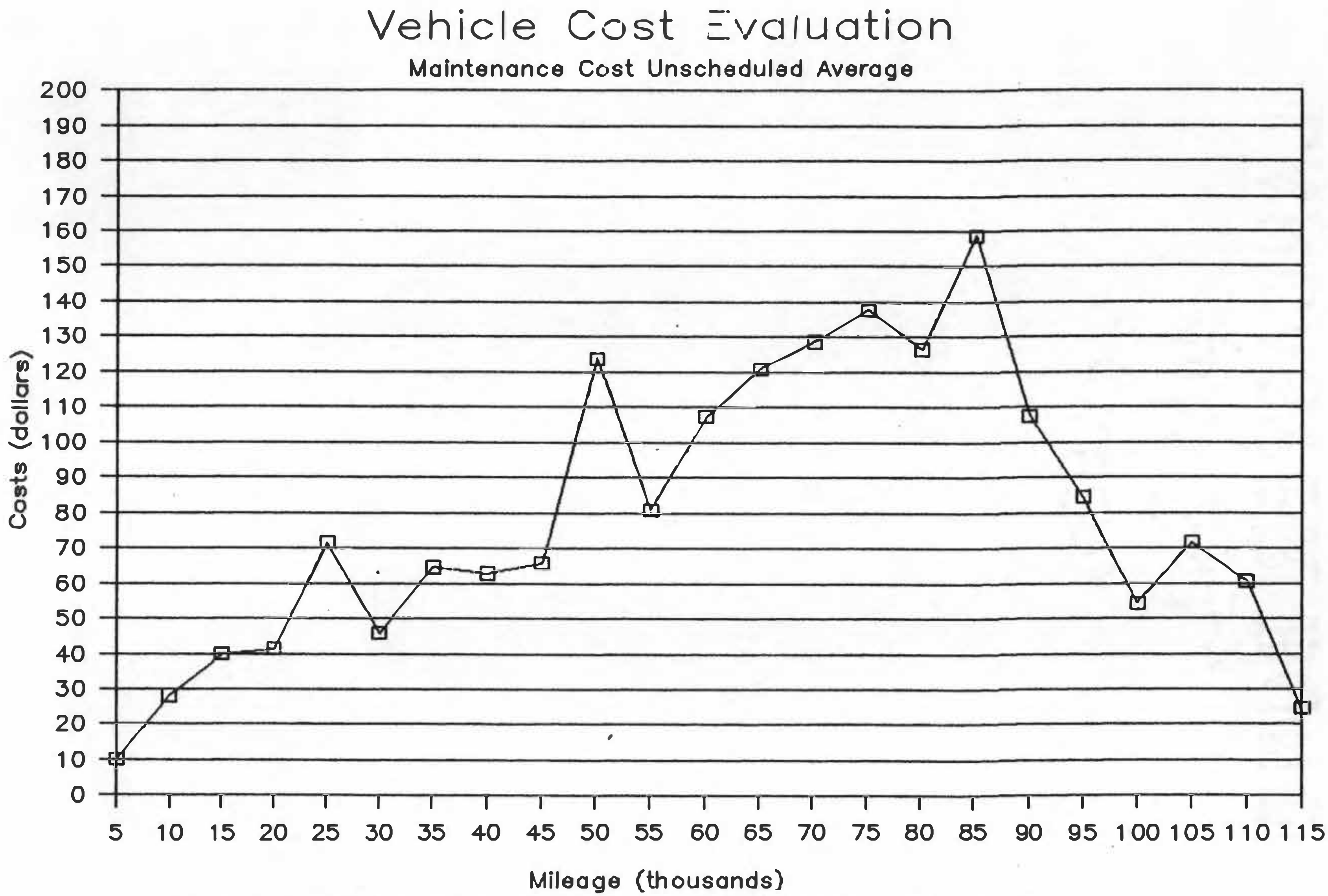


Figure 7. Maintenance Cost Unscheduled Average Per Number of Miles for Vehicles in Service

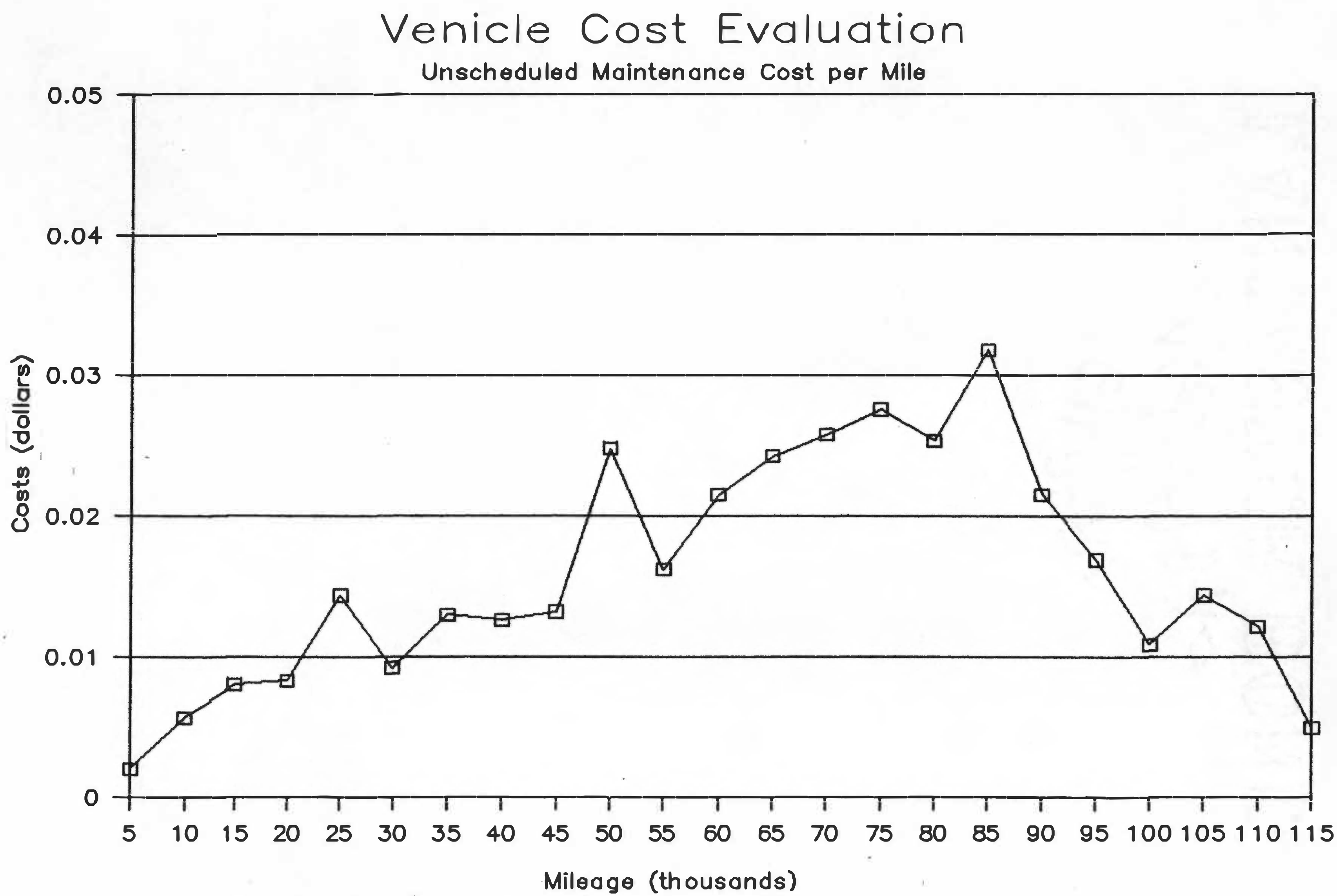


Figure 8. Unscheduled Maintenance Cost per Mile per Number of Miles for Vehicles in Service

operating the 1980 LTD Fords from February 1, 1980 through June 30, 1985 is presented in Figure 9. The figure shows the rate of accidents as they occurred in relationship to miles accumulated. The average rate of accidents before 70,000 miles was no greater than the average rate of accidents after 70,000 miles. In reference to safety factors there was no greater risk shown before 70,000 miles than after 70,000 miles.

6. DIFFERENCES OF SUCCESSIVE PERIODS

The time period in this study was from February 1, 1980 through June 30, 1985 with the miles driven during this time divided into 5,000 miles per period. The rate of increase in cost of operating 1980 LTD Ford vehicles was determined to be $30.11. Lotus 1-2-3 was programmed for the analysis and through computations of individual periods and differences of successive periods the rate of increase was determined. An attempt was made to determine the rate of increase for several intervals of mileage and to determine whether the rate was positive, zero, or negative, as indicated in Table 1.

In this study the results were positive and were applied to Figure 10 which is a nomograph that eliminates major computations. The results were reported in miles of operation. The data were analyzed by connecting point C, which is the cost of increase ($30.11), to point

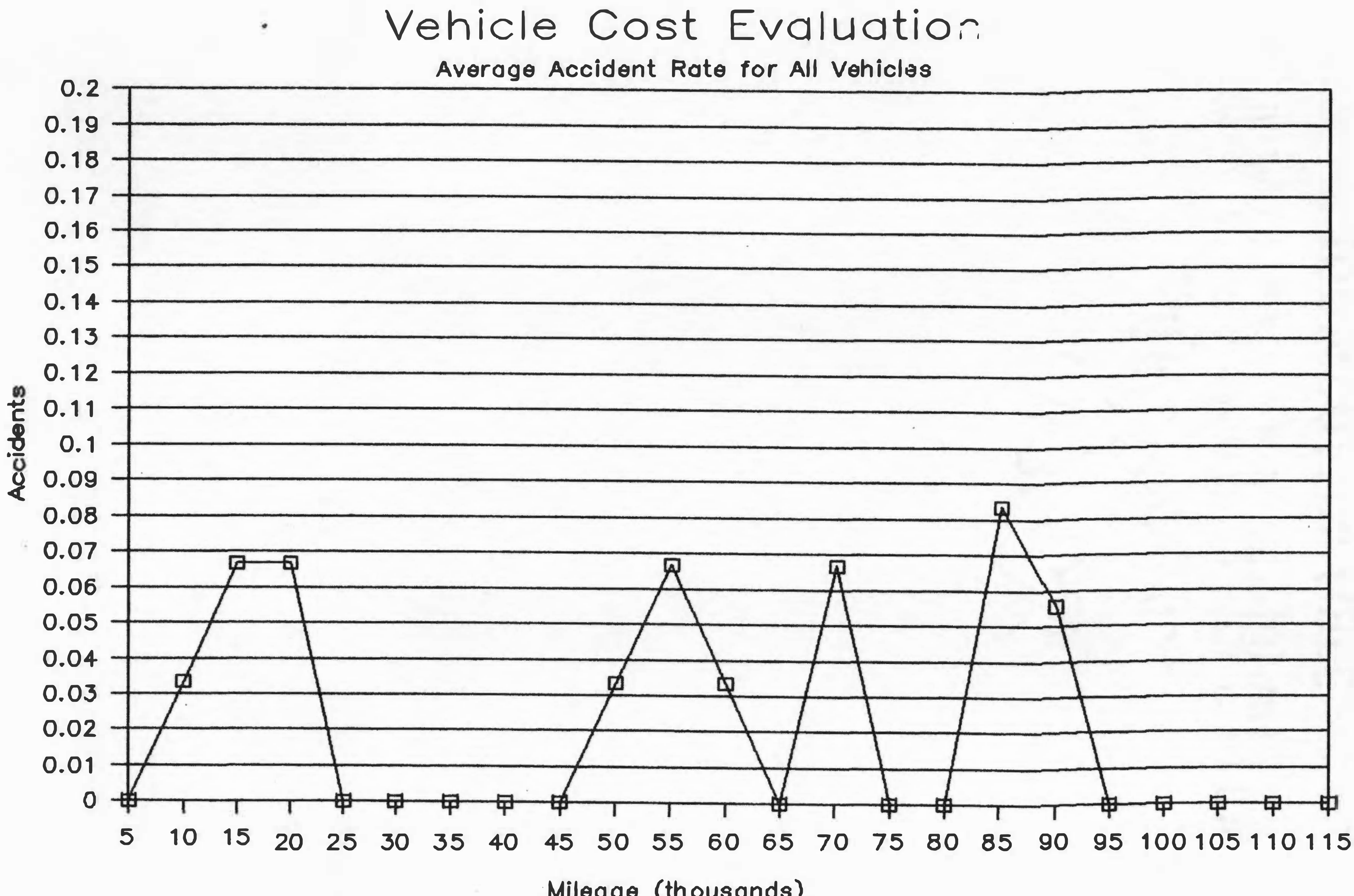
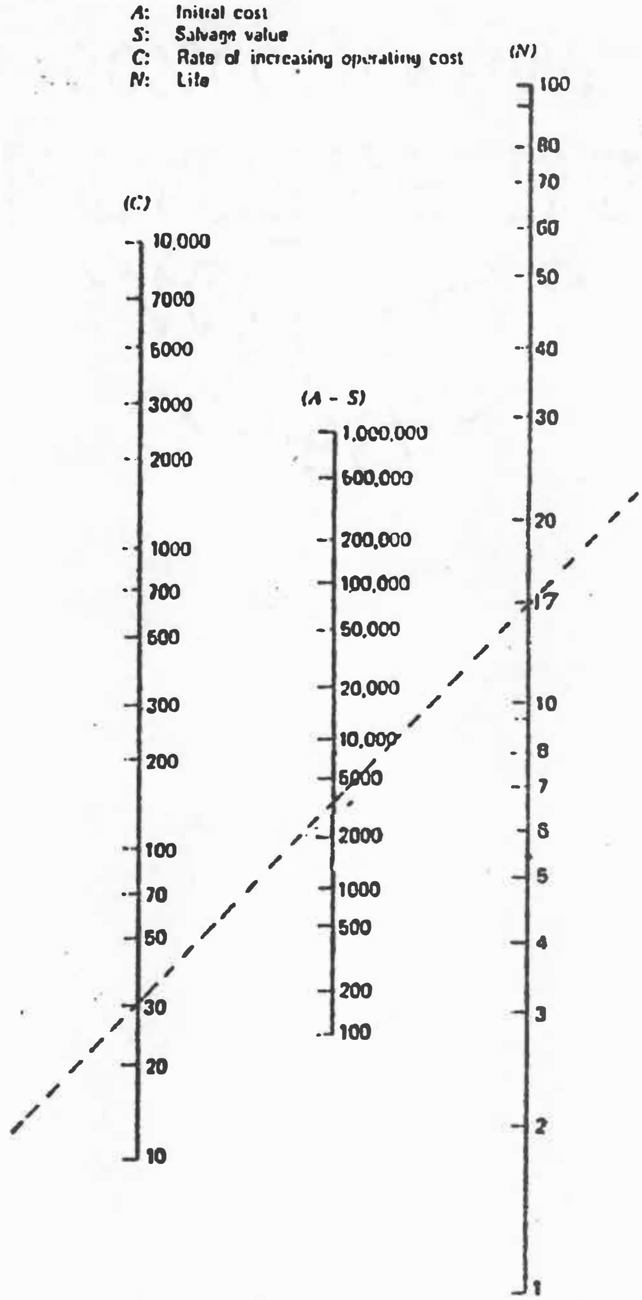


Figure 9. Average Accident Rate per Number of Miles for Vehicles in Service



Known Information:
C = $30.11 per period
A = $5,931
S = $3,340

Procedure:
(A-S) = ($5,931 - $3,341) = $2,591
Construct line through
C = $30.11
(A - S) = $2,591
Line intersects at 17
Hence keep the unit for 17
periods or 85,000 miles.

Figure 10. Nomograph for Determination of Replacement Cycles for Vehicles that Wear Out.

A - S, which equaled $2,591. The line was continued through point 17 (periods) which equaled 85,000 miles. This procedure takes into account the initial cost of the unit, its salvage value which can change with time and a rising operating cost. Thus, the total cost of operating the equipment was determined. The analysis took into account that if the equipment was operated for either less or more than the optimal period of time, its total cost of ownership and operation would be higher than for the optimal period.

After performing the computations on the computer the results were factored into the nomograph. In this study, the analysis for replacement of vehicles was based on 19 periods of time. This factor took into consideration the maintenance, both scheduled and unscheduled, trade-in value, accidents, oil usage and gasoline consumption. By using the difference of successive periods, $30.11 resulted as the cost rate of increase at the end of 19 periods. In Figure 10, the nomograph was shown with the actual rate of increasing operating cost of $30.11, and trade-in value of $2,591 applied. These known numbers were applied to the nomograph and intersected on the third line which gave the unknown number of periods. This was the procedure used in part to ascertain when vehicles should have been replaced on basis of overall cost of operation.

7. SUMMARY

In this chapter, the data were analyzed and the results were shown in the form of line graphs. The cost of ownership was shown in the form of a table which showed averages for average fuel usage, miles per gallon, fuel cost, and maintenance costs. The total cost of ownership was also presented in Table 1.

A nomograph was utilized for determining when vehicles should be replaced. The rate of increase of $30.11 was determined through computations of successive periods. This rate of increase along with trade-in value of vehicles were the two known numbers applied to the nomograph and hence the third unknown was derived.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

1. SUMMARY

The purpose of the study was to identify and analyze the life-cycle effectiveness and safety factors involved in operating T.B.I. motor vehicles from zero miles through their life-cycle. The study addressed four basic questions:

1. What are the economic savings when operating T.B.I. vehicles past seventy thousand miles as opposed to trading same vehicles when seventy thousand miles is reached?
2. Would operating T.B.I. vehicles past previous standards of seventy thousand miles create safety hazards?
3. When should vehicles be replaced for economic savings?
4. In reference to safety factors, at which mileage point should vehicles be replaced?

2. FINDINGS

ECONOMIC SAVINGS

The economics of operating T.B.I. vehicles past 70,000 miles is shown in the following categories:

1. Trade-in value of the vehicles was shown to be approximately $4,950 at 70,000 miles and approximately $4,350 at 115,000 miles. At $5,950 the trade-in point was approximately 35,000 miles.

2. Average fuel usage was shown as being 328.37 gallons at 5,000 miles and 344.96 gallons at 70,000 miles. From 70,000 miles to 85,000 miles there was a 12.47 gallon rise in fuel usage.

3. Miles per gallon obtained by the vehicles showed an average of 15.23 mpg at 5,000 miles and a decline to 14.49 mpg at 70,000 miles. At 85,000 miles 13.94 mpg was the average with a noticeable decline throughout the rest of the period.

4. Average fuel cost at 5,000 miles was $354.64 and $372.56 at 70,000 miles. The cost at 85,000 miles was $386.03 and a small rise and falling was noted for the rest of the periods.

5. Average maintenance costs at 5,000 miles was $38.87 and $164.21 at 70,000 miles. At 85,000 miles, the costs were $188.67 per period but a steady decline was

noticed for the following periods.

6. The number of vehicles in the study was originally 30 and this number remained constant until 80,000 miles. At 85,000 miles the number of vehicles remaining were 24, at 90,000 miles 16 vehicles remained. There were only 11 vehicles remaining at 100,000 miles.

7. The increasing cost rate of operating the vehicles up to 95,000 miles was $30.11, which was the point of cut off value at the end of the data.

8. Straight line depreciation was used to calculate total ownership cost with a starting value of $2,240.00 at 10,000 miles decreasing to $234.21 at 95,000 miles.

SAFETY STATUS RELATED TO OPERATING T.B.I. VEHICLES

The accident rate up to 80,000 miles was an average of 0.066 and after 80,000 miles, the accident rate was shown at an average of 0.083.

REPLACEMENT OF VEHICLES FOR ECONOMIC COST

Total ownership cost per period was $890.00 at 25,000 miles and declined to 512.86 by 70,000 miles. At 85,000 miles $501.76 was shown as being cost per period and the lowest cost per period of all periods. Therefore, a rise after this point indicated an increasing cost after 80,000 miles.

3. CONCLUSIONS

The following conclusions are based on the aforementiond findings.

1. T.B.I. vehciles, if traded at 85,000 miles instead of 70,000 miles would create economic savings for the organization.
2. The operation of T.B.I. vehicles past seventy thousand miles does not create safety hazards; and miles apparently have no bearing in terms of safety.
3. If the procedure for determining the life-cycle or replacement of T.B.I. vehicles was instituted, economic savings could be recognized.

4. RECOMMENDATIONS

This study was undertaken to assess the economic savings and safety factors for replacement of T.B.I. vehicles operated past seventy thousand miles. There is a positive outcome achieved by this study which is when to trade T.B.I. vehicles. However, there were other areas which merit continued improvement. Some suggested areas of concern include:

1. The price of commercial gasoline was consistantly higher than the price of state gasoline therefore, agents should be encouraged to use state gasoline whenever possible.
2. There should be quarterly inspections to determine if vehicles are being abused by operators.
3. All bids for vehicle parts and services should be audited specifically in terms of acceptable specifications designed to enhance longevity and safety of vehicles.
4. A study should be conducted to analyze the entire fleet of T.B.I. vehicles in terms of cost of operating, safety, and use and or abuse by agents.
5. T.B.I. management should enter all data on future purchasing, maintenance and accident records into a computer where monies to be spent could readily be identified.

CHAPTER VI

STUDY IN RETROSPECT

In Chapter V, it was indicated that three major conclusions inferred findings of this study. Two of these conclusions could create thought for future research.

1. If T.B.I. vehicles were traded at 85,000 miles, economic savings would be realized. Another study could be conducted to determine if inspections of vehicles, vehicle usage and inspection of vendors would create additional savings.
2. A study could be conducted to determine if vehcile accidents incurred by T.B.I. agents were due to operator error.

Perhaps further research is warranted to clarify and offer explanations for some of the findings and conclusions of this study.

This study is not all conclusive. There are other factors which may be contributory to the findings. The factors presented here are relative and each factor is related to and/or dependent upon the others. For example, economic savings depends on maintenance cost, fuel cost, type of vehicle and procedures utilized by administrators are all related. If D.A. Cox was correct in his study of governing speed of vehicles, than the governing of speed for T.B.I. vehicles could have a marred effect on gasoline consumption.

Fuel economy is of vital importance to T.B.I. administrators, for fuel is a primary cost factor in operating vehicles. The results presented by W.E. Norman in his studies concerning journey planning, could be utilized by T.B.I. planners in the future. A computer has been purchased by the bureau and data collected on travel routes could be programmed. The data analysis could be of use in planning routes in assignments of agents.

Martin W. Johnson's study for determining the preventabilty of accidents could be used when gathering statistics on proposed topics in future research. The information from this study could be used also when incorporating a policy for the use of vehicles by the T.B.I. agents. The carelessness of agents when operating T.B.I. vehicles could increase repair bills and create an increase in accidents. Even though the State of Tennessee is self-insured, more accidents cause greater spending from the budget.

The comparability factor (CF) presented by B.P. Orland could be used in comparing the safety performance of one district of the T.B.I. with another district of the T.B.I. The equation would allow the T.B.I. to budget more effectively its allocated funds to those areas where the need would be greatest.

As concluded in this study, economic savings can be achieved and a procedure is available for determining the life-cycle of vehicles. This procedure is available to police and fleet administrators. However, the procedure can only be effective if incorporated into planning aspects of the organization. For example, if management would incorporate the findings, conclusions, and recommendations of this study into their planning of purchasing of vehicles, economic savings could be realized.

When this study was started the researcher thought all of the data to be collected would be readily available on computer print-outs. This was not the case for most of the data were contained on MVMR reports which were stored in the T.B.I. stock room. The data when collected, weighed over one hundred pounds and each MVMR report pertaining to 1980 LTD Fords had to be hand sorted. The researcher anticipated that the study could have been conducted in two-thirds the time actually taken. Therefore, the study was an excellent learning experience in research methodology, because of the knowledge acquired on conducting research.

The researcher undertook this study with the prospect that it would serve as a guide for police administrators in forming policies for purchasing and maintaining a more economical and safe motor fleet. There are many instances of problems encountered by administrators when purchasing vehicles. Though purchasing is performed on a bid contract basis there are many options which the purchaser may exercise. Some options which may be exercised are: size of engines, transmissions, two or four doors, overall size of vehicle, electric door locks, one or two side mirrors and cruise control. These options allows the purchaser to request items which not only pertain to economic savings but incorporate safety features into the fleet, therefore, economic savings could be possibly be achieved and safety hazards possibly lowered.

This study is presented to the purchaser in the form of a guide in reference to economic and safety factors. The fact exists that contracts are given to the lowest bidder. This seems a fair method of handling state contracts. But the purchaser needs to be aware of the basis of bids in relationship to quality and safety. An example of purchasing from a low bidder is the replacement of tires. The tires of the low bidder may seem the most logical and economical purchase but agents have encountered tires which have to be replaced within five thousand miles and did not hold the road as well as another brand of tire did. Therefore, the low bid on paper seemed the best purchase but the life of the tires were short and poor traction created a safety hazard. Particular tire specifications are not required of the bidder. As recommended by the researcher of this study, higher requirements for life cycle and special specifications for tire safety must be incorporated into the purchasing of tires. Though tire specifications were not part of this study the cost of tires purchased was in the data. It is the expressed wish that this study be of benefit to administrators when purchasing fleet vehicles and replacement parts.

This study dealt only with the 1980 LTD Fords used by the T.B.I. and the data collected and analyzed within the realm of that make and model. During the collecting of data it was noted that the T.B.I. uses a variety of makes of vehicles. Some other makes used during the period 1980 through 1985 were Chevrolets, Chryslers, Dodges and Plymouths. Although the main body of the fleet during this period was Ford LTD's the other mentioned makes of vehicles supplied enough data that another study might be conducted to analyze the overall cost of operating the entire fleet of T.B.I. vehicles for that period. A study of that type would provide administrators even more results to be used in purchasing new fleets of vehicles of all types. A comparison could be made to determine which make of vehicle was most serviceable and most met the needs of the T.B.I. agents. This comparison could give a broader insight into economic savings and safety factors. For example, it was noted that one make of vehicle had a tendency for the front end to go out of alignment. This out of alignment caused a greater replacement of tires than usual and many front end alignments. The purchaser would certainly wish to know this data before purchasing that make of vehicle again.

Therefore, data of that magnitude would suggest another study of all vehicles utilized by the T.B.I. would be of extreme value.

If this study were to be duplicated, this researcher recommends that the T.B.I. headquarters in Nashville be contacted to ascertain where data is currently being stored. A suggestion for the management would be that all data on future purchasing, maintenance and accident records be entered into a computer where purchasers could readily ascertain how monies are being spent.

Also, the accident rate for different areas of the state, east, middle and west, could give an insight into performance of vehicles and agents.

As the study progressed, it was even more enjoyable for it became evident that a conclusion could be reached and from that recommendations could be made which could aid administrators in purchasing and policy making when dealing with economic savings and life-cycle of T.B.I. vehicles.

1. PERSONAL COMMENT

Health and safety should be an everyday priority in our lives for failure to heed the warning signs of either could be fatal. This study has been a learning experience not only in the safety aspects of operating motor vehicles but also a study of economic principles. As with health and safety, economics play a vital role in our existence.

Health and safety education offers a chance to learn, apply and form new attitudes and concepts when dealing with everyday occurrences.

LIST OF REFERENCES

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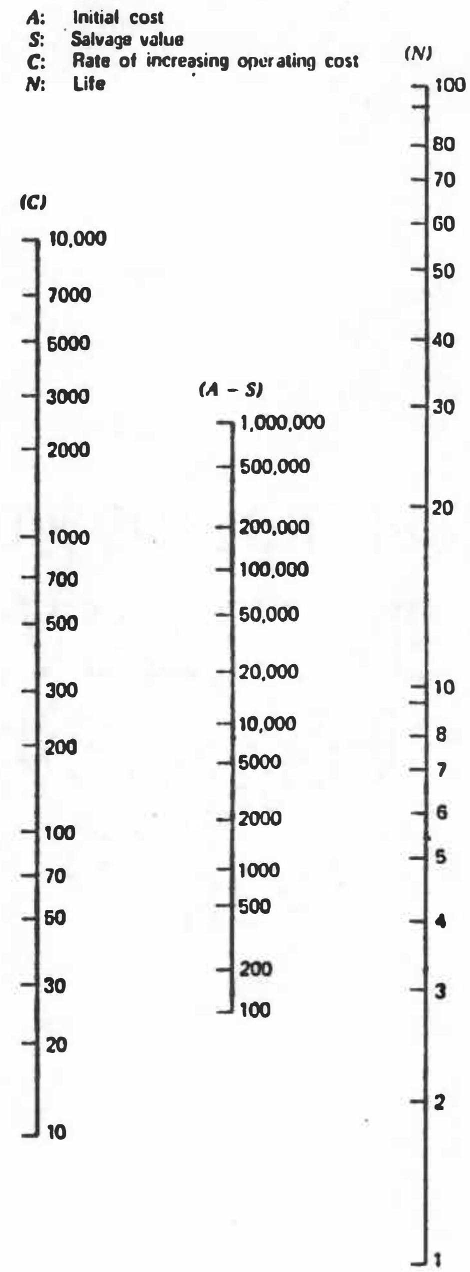
APPENDICES

APPENDIX A

NOMOGRAPH



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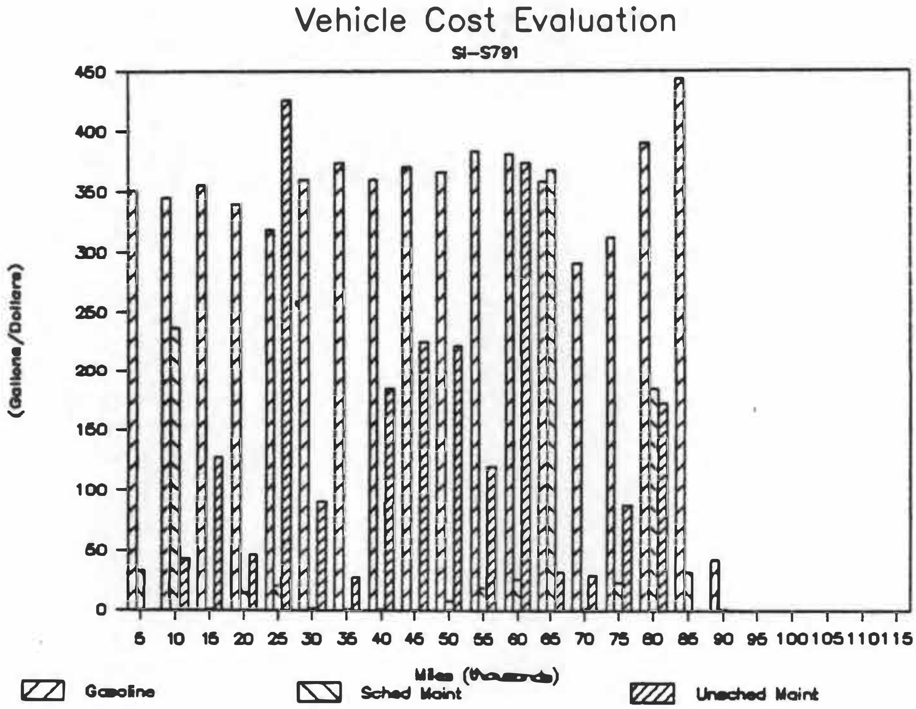
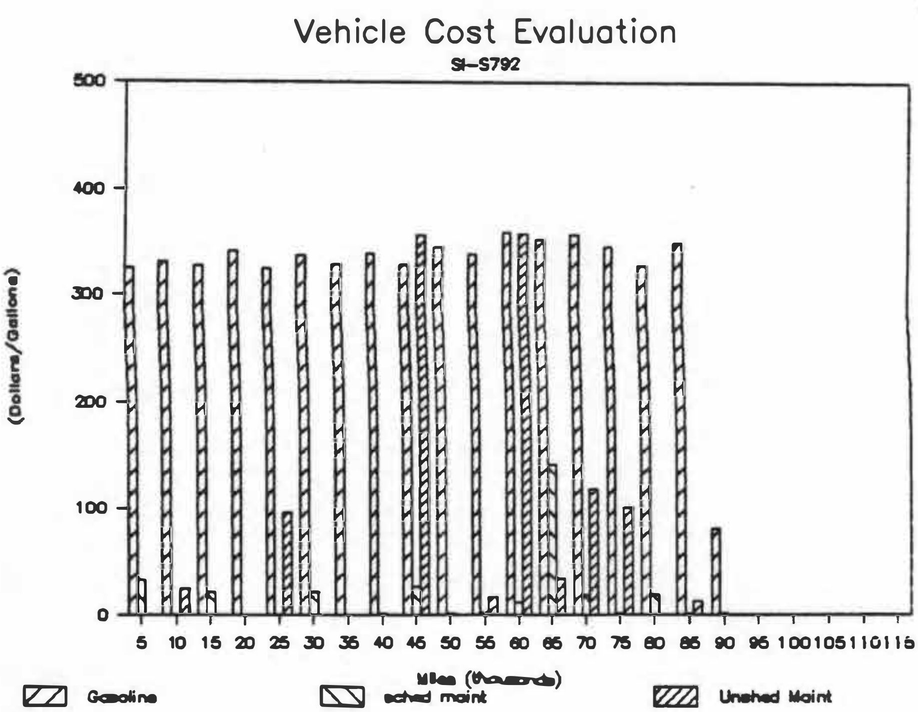
APPENDIX B

INDIVIDUAL VEHICLE EVALUATIONS



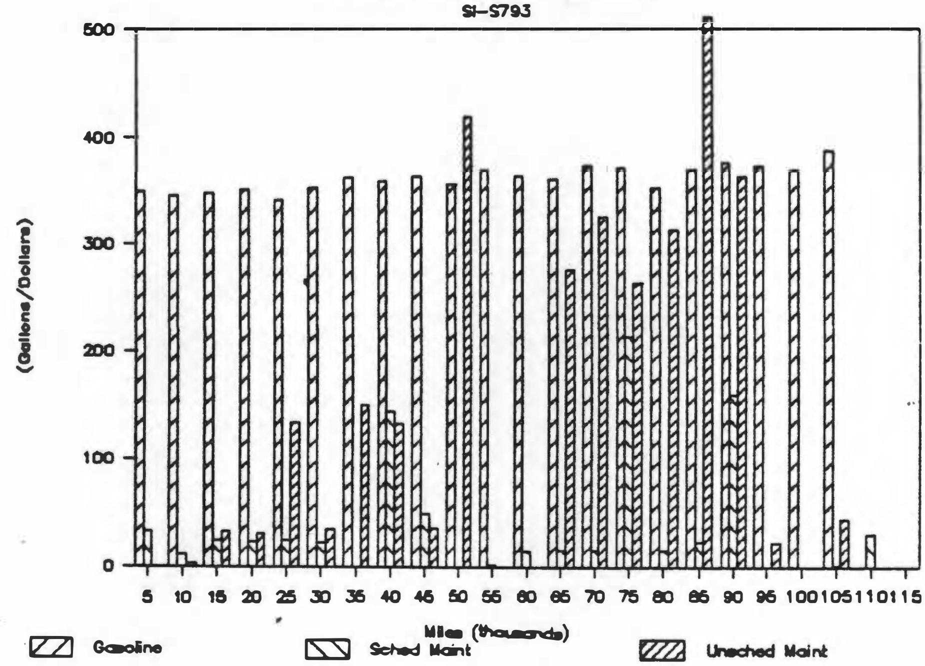
Vehicle Cost Evaluation
SI-S791
(Gallons/Dollars)
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint



Vehicle Cost Evaluation
SI-S792
(Dollars/Gallons)
Miles (thousands)
Gasoline
sched maint
Unshed Maint

Vehicle Cost Evaluation

SI-S793



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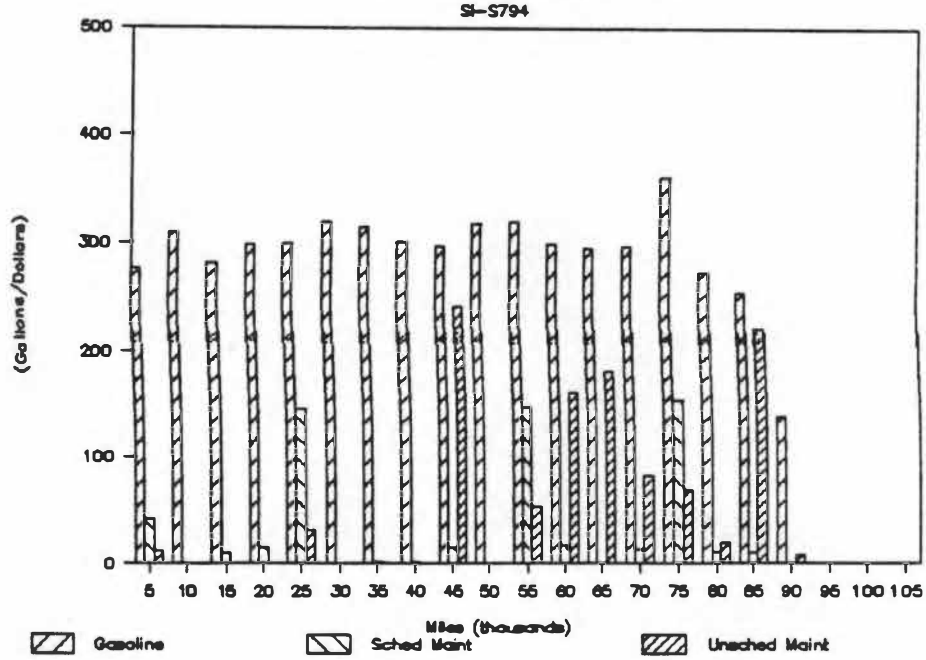

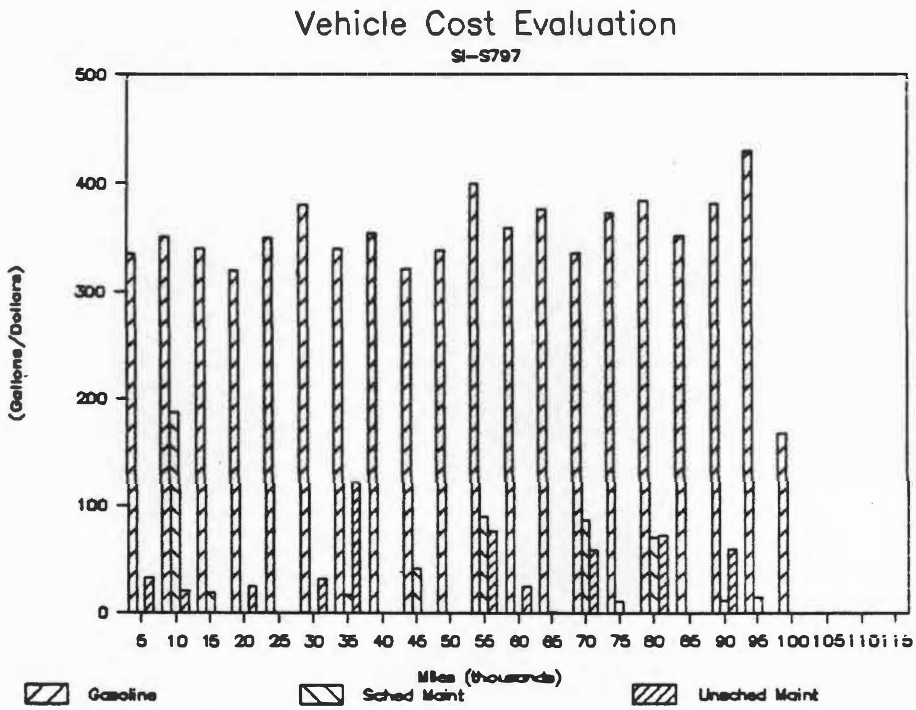

Vehicle Cost Evaluation
SI-S797
(Gallons/Dollars)
500
400
300
200
100
0
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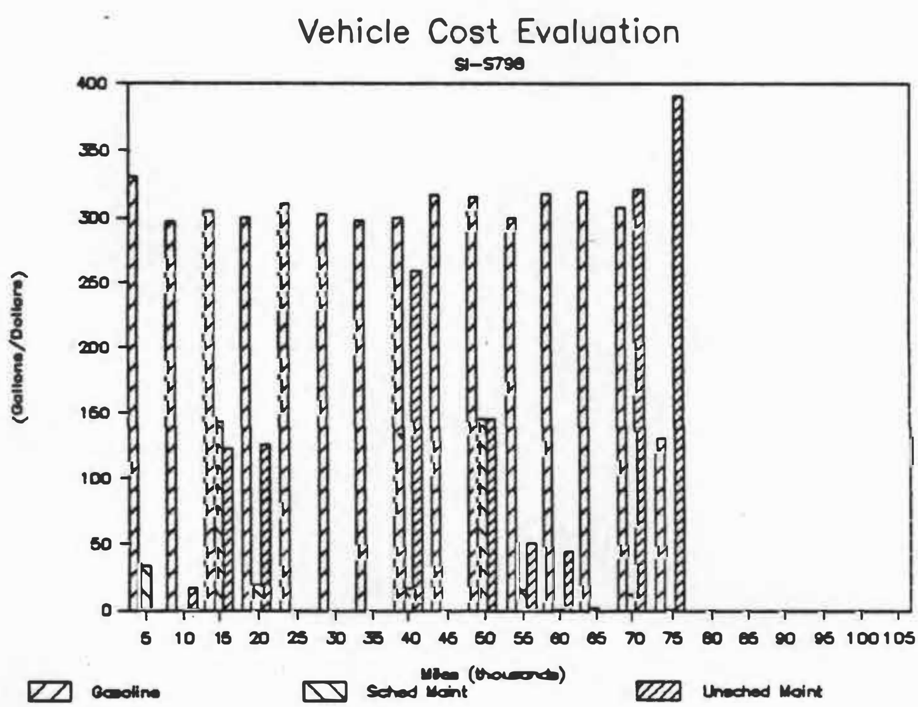
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint



Vehicle Cost Evaluation
SI-S798
(Gallons/Dollars)
400
350
300
250
200
150
100
50
0
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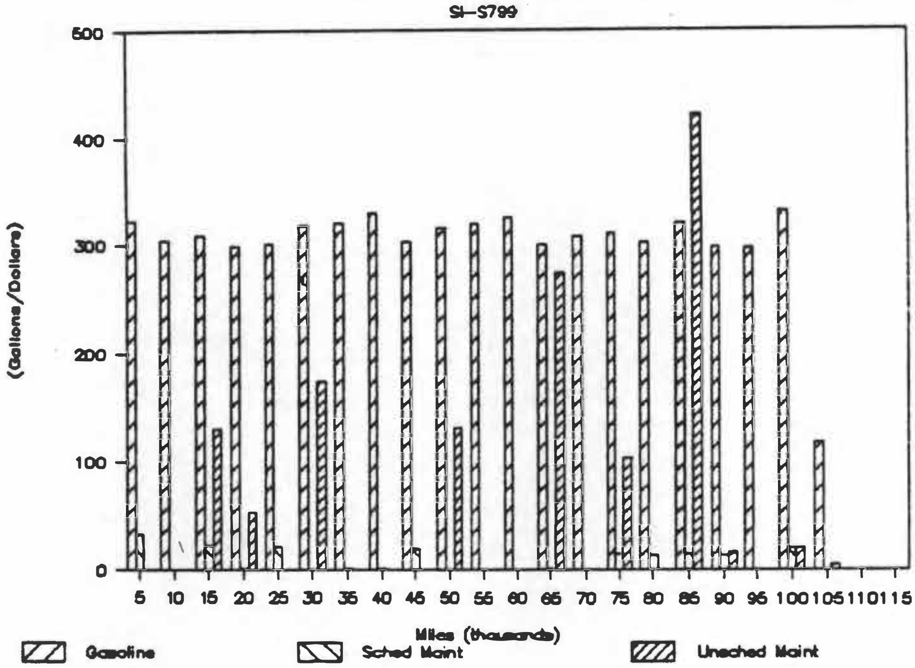
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint

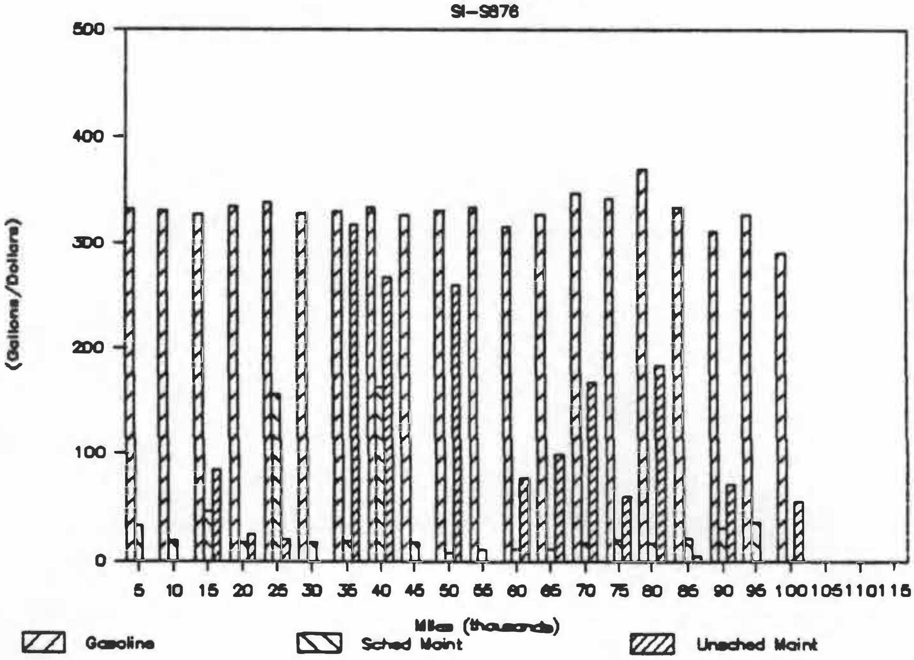
Vehicle Cost Evaluation

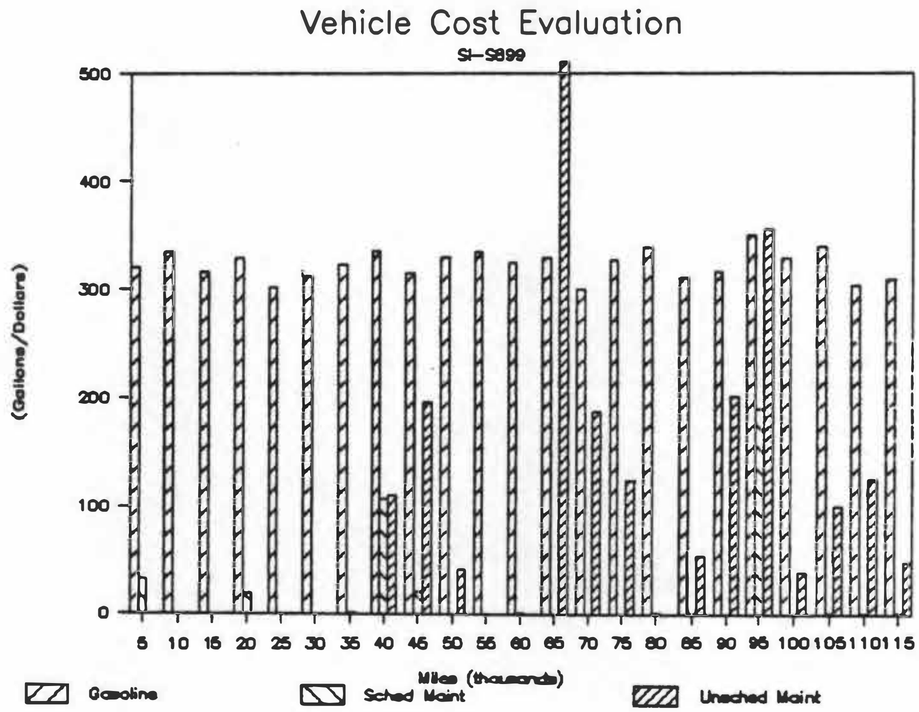
SI-S799



Vehicle Cost Evaluation

SI-S876

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SI-S899
500
400
300
200
100
0
(Gallons/Dollars)
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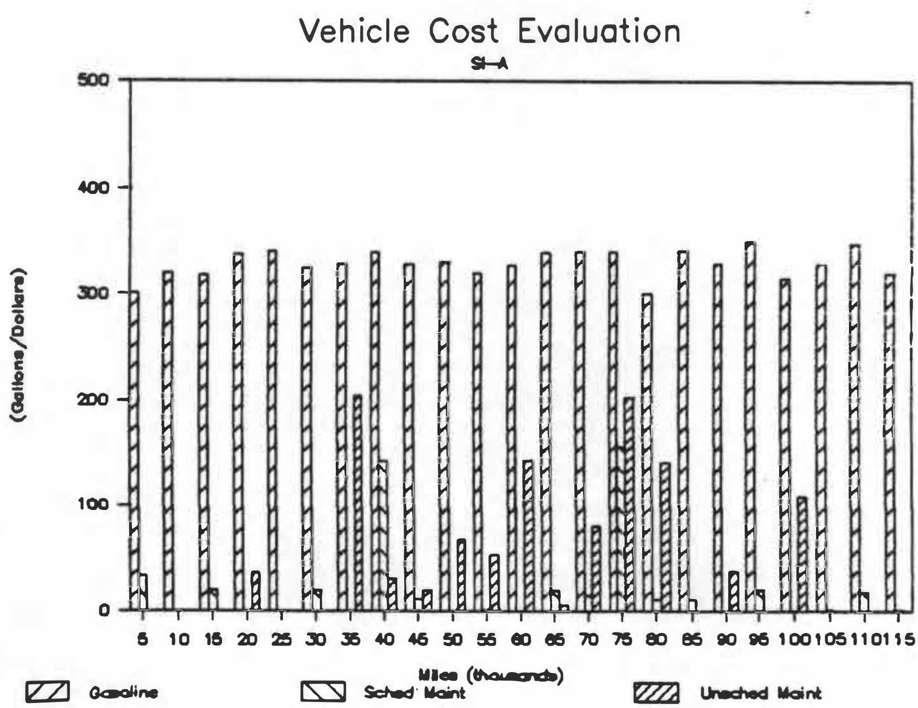
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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SI-A
500
400
300
200
100
0
(Gallons/Dollars)
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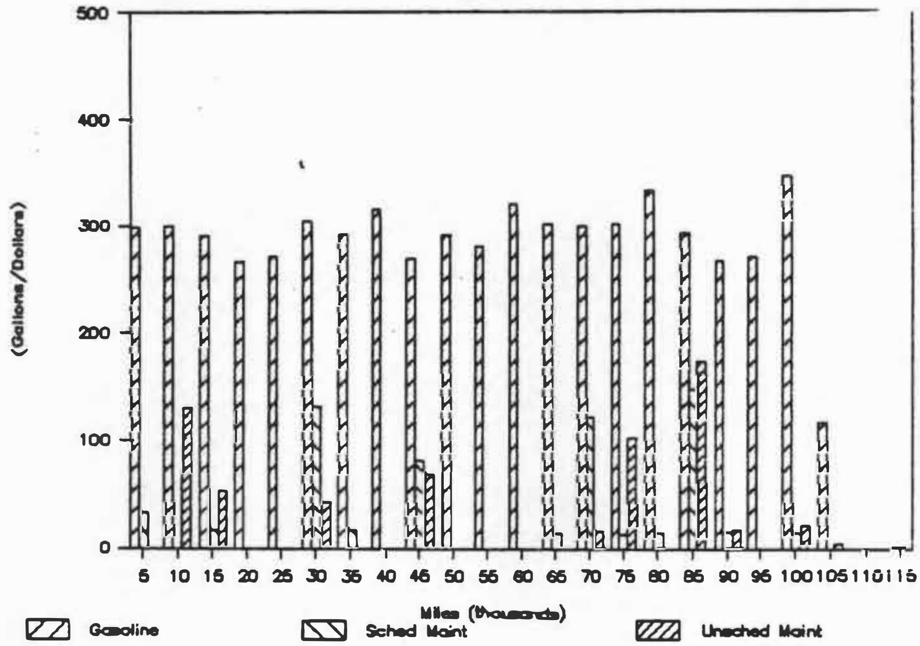
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint

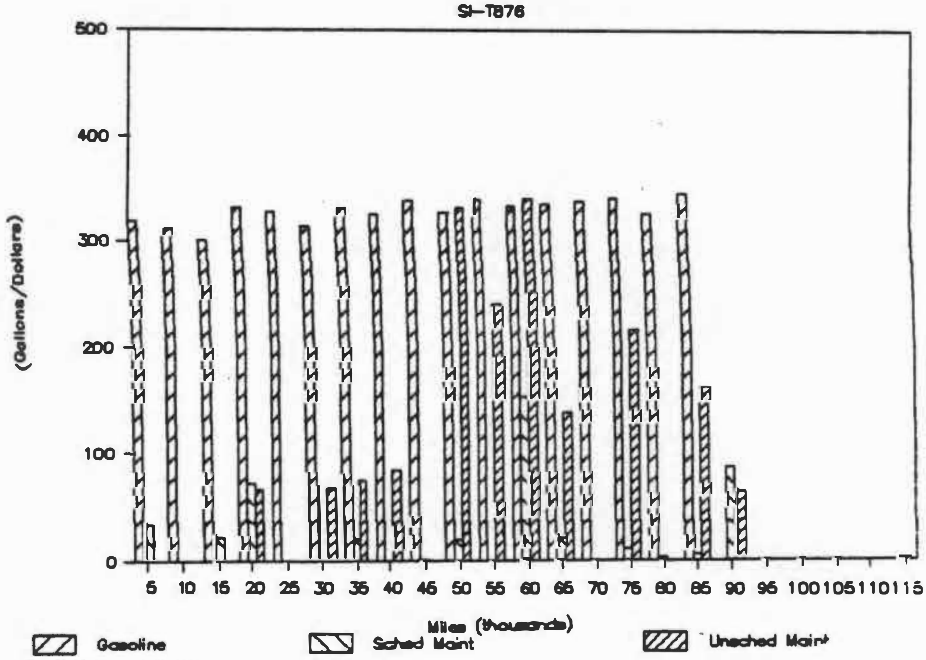
Vehicle Cost Evaluation

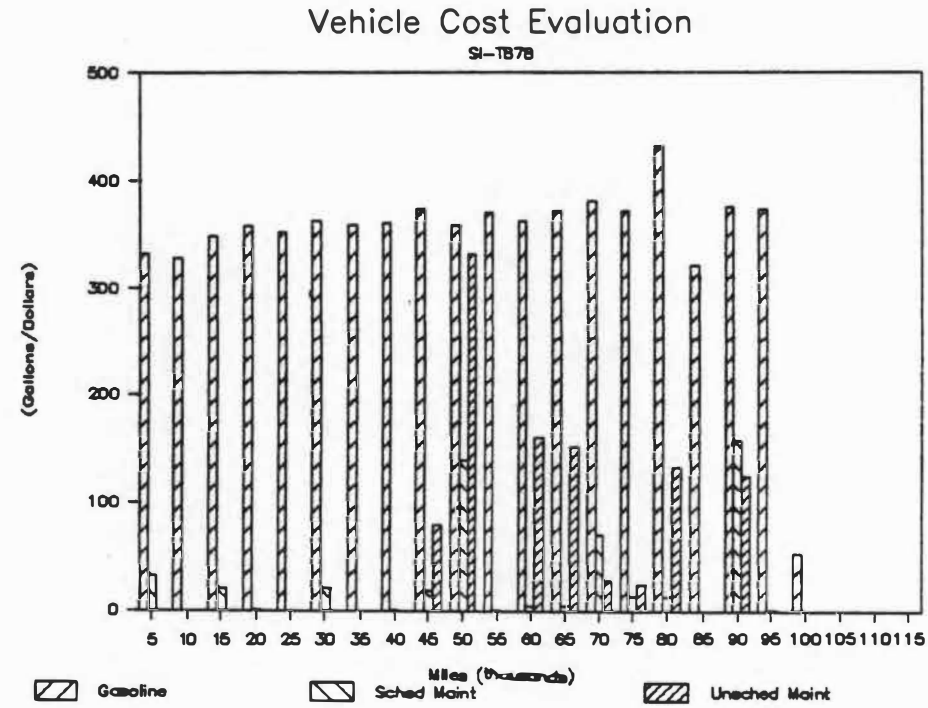
SI-T799



Vehicle Cost Evaluation

SI-T876

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200
300
400
500
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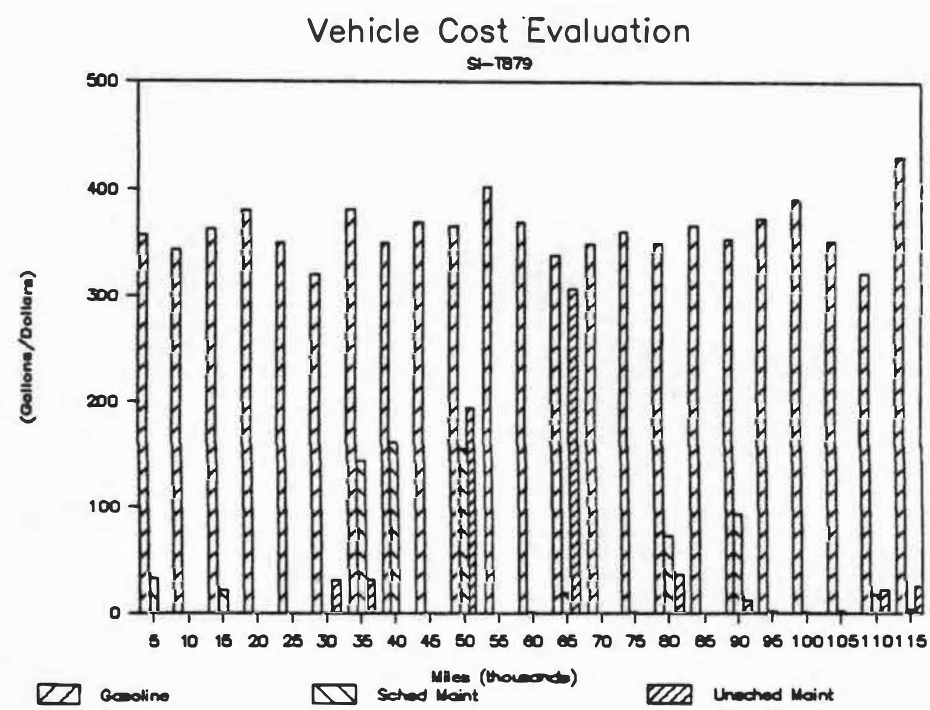
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint


Vehicle Cost Evaluation
SI-TB79
(Gallons/Dollars)
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100
200
300
400
500
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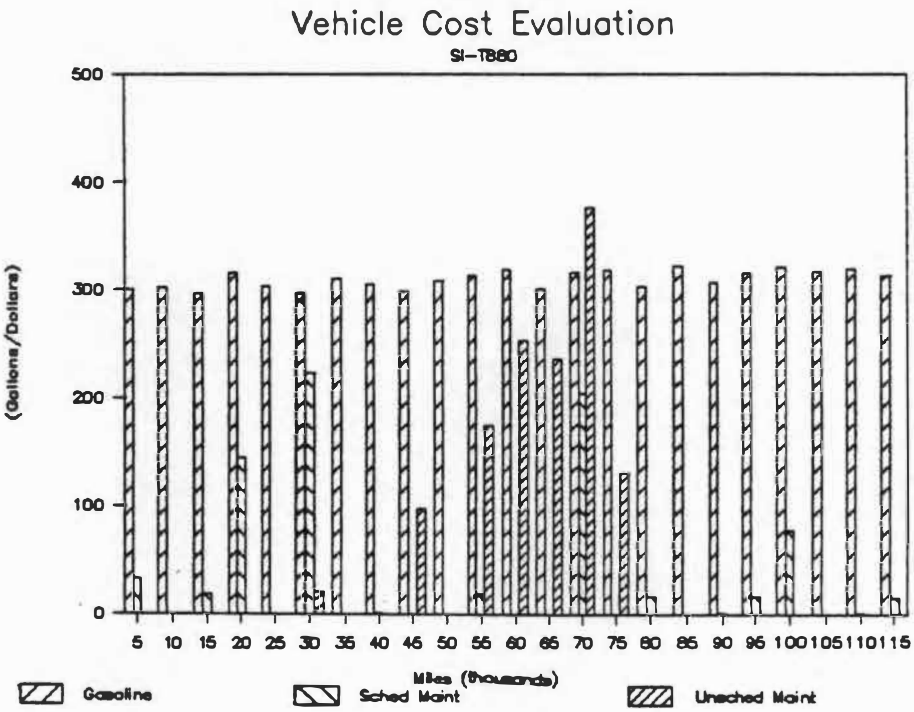
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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300
200
100
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(Gallons/Dollars)
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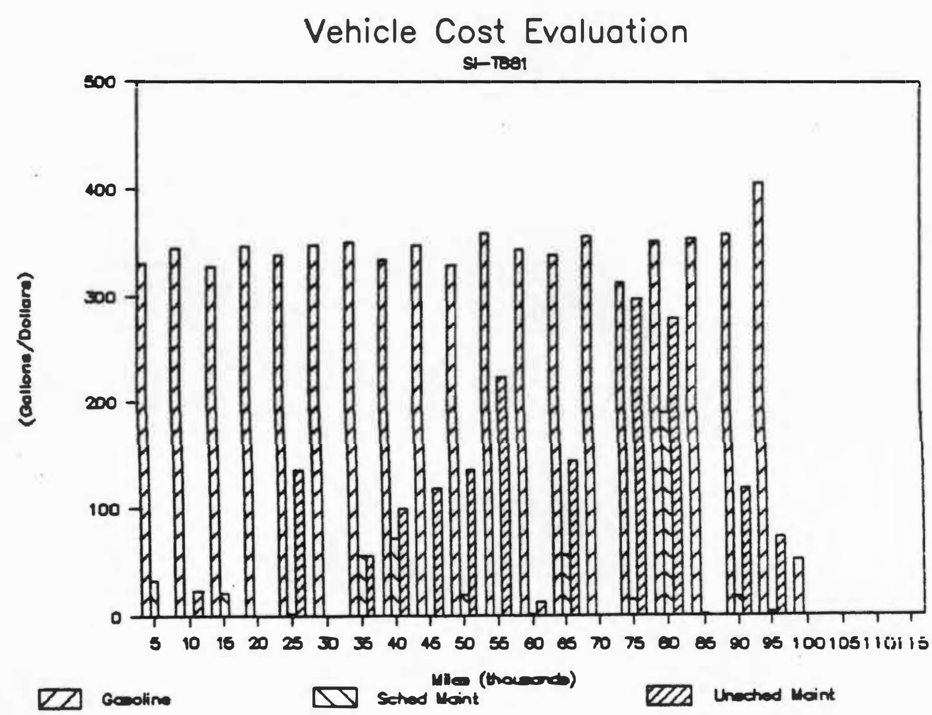
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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300
200
100
0
(Gallons/Dollars)
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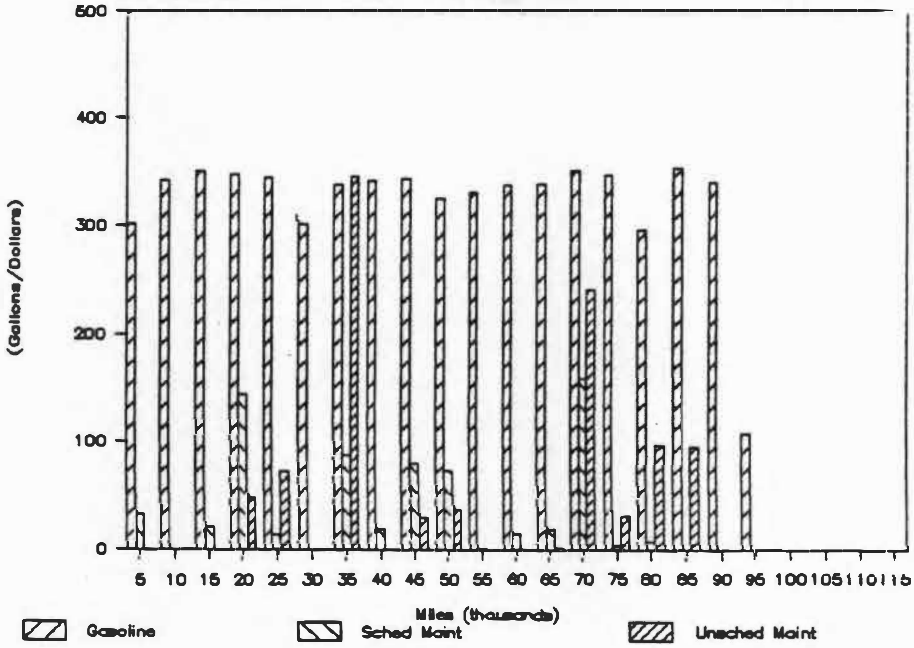
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint

Vehicle Cost Evaluation

SI-T882



Vehicle Cost Evaluation

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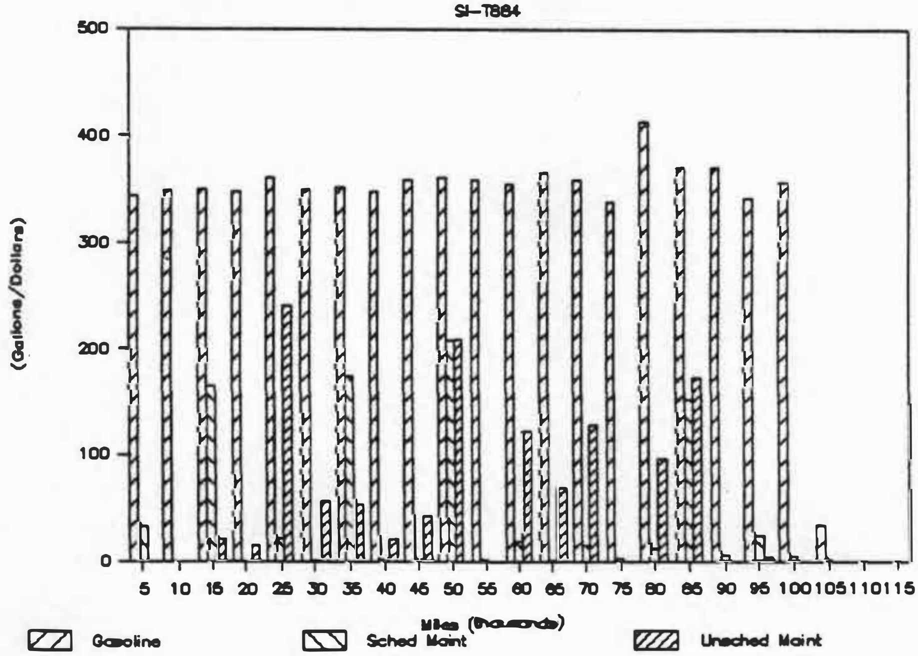

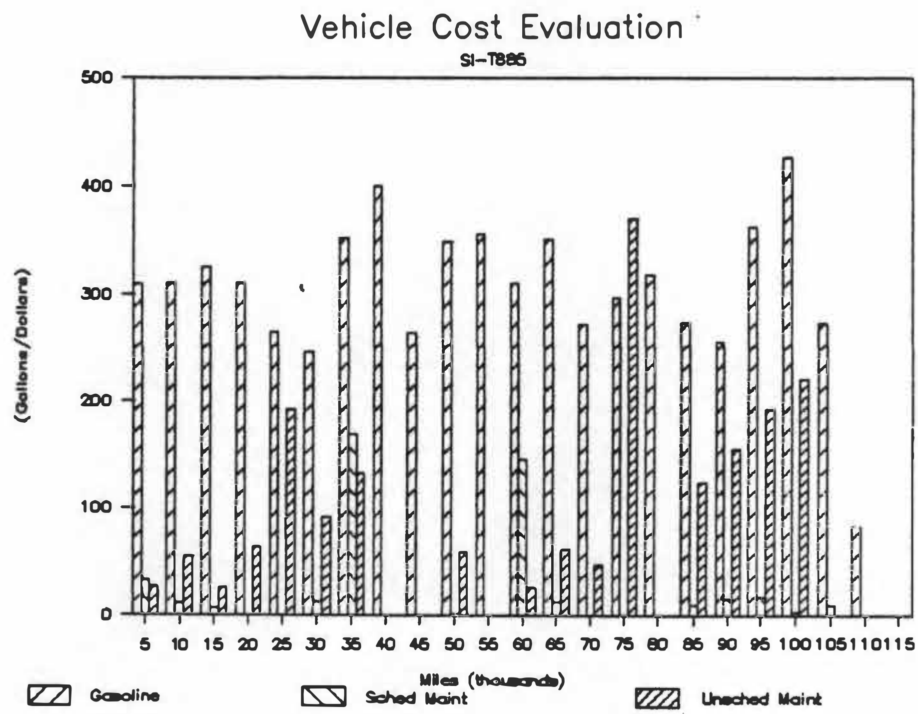

Vehicle Cost Evaluation
SI-T885
500
400
300
200
100
0
(Gallons/Dollars)
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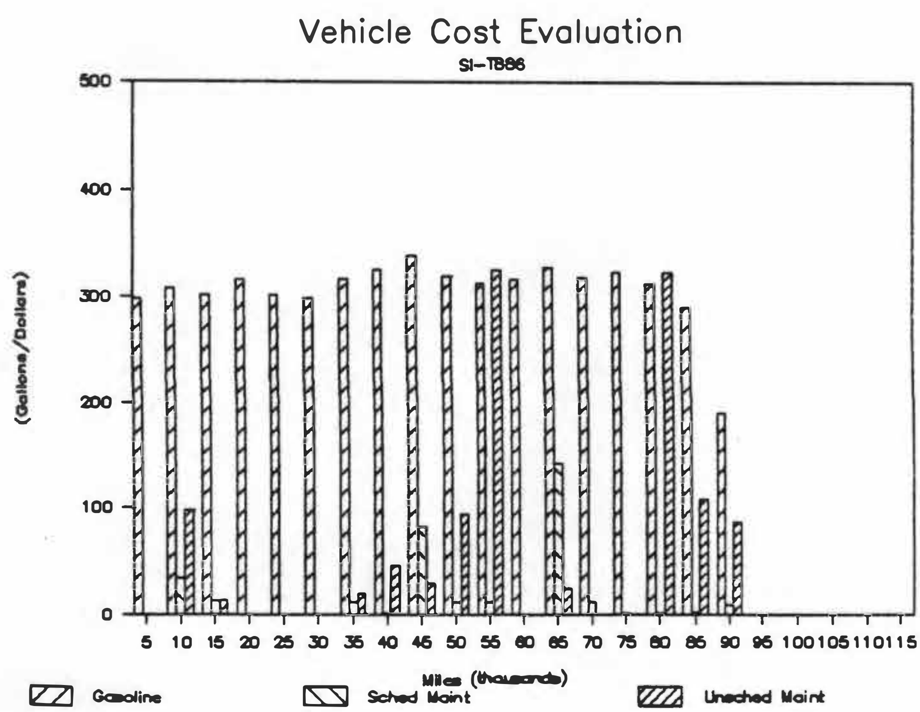
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint



Vehicle Cost Evaluation
SI-T886
500
400
300
200
100
0
(Gallons/Dollars)
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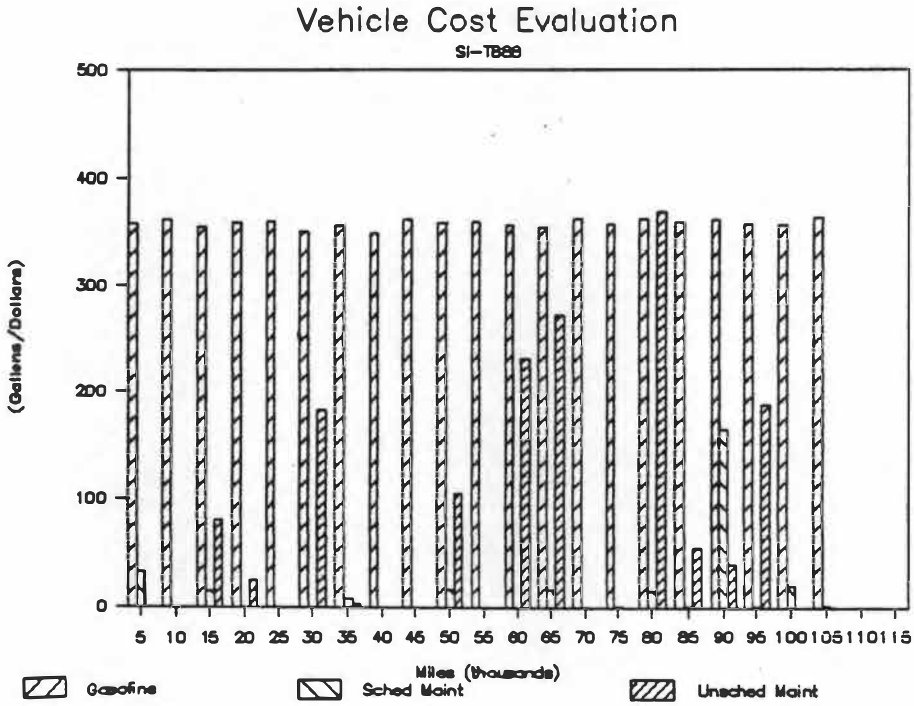
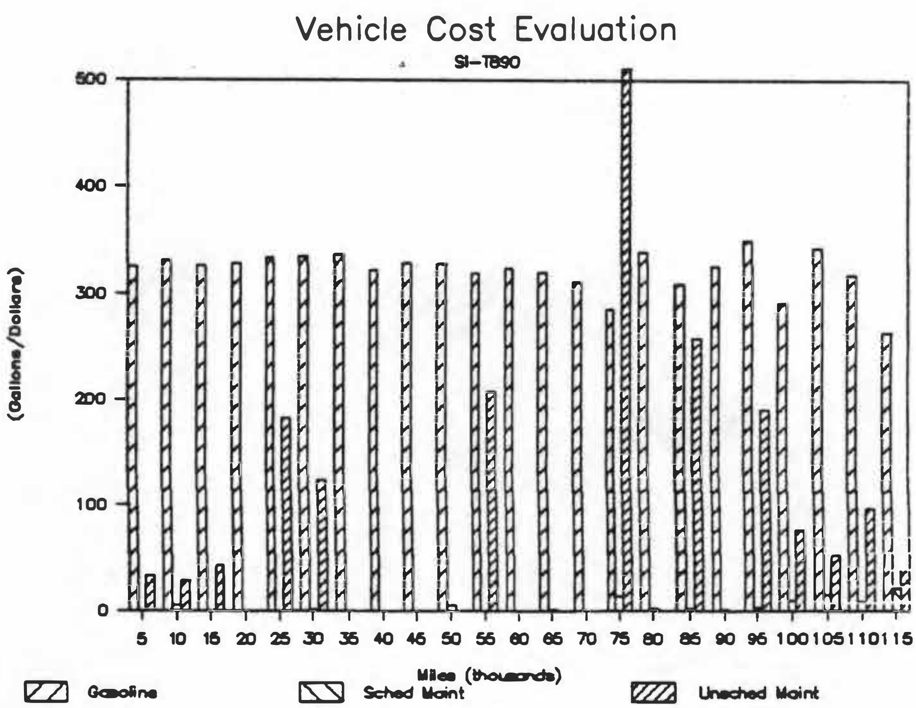
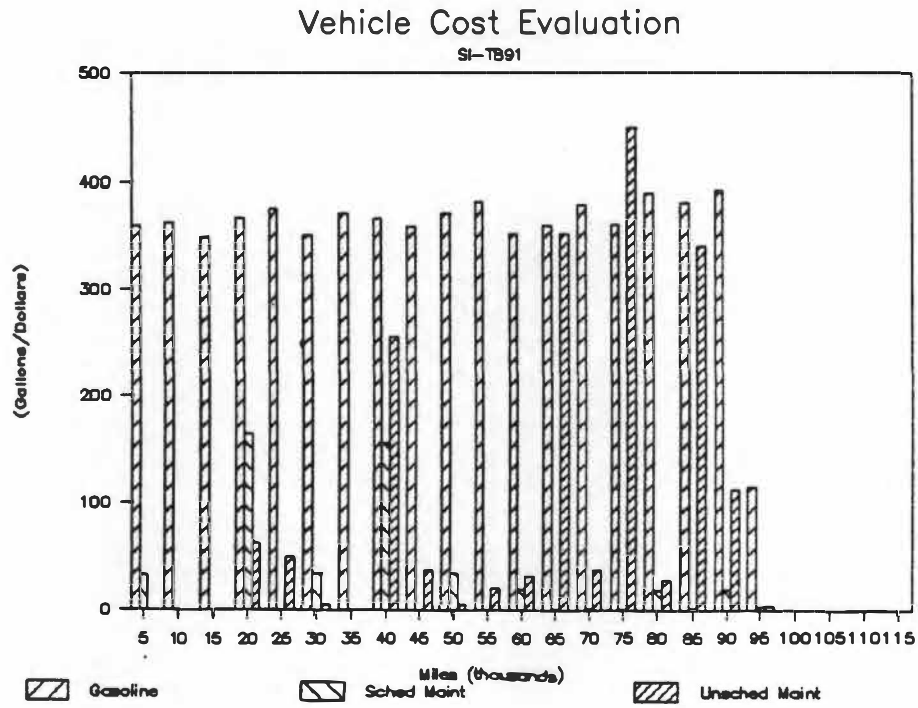
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint



Vehicle Cost Evaluation
SI-T888
(Gallons/Dollars)
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint



Vehicle Cost Evaluation
SI-T890
(Gallons/Dollars)
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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SI-TB91
(Gallons/Dollars)
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300
200
100
0
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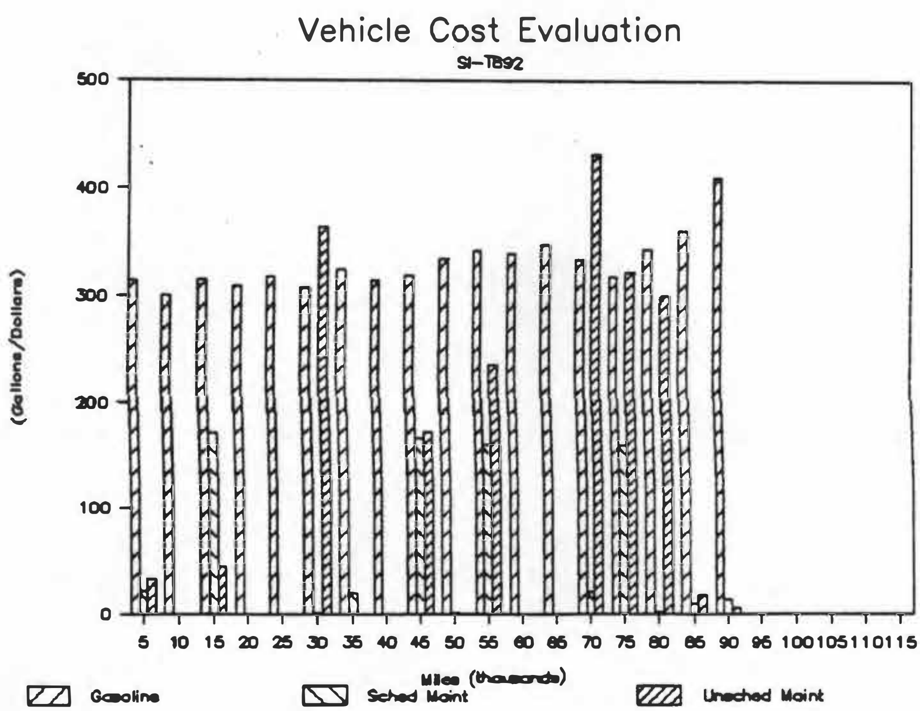
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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SI-TB92
(Gallons/Dollars)
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300
200
100
0
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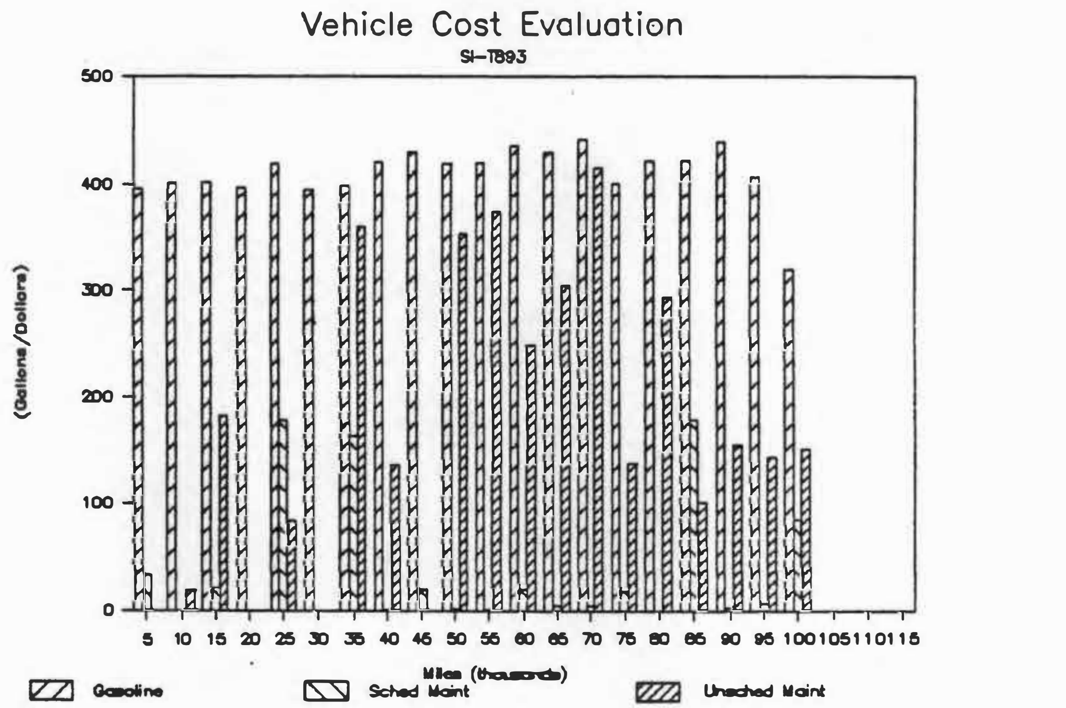
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint


Vehicle Cost Evaluation
SI-T893
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400
300
200
100
0
(Gallons/Dollars)
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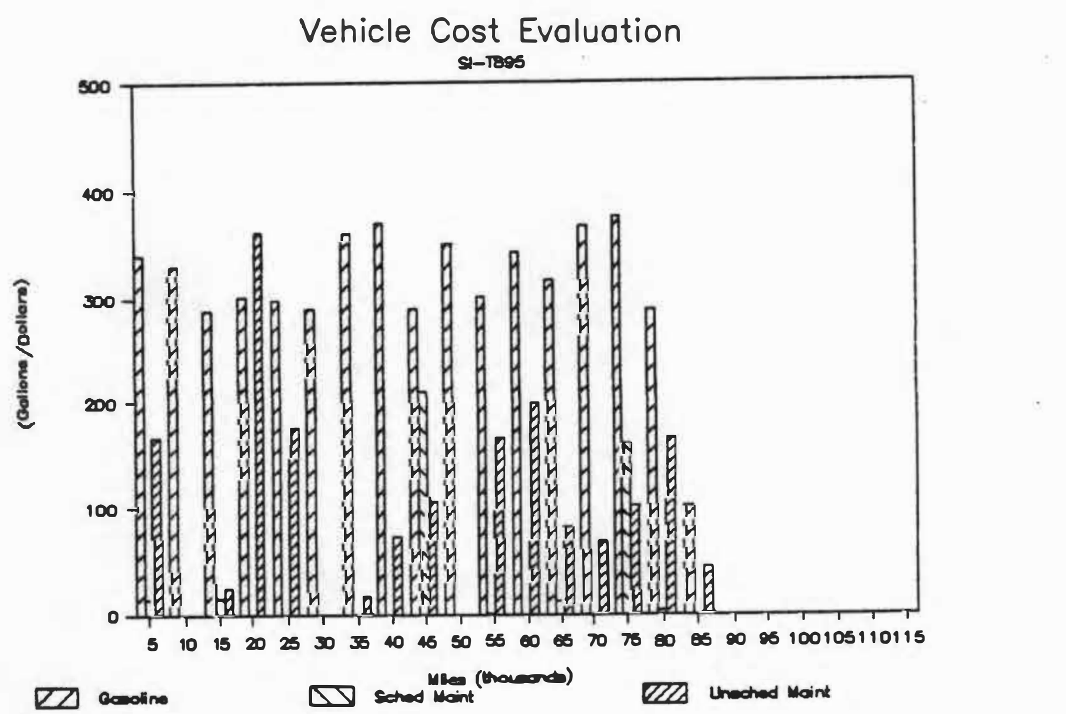
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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300
200
100
0
(Gallons/Dollars)
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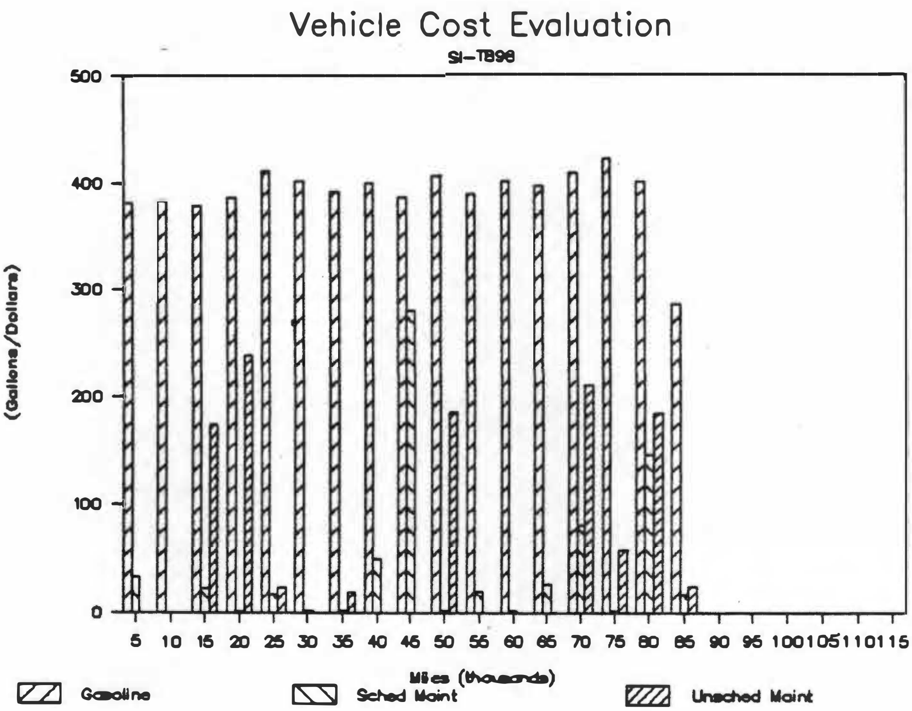
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint


Vehicle Cost Evaluation
SI-TB98
(Gallons/Dollars)
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400
300
200
100
0
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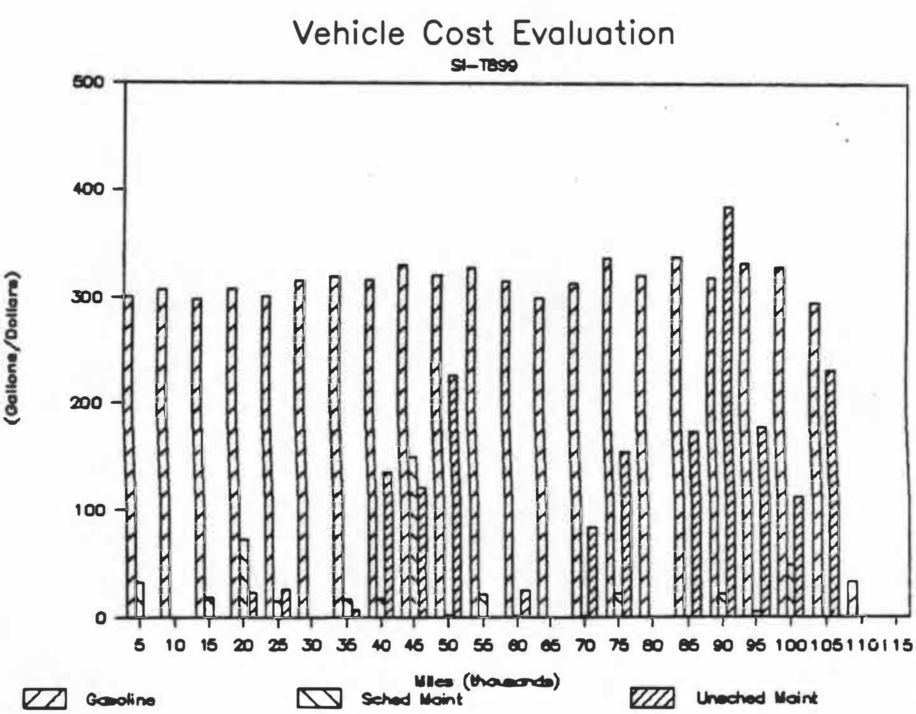
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint


Vehicle Cost Evaluation
SI-TB99
(Gallons/Dollars)
500
400
300
200
100
0
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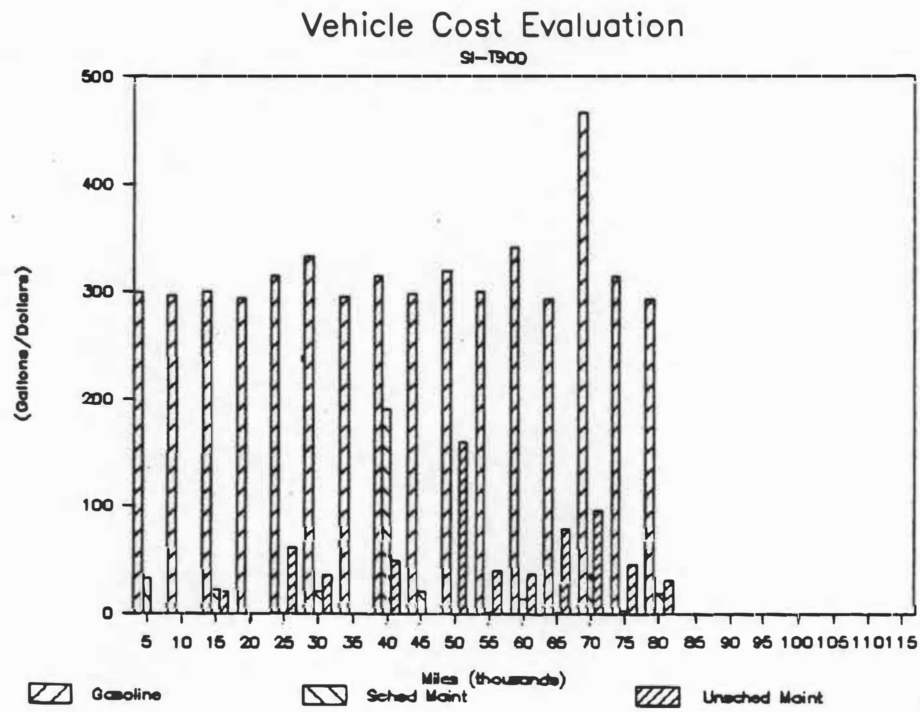
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint


Vehicle Cost Evaluation
SI-T900
(Gallons/Dollars)
500
400
300
200
100
0
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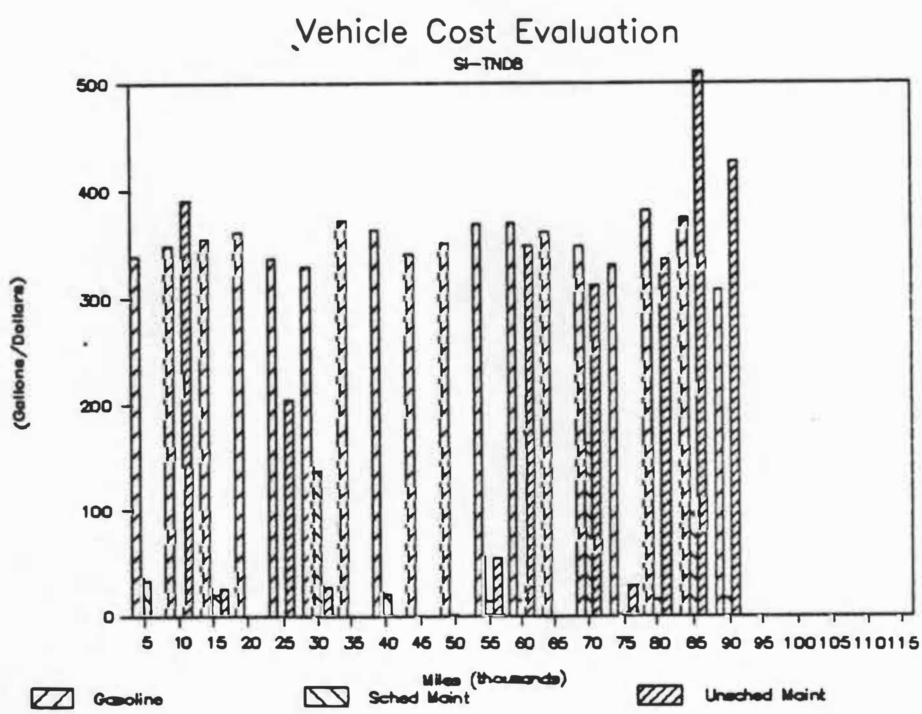
Miles (thousands)
Gasoline
Sched Maint
Unsched Maint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SI-TND8
(Gallons/Dollars)
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400
300
200
100
0
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Miles (thousands)
Gasoline
Sched Maint
Unsched Maint

APPENDIX C

MOTOR VEHICLE MAINTENANCE REPORT

TAG NUMBER ____________

3 LETTER COLOR CODE ________

DISTRICT 8 DOT CODE 92 MVM CODE B-4

4 LETTER CODE "MAKE" ____________ YEAR 19____

ASSIGNED TO: ____________________________

MONTH ____________ YEAR ____________

ENDING MILEAGE ____________

STARTING MILEAGE ____________

MILES DRIVEN THIS MONTH ____________

MILEAGE LAST OIL CHANGE ____________

TENNESSEE BUREAU OF INVESTIGATION
MOTOR VEHICLE MAINTENANCE REPORT

STATE GASOLINE		COMMERCIAL GASOLINE		MOTOR OIL		WASH	LUBE	TRANS. FLUID		NO. NEW TIRES	TIRE COST	PARTS AND REPAIRS	MILEAGE	DATE
GALLONS		GALLONS	COST	QUARTS	COST			QTS	COST					

(OVER)

VITA

Curtis Lee Sturgill was born in Lee County, Virginia on July 15, 1943. He graduated from Appalachian High School in 1963. In September, 1964 he entered the United States Army and served in Korea and Vietnam until September, 1968 when he was honorably discharged. From September, 1969 through July, 1971 he was with the Bristol, Tennessee Police Department. He joined the Tennessee Highway Patrol in July, 1971 and was stationed in Greeneville and Kingsport until August, 1977. While employed with the Tennessee Highway Patrol he received his Associate Degree in Criminal Justice from Walters State Community College in 1975 and graduated from East Tennessee State University in 1977 with a Bachelor of Science in Criminal Justice. In 1977, he joined the Tennessee Bureau of Investigation and was stationed in the Upper East Tennessee area. He received his Masters of Arts degree in Secondary Education in 1982. He is currently a Criminal Investigator with the Tennessee Bureau of Investigation and is the resident agent for Knox and Anderson counties.