EFFECTIVENESS OF MILES-PER-GALLON METERS AS A MEANS TO CONSERVE GASOLINE IN AUTOMOBILES

A REPORT TO THE CONGRESS AND THE PRESIDENT
FROM THE
SECRETARY OF TRANSPORTATION
JULY 1976

U.S. DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY
OFFICE OF THE ASSISTANT SECRETARY FOR SYSTEMS
DEVELOPMENT AND TECHNOLOGY

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

JUL 7 1976

The President
The White House
Washington, D. C. 20500

Dear Mr. President:

Pursuant to Section 512(a) of the Motor Vehicle Information and Cost Savings Act, as amended by the Energy Policy and Conservation Act (PL 94-163), I am transmitting this report on "Effectiveness of Miles-Per-Gallon Meters As A Means To Conserve Gasoline In Automobiles."

Respectfully,

William T. Coleman, Jr.

Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

JUL 7 1976

Honorable Nelson A. Rockefeller
President of the Senate
United States Senate
Washington, D. C. 20510

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Sincerely,

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Enclosure

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

JUL 7 1976

Honorable Carl Albert
Speaker of the House of Representatives
Washington, D. C. 20515

Dear Mr. Speaker:

Pursuant to Section 512(a) of the Motor Vehicle Information and Cost Savings Act, as amended by the Energy Policy and Conservation Act (PL 94-163), I am transmitting this report on "Effectiveness of Miles-Per-Gallon Meters As A Means To Conserve Gasoline In Automobiles."

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PREFACE

This report on miles-per-gallon meter effectiveness is submitted in response to the Motor Vehicle Information and Cost Savings Act as amended by the Energy Policy and Conservation Act (PL 94-163) which states:

> Sec. 512.(a) Within 180 days after the date of enactment, the Secretary shall prepare and submit to the Congress and the President a comprehensive report setting forth findings and containing conclusions and recommendations with respect to (1) a requirement that each new automobile be equipped with a fuel flow instrument reading directly in miles per gallon, and (2) the most feasible means of equipping used automobiles with such instruments. Such report shall include an examination of the effectiveness of such instruments in promoting voluntary reductions in fuel consumption, the cost of such instruments, means of encouraging automobile purchasers to voluntarily purchase automobiles equipped with such instruments, and any other factor bearing on the cost and effectiveness of such instruments and their use.

This report was prepared by the Transportation Systems Center, Cambridge, Massachusetts, under the direction of the Office of the Assistant Secretary for Systems Development Technology.

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This report is the response of the Department of Transportation to a requirement of the Energy Policy and Conservation Act (PL 94-163) for an assessment of fuel flow instruments reading directly in miles-per-gallon (mpg). The Act requests conclusions and recommendations with respect to:

1) a requirement that each new automobile be equipped with a fuel flow instrument reading directly in miles-per-gallon, and

2) the most feasible means of equipping used automobiles with such instruments.

It calls for examination of:

1) the effectiveness of such instruments in promoting voluntary reductions in fuel consumption,

2) the cost of such instruments,

3) the means of encouraging automobile purchasers voluntarily to purchase automobiles equipped with such instruments, and

4) any other factors bearing on cost and effectiveness of such instruments and their use.

BACKGROUND

A miles-per-gallon (mpg) meter is an instrument that measures and displays to the driver the fuel economy of his car in miles per gallon. The device uses sensors to measure the fuel flow in gallons per hour and the speed in miles per hour. These two measurements are processed electronically, and the numerical results in miles-per-gallon are displayed on a meter. The driver can directly see the effects of his driving operations, i.e., accelerating, braking, hill climbing, speed, etc., upon fuel

economy and can use this information to adjust these operations to improve fuel economy.

FINDINGS

- Conditions on urban and suburban streets, such as low speed, stop-and-go driving, and uneven cruising speeds and congested traffic, prevent the driver from making the most effective use of an mpg meter to improve fuel economy. In particular, city driving requires the driver's close attention to traffic, and he will find it difficult to devote much attention to an mpg meter. Over one-half of all vehicle miles traveled takes place on urban and suburban streets.
- Miles-per-gallon meters may be more useful in the one-third of all mileage driven on rural highways. They could help the driver to determine economical cruise speed and techniques for accelerating, decelerating and hill-climbing.
- A field evaluation of mpg meters currently being conducted with Department of Transportation sponsorship has collected fuel economy data on 400,000 miles of travel by 146 cars, half of which are equipped with mpg meters. These vehicles are driven daily under a broad spectrum of driving conditions. To date, the field evaluation has revealed no statistically significant increase in fuel economy due to the presence of the meters.
- Mpg meters compete for the driver's attention, and, possibly, could be a safety hazard. Redesign of the meter display may be a way to reduce the magnitude of this disadvantage.
- Installation of mpg meters during factory assembly of new cars is estimated by one developer to be approximately $75. The ease or difficulty with which an mpg meter can be installed in a used car varies with the configuration of the car, but an experienced mechanic with the proper tools could do the job in about six hours. Proper installation

is important since the fuel line is involved, and improper installation could cause either a fire hazard or blockage of the fuel line. At an hourly rate of $15 for a qualified mechanic, installation would cost $90 for labor plus a meter cost of $40 to $190.

CONCLUSIONS

- This study did not establish that use of mpg meters in new cars would save enough fuel to measurably reduce the nation's fuel consumption and/or to offset their own cost within a reasonable period of time, where the reasonable period for cost offset was taken to be 3 years (i.e., first ownership).
- It has not been established that use of mpg meters will save significant amounts of fuel in average vehicles driven over average operating conditions. Moreover, mpg meters have little potential for promoting fuel savings under congested traffic conditions.
- It would require about three years for a new large car or about six years for a new small car to pay for a factory installed meter if a 5% fuel economy increase could be obtained. For the least expensive commercially available mpg meters, costing about $130 installed in a used car, fuel economy increases of about 12% would be needed to cover the installed cost of the mpg meter within three years. These percentage increases in fuel economy are hypothetical examples.
- Means for encouraging consumers to purchase automobiles equipped with mpg meters include advertising, driver education, tax benefits, and subsidies to manufacturers of meters. These measures are only likely to be effective when it is shown that mpg meters are effective, economical, convenient and safe to use.

RECOMMENDATIONS

- There should be no requirement to install mpg meters in new cars.
- The Federal government should take no action to promote the installation and use of mpg meters in used cars at this time.

1.0 INTRODUCTION

1.1 BACKGROUND

This report is submitted in response to the Motor Vehicle Information and Cost Savings Act as amended by the Energy Policy and Conservation Act (PL 94-163) which states:

> Sec. 512.(a) Within 180 days after the date of enactment, the Secretary shall prepare and submit to the Congress and the President a comprehensive report setting forth findings and containing conclusions and recommendations with respect to (1) a requirement that each new automobile be equipped with a fuel flow instrument reading directly in miles per gallon, and (2) the most feasible means of equipping used automobiles with such instruments. Such report shall include an examination of the effectiveness of such instruments in promoting voluntary reductions in fuel consumption, the cost of such instruments, means of encouraging automobile purchasers to voluntarily purchase automobiles equipped with such instruments, and any other factor bearing on the cost and effectiveness of such instruments and their use.

Prior to the enactment of PL 94-163, the President's Voluntary Fuel Economy Program, initiated in 1974, had established a goal of increasing the fuel economy of the 1980 new car fleet by 40% over that of the 1974 new car fleet.[1*] This voluntary program depended on the willingness and capability of the automobile industry to design and manufacture new vehicles in accordance with legislated safety and emissions standards and fuel economy guidelines. Both the voluntary program and the mandated fuel economy standards of PL 94-163 affect the fuel economy of new vehicles.

Section 512(a) of the Energy Policy and Conservation Act demonstrates Congress' concern with reducing the fuel consumption of the existing automobile fleet and its desire for more information regarding the utility of driver-aid devices for promoting

*Superscripts refer to references listed in Appendix C.

voluntary reduction in fuel consumption. During 1974, private passenger cars in the U.S. were driven more than 995 billion miles and consumed approximately 74 billion gallons of gasoline.[2] For each percentage point reduction in total fuel consumption of cars, approximately 740 million gallons of gasoline would be saved annually.

Both industry and the Government are investigating techniques for reducing the automotive fleet's fuel consumption by influencing driving behavior and trip patterns. Since the popularity of the automobile as the primary mode of travel in the U.S. is not expected to diminish, improving the fuel efficiency of automobiles already in use by improving driver techniques would save significant amounts of petroleum.

Devices called driver aids may provide the necessary information and stimulus to influence driving behavior. A number of types of devices can display information regarding the relative operational fuel efficiency of driver actions. The driver could use this information to avoid uneconomical driving practices. One such device is a fuel flow meter reading directly in miles per gallon, commonly referred to as a miles-per-gallon (mpg) meter. The mpg meter is the principal subject of this report. Other devices are described in Appendix A.

The Federal Government has recently initiated programs to investigate fuel-efficient driving techniques, to determine their effectiveness in realistic driving situations, and to ascertain the applicability and utility of various driver aid devices for training in and continued use of these techniques.[3] At present, however, there are insufficient data available to permit accurate assessment of the fuel-saving potential of any of these strategies.

1.2 SCOPE

This report evaluates the advisability of establishing legislation for a requirement to equip new automobiles with mpg meters. This report also examines the means of equipping used automobiles

with mpg meters on a voluntary basis. Findings and recommendations are based on an analysis of the utility and safety of currently available mpg meters as a driver aid for saving fuel. The report addresses the specific questions posed by Congress regarding the mpg meter. Factors related to the cost and fuel saving effectiveness, means of encouraging voluntary purchase of mpg meter equipped automobiles, implications of mandatory mpg meter installation, and present conclusions and recommendations are discussed.

Other driver aids are discussed in Appendix A. Appendix B presents a summary of responses to the *Request for Information and Public Comment on Fuel Flow Meters*.

2.0 MPG METERS

This chapter describes currently available mpg meters, their installation requirements and costs. It also discusses the utility and safety of the meters. Improvements to correct limitations and disadvantages of present commercially available mpg meters are also discussed.

2.1 CURRENTLY AVAILABLE MPG METERS

Mpg meters are instruments that measure and display to the driver the fuel economy of a car in miles-per-gallon as it is driven. If mpg meters are to be useful, they must provide the driver with information of sufficient clarity and timeliness to enable him to select fuel-efficient, safe driving strategies. He should be able to recover the cost of the mpg meter through fuel savings within a reasonable period of time, say 3 years.

To our knowledge, there are three U.S. manufacturers of mpg meters: FloScan Instrument Company, Inc., Seattle, Washington; Miles Instrument Co., Milwaukee, Wisconsin; and SpaceKom, Inc., Santa Barbara, California. The meters are not available as optional equipment for new cars, but only as add-on equipment, through auto-accessory outlets. They include two transducers,* a signal processor and a display unit. One transducer is coupled to the speedometer drive or the distributor and measures speed (miles-per-hour). The other transducer is in the fuel line and measures fuel flow (gallons-per-hour). This information is processed electrically, and the results are displayed as miles per gallon on a digital or analog display meter mounted on the dashboard or steering column. Figure 2-1 shows a typical installation. Figure 2-2 shows a digital and an analog display meter. Table 2-1 lists

*A transducer is a device actuated by power from one physical system (e.g. mechanical) to provide power to another physical system (e.g. electrical).

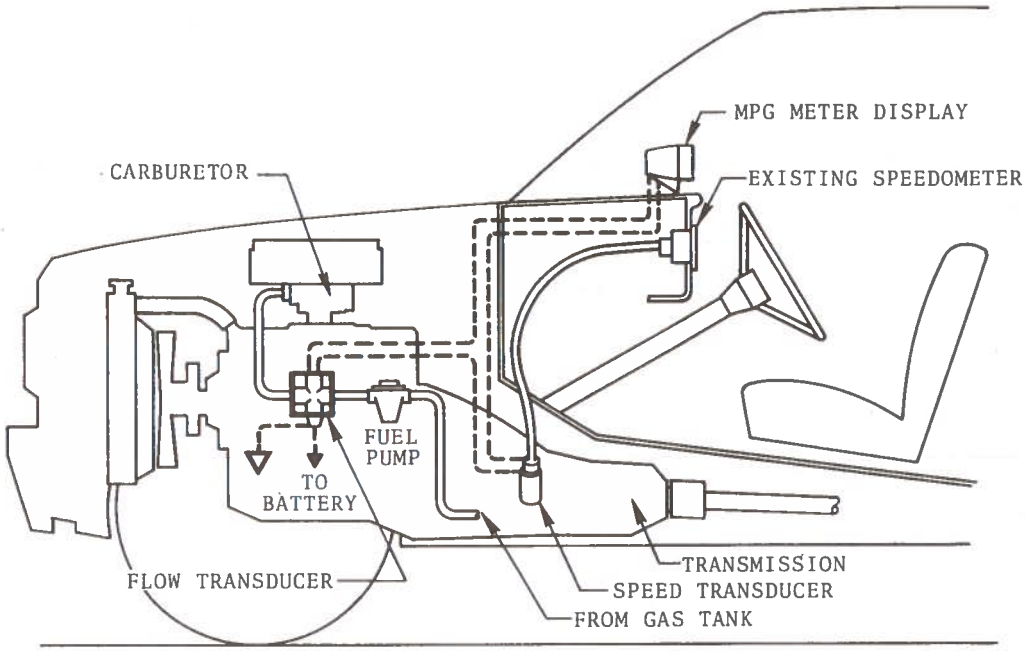
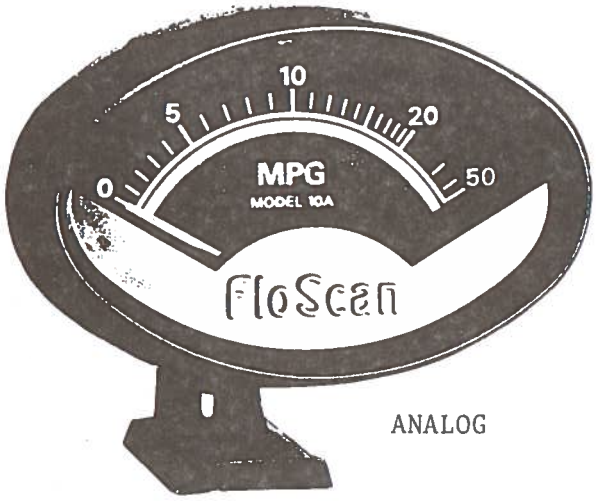
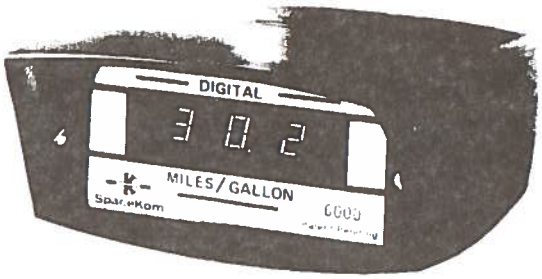


Figure 2-1. Typical MPG Meter Installation



ANALOG



DIGITAL

Figure 2-2. Digital and Analog MPG Meter Displays

TABLE 2-1. COMMERCIALLY AVAILABLE MPG METERS

Company	FloScan Instrument Co.	Miles* Instrument Co.	SpaceKom, Inc.
Model No.	(a) 10A with flow transducer Model 100 (b) 10A with flow Transducer Model 255-PB-15	None	(c) 4040 (d) 6000
Speed Transducer	AC Generator. Frequency proportional to speed	Speed indication taken from distributor. Relates to speed only in high gear	DC Generator. Voltage proportional to speed.
Flow Transducer	Digital (propeller)	Analog (variable orifice)	(c) Analog (ball and spring) (d) Digital (ball in race)
Display	Analog (cross-coil mA Meter)	Analog (mA Meter)	(c) Analog (mA Meter) (d) Digital
Cost+	(a) $ 79.95 (b) $189.95	*	(c) $39.50 (d) $99.50

*Not currently in production.

+Not installed.

the various commercial models, their salient features and costs. Since there are significant differences in the methods of measurement and display employed in the different mpg meters, the various components are considered separately.

2.1.1 Speed Transducers

In the SpaceKom and FloScan models, the speed transducer is connected to the speedometer cable between the transmission and speedometer. Its housing contains a stationary coil of wire (stator) within which a permanent magnet (rotor) rotates at the speed of the speedometer drive. A measure of the rotational speed is obtained from the magnitude of the voltage or the frequency generated in the coil. The device can measure speed as accurately as the speedometer of the vehicle can. Factors such as tire inflation pressure and tire temperature affect the accuracy of the speed measurement, but it is generally accurate to $\pm$2%. In the Miles model, a measure of the speed is obtained electrically from the distributor; since the distributor rotates at the speed of the engine, this method indicates vehicle speed only when the transmission is in high gear.

2.1.2 Fuel-Flow Transducers

The fuel-flow transducer is connected in the fuel line between the fuel pump and the carburetor. Two types of analog and two types of digital transducers are used. In the analog types, the value of a variable resistance is changed by the linear displacement of a ball or slug. In the digital types, a ball or propeller interrupts a beam of light at a rate proportional to the fuel flow. The change in light intensity is converted to an electrical signal. Transducers are available to cover fuel-flow ranges of all available automobiles.

Manufacturers of mpg meters state that the accuracy of their meters is $\pm$2% (at 15 mpg). Tests conducted for the Department of Transportation by the National Bureau of Standards under

temperature, vibration, and electrical interference conditions typical of the automotive environment indicate that errors up to 50% or more can occur.[4]

2.1.3 Electronic Signal Processing

The electronic circuitry processes the electrical signals from the speed and fuel-flow transducers to produce a signal that is directly proportional to miles-per-gallon or which can be related to miles-per-gallon on a display device.

It is simpler to process signals from analog transducers than to process signals from digital transducers. Both available analog fuel-flow transducers (SpaceKom and Miles) change an electrical resistance in proportion to the fuel flow rate. The voltage generated by a speed transducer when applied to this resistance produces a current which is linearly proportional to miles per gallon.

Digital flow transducers produce a train of electrical pulses at a rate proportional to the fuel flow rate. The FloScan unit filters the digital pulse train and applies it to one coil of a cross-coil* display meter. The other coil is excited by the filtered signal from the speed transducer. The scale of the display meter is non-linear and tends to be crowded at high mpg values.

The SpaceKom unit converts the dc output of the speed transducer to a pulse train with a repetition rate proportional to speed. The fuel-flow transducer produces a pulse train proportional to fuel flow. Over a given period of time, the total number of pulses from the speed transducer is proportional to distance (miles) and the total number of pulses from the fuel-flow transducer is proportional to fuel consumed (gallons). The system is

*In a cross-coil meter, two coils are mounted orthogonally on an armature free to rotate in the magnetic field of a permanent magnet.

designed to meter the distance traveled corresponding to a preset amount of fuel consumed (e.g., 0.01 gallon), with the digital display calibrated in miles per gallon.

2.1.4 Display Meters

Mpg meters are available with digital or analog displays. A digital display is more expensive and demands more of the driver's attention. The digital reading is updated every 2 to 15 seconds depending on the fuel-flow rate. At low fuel-flow rates, corresponding to slow driving speeds, the reading may change just once in fifteen seconds, and the driver must watch the meter intermittently for at least that period to determine how his actions affect fuel economy. Reading an analog meter is less demanding on the driver as it is continually being updated.

2.2 INSTALLATION OF MPG METERS

The ease of installing an mpg meter in a used car depends on the lay-out and accessibility of the engine compartment and on finding a satisfactory location for the display meter. Four separate items must be installed: the speed transducer, the fuel-flow transducer,* the display meter and the interconnecting electric wiring. Experience in mpg meter field studies performed for DOT (see paragraph 2.3.2) indicates that a trained mechanic who has made repeated similar installations and who has the appropriate tools and fittings can install an mpg meter in about 6 hours. A mechanic with no previous experience or a mechanically inclined layman would probably take much longer.

In some cars, the speed transducer can be installed easily between transmission and speedometer cable. In other cars it must be installed behind the speedometer, a procedure which may require

*Many late-model cars have multiple fuel lines and the fuel flow to the engine cannot be monitored accurately with a single fuel-flow transducer.

removal of the dashboard. Also, the speedometer cable must be completely removed and cut in some cases to accept the transducer.

Some fuel-flow transducers are equipped with a vapor return to minimize vapor bubbles and fluctuations in fuel pump pressure. For these, it may be necessary to install a line back to the gas tank unless the car is already so equipped.

Installation of the fuel-flow transducer and the electrical connections require the greatest care. An improperly installed fuel-flow transducer can cause gasoline leakage, which is a fire hazard, or eventual blockage of the fuel line, which can render the car inoperable. Electrical connection of the mpg meter system must be made to the car battery through a properly rated fuse, to assure against undesirable discharging of the battery, damage to the car's electrical system, or fire.

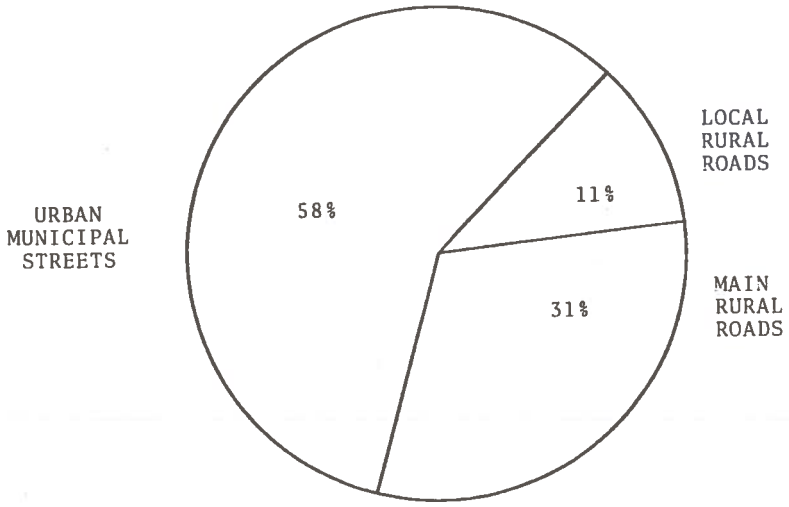
Assuming an hourly rate of $15 and 6 hours of a mechanic's time, installation of an mpg meter would cost at least $90. This amount must be added to the purchase price of the mpg meter, given in Table 2-1, to estimate total cost of an installed mpg meter.

Installation and safety problems would be eliminated and costs reduced if mpg meters were installed on the new-car production line. The display would be located in the instrument cluster. Electrical connections would be included in the wiring harness, and the transducer installation would be subject to industrial design, quality control and inspection procedures.

2.3 UTILITY OF MPG METERS

2.3.1 Conditions of Fuel Use

The length and speed of automobile trips influence fuel economy. A car must be driven 15 to 20 miles (depending on the ambient temperature) before the engine, transmission, bearings and tires reach the temperature where the best fuel economy can be realized.[5] The most economical speed for most modern cars is between 30 and 45 miles per hour.[6] As shown in Figure 2-3, over



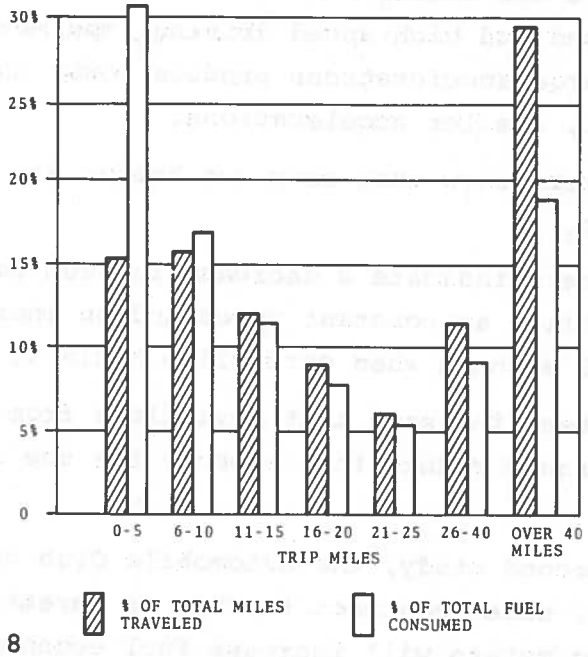
Source: Reference 7

Figure 2-3. Vehicle Miles Traveled (VMT) on Different Type Roadways

one half of the mileage traveled by all cars is on urban streets, where trips are generally too short for the car to warm up completely and where the cars do not travel at the optimum speed. In fact 87% of all trips were less than 15 miles long; the most frequent trip was less than one mile.[8] Figure 2-4 illustrates fuel usage as a function of trip length. It shows that, even though trips of 5 miles or less comprise only 15% of total trip mileage, they consume more than 30% of all fuel used. Thus, for mpg meters to substantially impact fuel economy, they must be usable in urban driving conditions.

2.3.2 Field Studies

A survey of the literature and market place produced no information on the effectiveness of mpg meters for improving fuel economy and, therefore, provided no basis for estimating their utility in this regard. TSC has, therefore, initiated two separate



Source: Reference 8

Figure 2-4. Distribution of Miles Traveled and Fuel Consumed as a Function of Trip Length

field studies of these devices; one to determine if and where they can be used to save fuel, and the other to determine if drivers use them for that purpose.

In the first study, mpg meters were installed in 10 cars owned by TSC staff who use them for commuting and general urban and highway driving. The results of eight weeks of evaluation follow:

- Mpg meters have to be monitored closely to be used effectively.
- Mpg meter indications lag behind the driver's actions that produce them. This lag masks the effects of speed variation on fuel economy. The extent of lag varies from 1 to 5 seconds among the 10 cars.
- When cars accelerate over the short distance common in stop-and-go traffic, the mpg meter indications do not respond sufficiently and quickly enough to assist the driver in selecting economical acceleration rates.

- When the car accelerates under conditions characteristic of open road and high speed driving, mpg meters show that sudden, large accelerations produce lower mpg readings than do gradual, smaller accelerations.
- Mpg meters show that cars get better gas mileage as they warm up.
- Mpg meters indicate a decrease in fuel economy when cars climb hills at constant speed and an increase or maintenance in fuel economy when cars climb hills at decreased speeds.
- Mpg meters indicate that deviations from the 30-45 mph speed range reduce fuel economy for the cars used in TSC tests.

In the second study, the Automobile Club of Southern California (ACSC), under contract to TSC, is investigating whether the use of mpg meters will increase fuel economy. The ACSC is using two groups of seventy-three cars each. One group is equipped with mpg meters. All the cars are mid-size with 350-cubic-inch engines and are permanetnly assigned to individual ACSC employees stationed at the Los Angeles office. They use these cars mainly for commuting and business in the Los Angeles area. They drive an average of 1400 miles a month at an average fuel economy of 13.6 miles per gallon. Mileage and fuel use data will be collected for 12 weeks in the study. Data gathered during the first 6 weeks, representing over 400 thousand miles of travel, is now available and a preliminary analysis was prepared for this report.

The average mileage and fuel economy for each car used in the study were obtained from records of the past year. The median mileage and mpg performance for the 146 cars used in the study were calculated. The cars were randomly divided into two groups. Each group contained approximately the same number of cars with monthly mileage and average mpg performance above and below the median values of the 146 cars. To assure the comparability of the two groups, the mean mpg performance levels were calculated for each, and a "t" test[9] was used to statistically compare them. The

results of the test indicated that there was no reliable difference between the means for the groups. It was concluded that the groups were comparable for the purpose of this test.

The 73 cars in the instrumented group were equipped with FloScan mpg meters (Model #10A) by ACSC mechanics. The meter displays, as shown in Figure 2-5, were mounted on the steering wheel column of the cars.

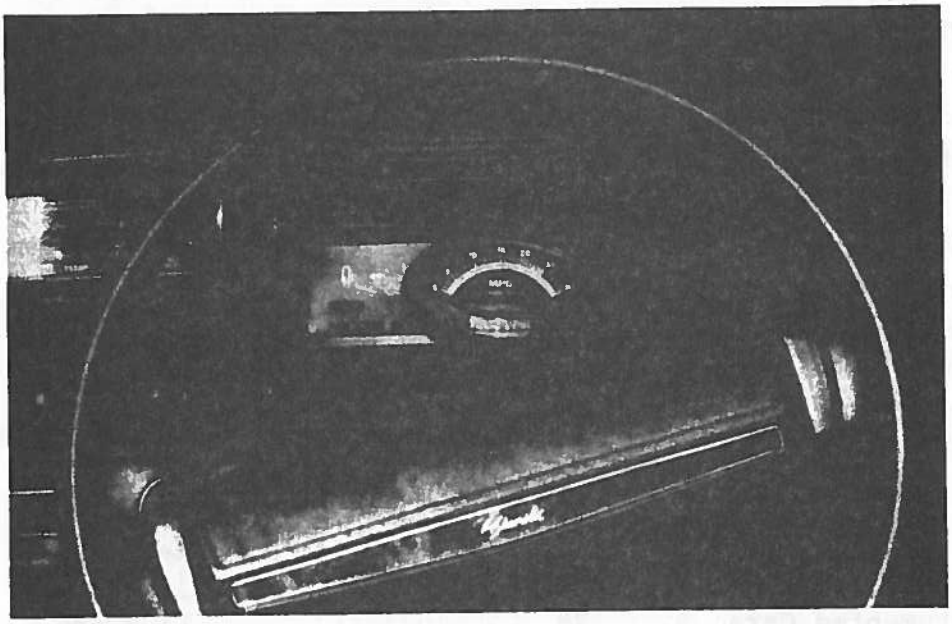


Figure 2-5. MPG Meter Display Mounted on Steering Column

Drivers in both groups were given an EPA booklet on tips for increasing driving economy, a letter describing the purposes of the study, and instructions on the data collection procedures. The drivers in the instrumented group were also told that they could increase their fuel economy by keeping the mpg indicator needle as high on the mpg scale as possible. All drivers were told that at the end of each three weeks of the twelve week data-collection period their fuel economy would be compared with

their past performance, as indicated in the club fuel-use records and they would be paid the dollar value equivalent of the fuel saved over that period. If their fuel economy decreased they would be so informed.

At the start of each three-week data-collection period, each car's gas tank is filled and the mileage from the odometer is recorded. During the period, the driver buys gasoline on a company credit card, as he normally would, and keeps the gas receipts. At the end of the three weeks, the gas receipts are collected, the gas tank refilled, and the odometer reading recorded.

Table 2-2 shows the mean fuel economy of the instrumented and comparison groups of cars and the percentage differences between these values for the first 6 weeks of the study. The table shows that the mean mpg performance was 1.5% higher for the instrumented group, but a "t" test calculated to evaluate this difference indicated that it is not statistically reliable. A difference in mpg performance of this magnitude will occur about 40% of the time by chance.

TABLE 2-2. MPG MEANS FOR INSTRUMENTED AND COMPARISON GROUPS

Test Group	Group Size	Mean MPG (6 weeks)
Instrumented Cars	73	14.0 mpg
Comparison Cars	73	13.8 mpg
	Difference	0.2 mpg (1.5%)

2.3.3 Congested Traffic

The utility of mpg meters in assisting the driver to improve fuel economy in congested traffic is limited. In noncongested urban driving, the devices may be somewhat more useful. The characteristics of congested traffic that limit fuel economy are: stop-and-go driving, uneven cruising speeds, and low speeds. In

addition, it is difficult for the driver to monitor the meter while driving in heavy traffic. General Motors Corp. emphasized these characteristics in their comments (see Appendix B). Furthermore, the meter always reads "0 mpg" when the car is not moving, and fuel is wasted during high-speed idling and revving. It is doubtful, therefore, that mpg meters will promote improved fuel economy in stop-and-go traffic. However, the consistently high fuel-consumption rates indicated during separate short trips might motivate drivers to combine such trips whenever possible.

2.3.4 Highway Traffic

Open-road driving includes all of the maneuvers and conditions of city driving, but on the highway, these activities usually occur less frequently, at higher speeds, and over longer periods of time. The relatively high speeds and the smaller number of speed and directional changes are two important reasons for the greater fuel economy in highway driving.

On the highway, the meter may be used for determining economical cruising speeds and techniques for accelerating, decelerating, and ascending hills. While the car cruises at constant speeds, the meter will indicate reductions in fuel economy from weaving in and out of traffic and from driving above or below the optimum speed of the car. Accordingly, it will also show that driving below the speed limit is more efficient than driving above it. While the car climbs a grade, the meter will indicate that fuel can be saved by slowing a little rather than by trying to maintain a constant speed. Long, gradual accelerations and long, slow decelerations will show better fuel economy than shorter, more sudden speed transitions. Therefore, the mpg meter does have a potential for improving fuel economy of open road driving.

2.4 SAFETY CONSIDERATIONS

Because of the potential danger of inattention during driving, and because of the difference in driving speeds which might be characteristic of cars with different optimal speeds

and drivers with varying levels of interest in saving fuel, mpg meters are a potential safety hazard in both urban-suburban and rural-highway driving.

The large number of cars, intersections, and side-street activity encountered make it unsafe to attend to anything but events outside the car when driving on urban-suburban streets. The activities during which the meter is the most useful for saving fuel are also the most dangerous. Therefore, the fuel-conscious driver may feel compelled to monitor his meter most closely when engaged in driving maneuvers having the highest accident potential. Accidents would be expected if drivers watched their meters and thus reduced their attention to other traffic and the road while passing, merging with traffic, or using entrance and exit ramps to and from major highways. The extent to which an attentional diversion from the driving task would decrease safety is unknown at this time. Certainly, driving safety will decrease as the amount of attention given the mpg meter is increased. On the other hand, the necessity for monitoring the meter closely to save fuel will decrease as the driver's experience with the device increases.

2.5 IMPROVED MPG METERS

A number of the disadvantages of current meters could be corrected through redesign and matching the meters to the cars in which they will be used. Readability and safety of using the meters could be increased if separate scales or indicator systems were designed and used for different driving conditions. In conditions where the driver has the time and the traffic provides the flexibility, the accuracy of a well-differentiated scale could be used to get the best gas mileage possible. Indicator lights sensitive to critical mpg ranges could be mounted on the car fenders for use in congested traffic. In stop-and-go traffic, when it is hazardous for the driver to look away from traffic, he could drive within acceptable fuel-economy ranges by monitoring the indicator lights without losing sight of traffic.

Response lag and meter instability could be reduced and the integrity of the automobile fuel system could be maintained if the meters were designed as integral parts of the automobile. Faster response time would be more informative regarding the effect of specific driver activities on fuel economy.

2.6 CHAPTER SUMMARY

Mpg meters have not demonstrated statistically significant improvement in fuel economy during recent, short-term field tests conducted by the Transportation Systems Center. However, the use of mpg meters may lead to fuel savings over the long term and under conditions other than those considered. These conditions might include training in fuel-saving techniques or the use of the meter to indicate when tune-ups are required, but the effectiveness of these uses remains to be investigated. Although it cannot now be concluded that mpg meters will be effective, the economic benefits which might accrue for assumed effectiveness levels are presented in the following chapter.

3.0 ECONOMIC BENEFIT CONSIDERATIONS

3.1 GENERAL

If the Government is to promote the installation and use of mpg meters in cars, the meters must, as a minimum, lead to fuel savings sufficient to offset their cost within a reasonable period of time.* This chapter provides the results of parametric analyses of the value of fuel savings as a function of time for different assumptions about the improvement in fuel economy that may be achieved through use of mpg meter.

3.2 ANALYSIS OF POTENTIAL COST SAVINGS

Effective mpg meters or any other driver aid would produce two results: national consumption of gasoline would be less than it would be without the use of the meters, and the driving costs would be lowered because of increased fuel economy.

The objectives of this section are to evaluate the extent of the economic benefit that may accrue to the nation in the form of decreased demand for gasoline, and to analyze the cost/savings tradeoff for automobile owners to determine the conditions under which their investment in mpg meters would be economically warranted.

A parametric analysis was conducted for assumed increases in fuel economy, ranging from 2% to 10% over a period of 10 years. Potential national gasoline savings were determined for installation of mpg meters in all new and used cars and for installation in new cars only. Potential dollar savings (discounted at a 10% rate) to the individual driver from his use of mpg meters were determined for all cars currently on the road and for new cars, large and small.

*In case of National emergency, i.e. oil embargo, the cost benefit may not be the governing factor.

3.2.1 Assumptions

The analysis of the effectiveness of mpg meters or any other driver aids to improve fuel economy is based on the following information and projections:

1. The number of miles driven by a car in any one year depends on the age of the car. Figure 3-1 shows the estimates of yearly mileage based on data reported by the Federal Highway Administration.
2. Projections of population size and number of future households are based on Bureau of the Census data.
3. Projections of rates of growth of macroeconomic variables are based on forecasts by Data Resources, Inc.[11]

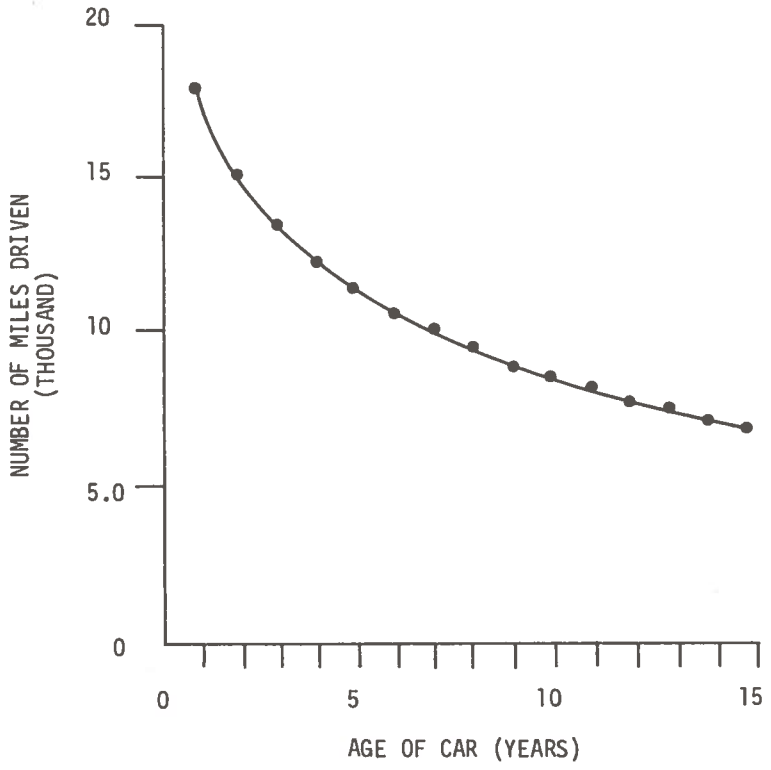


Figure 3-1. Miles Driven Annually As a Function of Vehicle Age

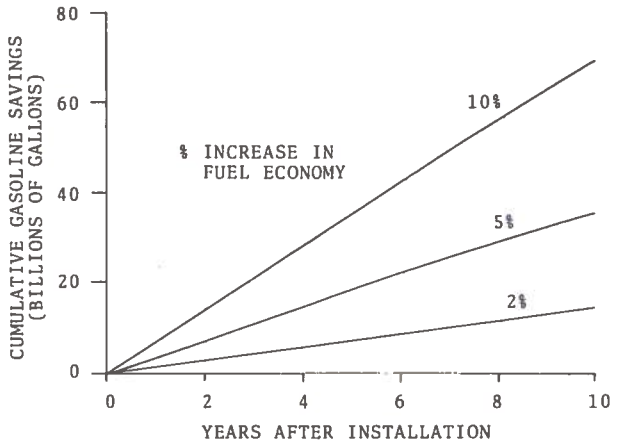
3.2.2 National Fuel Savings for Assumed Fuel Economy Increases

Future rates of fuel consumption by the national automobile fleet were determined with a model developed by the Transportation Systems Center for projecting vehicle miles traveled (VMT), new-car sales, and fleet size. The model determines these values from the demographic, economic, and fuel-economy performance assumptions listed above.

National gasoline consumption for different assumed levels of increased fuel economy was estimated by assuming that mpg meters were installed in the entire existing fleet at the same time, and were also installed in all new cars sold from that time on. The results of this analysis are presented in Figure 3-2, which illustrates potential cumulative savings in gasoline consumed by the national automobile fleet, assuming no change in the price of gasoline. Results of a similar analysis which assumed that mpg meters were installed only in new cars starting with the 1975 model year, are presented in Figure 3-3. The figures illustrate that, over a period of 10 years, potential cumulative savings in gasoline would vary between 14.8 and 68.7 billion gallons depending upon the assumed increase in fuel economy from the installation of mpg meters in the entire fleet. The figures illustrate that if the meters were installed only in new cars the potential cumulative savings would be between 6.2 and 29.0 billion gallons.

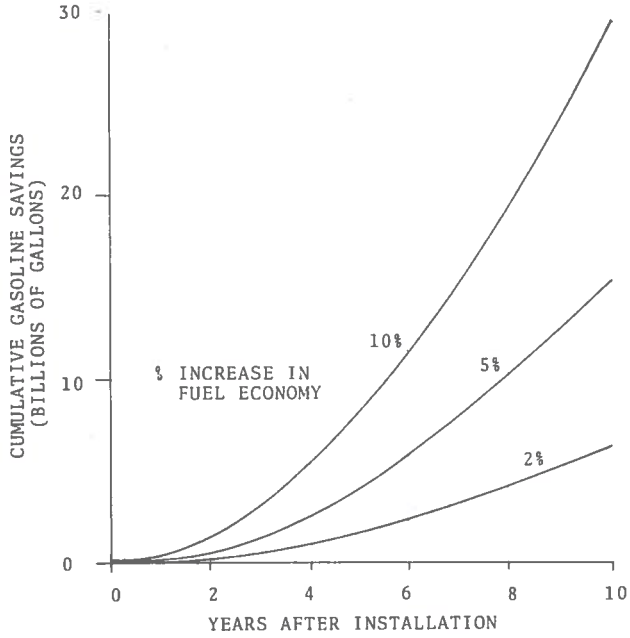
3.2.3 Cost/Savings Considerations for After-Sale and Original Equipment Purchases

The time required for the owner of an average car on the road today (age, 5.7 years[12]; fuel economy, 13.5 mpg[2]) to recover the cost of installing an mpg meter is related to fuel savings at the current price of $0.58/gallon, as shown in Figure 3-4. The least expensive mpg meter (cost, $130 installed) will pay for itself in about 3 years if it can aid in improving the car's fuel economy by 12%. If the improvement in fuel economy is 5%, the net present value of the fuel saved almost equals the installed cost of the least expensive mpg neter after 10 years.



o These are parametric curves used for analysis only. No conclusions should be drawn concerning performance of actual mpg meters

Figure 3-2. Cumulative Gasoline Savings As a Function of Time After Installation of MPG Meters In All Cars For Various Assumed Percent Improvements In Average Fuel Economy



o These are parametric curves used for analysis only. No conclusions should be drawn concerning performance of actual mpg meters

Figure 3-3. Cumulative Gasoline Savings As a Function Of Time After Installation of MPG Meters In New Cars For Various Assumed Percent Improvements In Average Fuel Economy

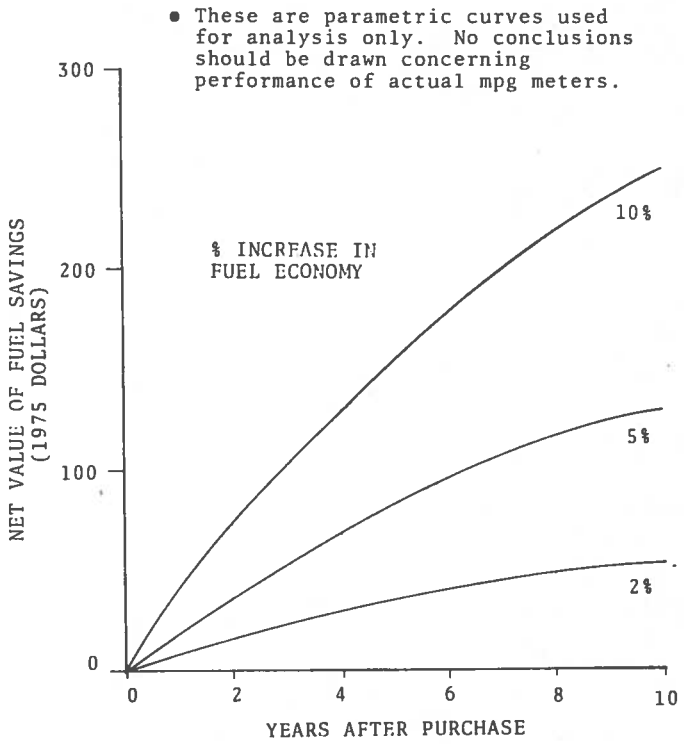


Figure 3-4. Average-Car Owner's Time Required To Break Even On The Purchase Of MPG Meters

Figure 3-5 illustrates the economic advantages of installing mpg meters during new-car assembly. If a factory-installed mpg meter costs $75, as at least one developer estimates, small-car buyers will have to achieve an 8% increase in fuel economy at 1975 gasoline prices if they are to recover its cost within three years. Large-car buyers need only achieve a 5% increase in fuel economy to revover the cost within three years, because the larger cars use more gasoline and can thus save more money through improved fuel economy. To recover mpg meter costs during the 10-year life of the car, the necessary increases in fuel economy are 3.75% for small cars and 2.3% for large cars.

It should be reemphasized that these values are the result of econometric analysis and do not reflect either the proportion of the fleet that is likely to be instrumented, or the actual effectiveness of mpg meters. The analyses assumed a discount rate of 10% per annum and a gasoline price of $0.58/gallon.

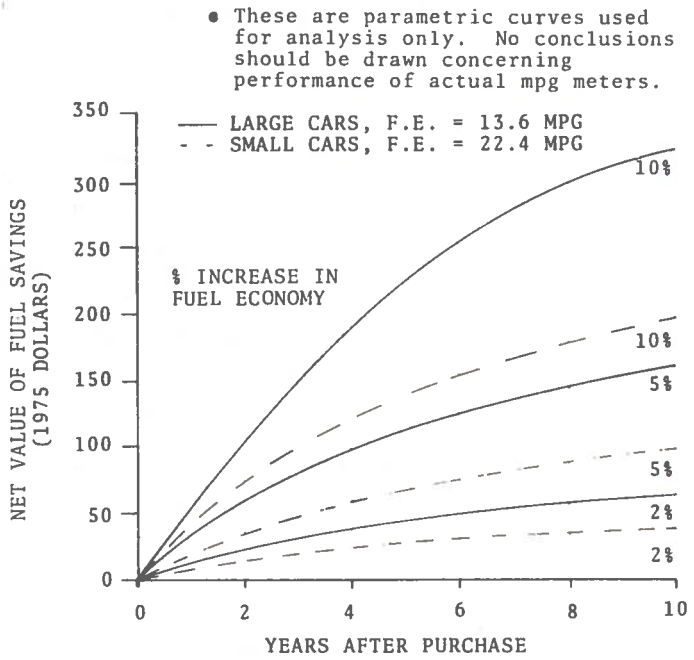


Figure 3-5. New-Car Buyer's Time Required To Break Even On The Purchase Of MPG Meters

4.0 MEANS OF ENCOURAGING PURCHASE AND USE OF MPG METERS AS ADD-ON EQUIPMENT

This chapter discusses means potentially available to the Federal Government for encouraging the purchase of mpg meters as add-on equipment. This report responds to the provisions of Section 512(a) of the Energy Policy and Conservation Act which requested that this subject be discussed, and is not intended to advocate adoption of such measures.

The Federal Government would be justified in encouraging the purchase of mpg meters only when the following minimum conditions have been met:

- o The effectiveness of mpg meters for fuel conservation under a variety of driving conditions has been demonstrated by fleet tests.
- o Sufficient fuel savings are attainable through mpg meter use to warrant their purchase cost.
- o Mpg meters are safe to use.

Further, there should be a public policy determination that the national interest would be served by such encouragement.

Measures of encouraging device purchase are:

- Public advertising
- Driver education
- Tax benefits
- Direct subsidy to meter manufacturers

4.1 PUBLIC ADVERTISING

The news media could be used, as they were during the oil crisis of the early '70's, to remind the public of the need to conserve gasoline and the feasibility of doing so through economical driving techniques. TV and radio advertisements, financed by the government and similar in pattern to those used during the oil crisis, would give the viewer or listener the names and addresses

of agencies providing specific information. Supportive advertisements in newspapers and magazines, presumably financed by automobile and device manufacturers, could give more information on the use of proven devices to help the driver improve his fuel economy.

4.2 DRIVER EDUCATION

To conserve fuel, drivers must learn fuel-economical driving habits. Existing programs for driver education could be augmented with fuel-efficient driving-technique instructions using mpg meters to reinforce the training. This training could be provided to new drivers, to those who are directed by the courts to undergo further driver training, and to those interested in developing fuel-efficient driving techniques.

4.3 TAX BENEFITS

Income-tax reductions or tax credits may be considered as additional incentives for the purchase and installation of mpg meters. However, tax benefits awarded indiscriminately could encourage a proliferation of so-called fuel saving devices which might or might not be useful in assisting drivers to conserve fuel. Since it would be inappropriate for the Federal Government to support ineffective devices, a test and evaluation program to determine which devices were effective would be advisable. The administrative and legal complications of a tax benefit program would be considerable.

4.4 DIRECT SUBSIDY

A direct subsidy to manufacturers of mpg meters by the Government might also be considered. This would also be an expensive approach. A subsidy to manufacturers whose products did not meet acceptable performance standards would be inappropriate. Thus, it would be necessary to establish acceptance and qualification standards. The private sector might be reluctant to submit to this kind of Government interference.

5.0 ISSUES ASSOCIATED WITH MANDATORY INSTALLATION OF MPG METERS IN NEW CARS

Pertinent issues which must be addressed in mandating the installation of mpg meters include:

Effectiveness for Saving Fuel

Installation of mpg meters should not be mandated before their effectiveness for increasing fuel economy is demonstrated.

Cost Effectiveness

The savings from improved fuel economy achieved with the mpg meter should enable the car owner to recover the cost of the meter over a reasonable period of time, say three years, which is typical of first ownership.

Equitable Impact

Since the cost of mpg meters would probably be the same regardless of the cost of the cars in which they are installed, the resulting price increase due to the installation of meters would be proportionately greater for low-priced cars. Therefore, the relative economic impact of mandated installation would fall more heavily on purchasers of less expensive cars.

Effects on Automobile Industry

The effects on the various elements of the automobile industry of a mandatory requirement to install mpg meters in new cars must also be considered. For example, American Motors (Appendix B) indicated that the mandatory installation of a $50 meter in their cars would probably decrease sales by 2800 units annually. Indirect effects, often attributed to enforced legislation, include such factors as loss of producer flexibility and initiative when no choice of alternative action is given.

Government Costs

Government expenditures would be required for the administration of a mandatory mpg meter program. As a minimum, this program would include establishment of specifications and enforcement of performance standards of mpg meters.

6.0 CONCLUSIONS

- At the present time it has not been demonstrated that the use of available mpg meters will improve fuel economy for typical drivers.
- The most effective means of equipping used cars with mpg meters is to convince the public that the meters will save them money.
- The least expensive commercially available mpg meters would cost about $130 installed. Fuel economy increases of about 12% would be needed to cover the installed cost of the mpg meter after the third year.
- An original equipment price of $75 is estimated when mpg meters are factory installed in new cars. A 5% fuel economy increase resulting from the use of the mpg meter would pay for the meter through fuel savings in about three years for a large car or about six years for a small car.
- Means for encouraging consumers to purchase automobiles equipped with mpg meters include advertising, driver education, tax benefits, and subsidies to manufacturers of meters. These measures are only likely to be effective when it is shown that mpg meters are safe, economical, effective and convenient to use.

7.0 RECOMMENDATIONS

With respect to *"(1)...a requirement that each new automobile be equipped with a fuel flow instrument reading directly in miles per gallon,"* it is recommended that the Congress not mandate such a requirement.

With respect to *"(2)...the most feasible means of equipping used automobiles with such instruments,"* it is recommended that no action be taken to promote the use of mpg meters in used cars at this time.

APPENDIX A. OTHER DRIVER AIDS FOR CONSERVING GASOLINE

Other driver aids are commercially available, as both original and add-on equipment. The manifold vacuum gauge is the most widely used monitor of automobile fuel economy. A large variety of these gauges is available. They are simple in design, reliable in operation, relatively inexpensive, and easy to install as add-ons. All major U.S. auto manufacturers offer vacuum gauges as optional equipment on new cars. Meter readings, flashing lights or audio signals show the driver his fuel economy.

The speed control and the cruise control, are available either as original or add-on equipment. These devices automatically maintain a steady speed, and thus improve fuel economy.

Fuel-flow meters, which measure the rate at which fuel is being consumed, and fuel totalizers, which measure the amount of fuel consumed for a selected period of time, are also available as add-on equipment. Both may assist the driver to improve fuel economy.

Devices for measuring exhaust temperature have proven helpful in measuring engine efficiency and fuel economy on diesel trucks. They have recently become available as add-on equipment for automobiles.

A brief description of these driver aids is given below; more detailed description is in a report prepared for the Department of Transportation by Aerospace Corp.[13]

1. Manifold vacuum gauges

Vacuum gauges measure the intake manifold vacuum and provide good correlation to fuel economy under most operating conditions. The information is presented to the driver by visible or audible signals.

The lowest manifold vacuum occurs when the throttle is wide open; higher vacuum occurs when the throttle is partially closed. The highest vacuum occurs when the car is decelerating with the throttle nearly closed. Since the throttle position is related to engine load or horsepower, the intake manifold vacuum is a measure of the load on the engine. Low readings indicate high loads and high fuel consumption. It has been recognized for many years (principally by those involved in automobile performance testing, racing, and economy runs) that gauges which measure the intake manifold vacuum can be useful for monitoring engine operating conditions related to fuel consumption.

The vacuum gauge is simple, easy to install, and costs about $15. Installation is accomplished by connecting a vacuum hose directly to the intake manifold or by cutting a convenient vacuum line and inserting a tee. The generally accepted method of using a vacuum gauge to minimize fuel consumption is to drive so that the manifold vacuum is at the highest possible value when the transmission of the car is in high gear. For a typical engine, the intake manifold vacuum will be about 18 to 20 inches of mercury (in. Hg) at idle, about 15 at cruise, and 5 to 10 while climbing a moderate hill. Moderate accelerations can be accomplished at 10 in. Hg. Climbing a steep hill, accelerating very rapidly, and other high load conditions, can drop the engine vacuum to near zero.

At steady speeds on a level road, the vacuum reading on a typical automobile will peak somewhere between 30 and 40 miles per hour. The busy driver may have some difficulty monitoring the vacuum level because it is sensitive to small changes in accelerator pressure. Unless the automobile is driven at a steady speed on a level road, the vacuum reading will continuously fluctuate. Also, a shift of the transmission to a different gear ratio will affect vacuum level and the corresponding fuel consumption.

When the car ascends a hill, the vacuum level will drop if constant speed is maintained. It will drop further if the car is accelerated up the hill. On the other hand, the vacuum level will decrease less if the car decelerates somewhat while climbing. Thus, the principal information gained from a vacuum gauge is that to maintain high engine vacuum one should accelerate slowly and, if possible, decelerate ascending hills. Since the vacuum gauge is also sensitive to moderate accelerations and decelerations, it indicates whether the driver is maintaining a steady foot on the accelerator.

A basic shortcoming of the vacuum gauge is that it indicates engine load rather than fuel economy (miles per gallon). Fuel economy at very low speeds (e.g., 20 miles per hour) is generally poor. However, since the engine load at this speed is very low, the vacuum gauge will display a relatively high reading, possible leading the uninformed driver to believe he is driving economically when, in fact, he is not.

A large number of vacuum gauges for automotive use are on the market. Most are circular diaphragm devices, similar in appearance.

One side of the diaphragm is exposed to atomospheric pressure; the other, to engine intake manifold pressure. Pressure differences move the diaphragm. Through suitable mechanical linkage, the diaphragm movement operates a dial indicator needle. Most gauges range from 0 to 30 in. Hg of manifold vacuum.

An alternative means of providing vacuum-based engine load information to the driver uses lights rather than a dial. In this design, a vacuum diaphragm operates a switching device to either actuate a light when the vacuum reading drops below a certain level or to turn on different colored lights corresponding to the different economy zones. One instrument uses different colored lights to indicate "best", "good", and "poor" fuel economy.

All of the major American automobile manufacturers offer vacuum-actuated devices. General Motors, Ford, and American Motors offer, as optional equipment in various models, either a vacuum gauge or a warning light which turns on when the intake manifold vacuum drops below a preset level. The faces of the vacuum gauges are divided into colored zones. All of these units are mounted on the instrument panel.

Chrysler offers a warning light device called the Fuel Pacer System. This device produces a warning signal that uses the turn indicator light on the left-front-fender to indicate poor fuel economy. Above about 5.5 in. Hg, the light remains off. Between 5.5 and 4.5 in. Hg, the light may blink rapidly. Below 4.5 in. Hg the light remains on. Vacuum values of 4.5 and 5.5 in. Hg were

chosen because at approximately 5 in. Hg, the carburator power jet is activated causing the air-fuel ratio, and thus the fuel economy, to decrease.

2. Speed and cruise control devices

Both the magnitude and constancy of driving speed influence fuel economy. Most cars achieve maximum fuel economy when cruising between 30 and 45 mph. Lower speed decreases economy mainly because of engine inefficiency; higher speed decreases economy because of greater wind resistance. Variation in speed is uneconomical because of the power needed to overcome inertia.

A number of devices on the market indicate or control speed. Some of these flash a warning light or sound a signal when a preset speed is exceeded; others, called cruise controls, automatically hold the car at a steady preset speed. The driver can override this device with either the gas or brake pedals.

Speed warning systems are available as add-on equipment at a cost of $7 to $50. Cruise control is available either as original or add-on equipment at a cost of about $100.

The warning devices can signal the driver who unintentionally exceeds the preset speed and thus may prevent wasteful high speed patterns. They are, however, not useful in stop-and-go driving. Cruise controls can be used only where traffic is sparse and steady enough to permit long stretches of constant speed.

3. Fuel-flow meters and fuel totalizers

Fuel-flow meters and totalizers use transducers in the fuel line. Fuel-flow meters measure the flow of fuel and indicate to the driver the rate at which he is using gasoline. This tells

the driver, for instance, that hard acceleration uses more fuel than easy acceleration or that acceleration in a lower gear uses less fuel than acceleration in a higher gear. But, as this information is not easily relatable to distance traveled, it could cause the driver to estimate fuel economy erroneously. Fuel-flow meters cost at least $50 as add-on equipment.

Totalizers measure in tenths or hundredths of a gallon the total amount of fuel used over a selected period of time. They can be reset to zero at any time. They could be useful in promoting economical driving habits, since they simply and accurately inform the driver of the amount of gas used for a specific trip. They cost about $50 as add-on equipment.

The fuel line must be interrupted and electrical connections must be made to install the transducer for both fuel-flow meter and totalizer. Thus, proper installation is necessary to avoid the potential hazards detailed in Section 2.4.

4. Exhaust temperature gauges

These gauges measure exhaust manifold temperature. Exhaust temperature is affected by engine power levels and late fuel burning, both factors in fuel economy. They have been used mostly in diesel trucks to measure engine efficiency under cruising conditions and only recently have been tried in automobiles.

A driver would use this device as he would an mpg meter. The information obtained from a temperature gauge could be useful to the technically oriented driver, but probably not to the average driver because of the difficulty in interpreting readings. The reading does not directly indicate fuel economy but only provides

information from which a trained driver can estimate fuel economy. In addition, there is a considerable lag between changes in the exhaust manifold temperature and changes in engine operating conditions that affect fuel economy. They cost from $75 as add-on equipment.

APPENDIX B. SUMMARY OF RESPONSES TO REQUEST FOR INFORMATION AND PUBLIC COMMENT ON FUEL FLOW METERS (F.R. Vol. 41, No. 43, March 3, 1976)

I. BACKGROUND

The Federal Register of March 3, 1976 published the Request for Information and Public Comment on DOT's study on the advisability of requiring that each new automobile be equipped with a fuel-flow instrument reading directly in miles per gallon (mpg) and the most feasible means of equipping used automobiles with such instruments.

To assist in the study, the public was invited to submit to Public Docket OST File No. 41 by April 9, 1976, information and comments on the following four issues:

- The effectiveness of such instruments in promoting voluntary reductions in fuel consumption.
- The cost of such instruments.
- Means of encouraging automobile purchasers to voluntarily purchase automobiles equipped with such instruments.
- Any other factor bearing on the cost and effectiveness of such instruments and their use.

In addition, any other information and comments pertinent to the objectives of the study were invited, and specific attention was addressed to the following questions:

- Would meters reading directly in miles per gallon be effective in promoting a reduction in fuel consumption?

- What is an appropriate basis for deciding whether each new automobile should be equipped with such a device on either a mandatory or an optional basis?
- Under what conditions would it be appropriate for used automobiles to be equipped with such devices?
- What price is reasonable for such a device installed in an automobile?
- What savings in fuel cost would justify costs of the meter?
- What other driver aids merit consideration?
- What reasons and supportive data exist for judging their effectiveness?
- If meters reading directly in miles per gallon are effective, how can their use be stimulated effectively?

II. RESPONSES

Sixty-one respondents submitted information or comments to the Public Docket. All responses received were included in the Docket File, even those which arrived after the official closing date. Two respondents were manufacturers of driver aids who submitted information on their devices (Miles Instrument Co., and SpaceKom, Inc.). C&E Enterprises, the manufacturer of the Accelerite, a vacuum gauge device, also responded. Seven automobile manufacturers submitted comments and data on the effectiveness of mpg meters, on driving techniques, and on marketing information.

III. DOCKET CONTRIBUTORS

Docket Contributor	Address
* The Willet Companies	Chicago, Illinois
* Village of Skokie	Skokie, Illinois
* Browning-Ferris Industries	Barrington, Illinois
* Hinckley & Schmitt	Chicago, Illinois
* Gateway	Chicago, Illinois
* ETMF (Freight Systems)	Chicago, Illinois
* Standard Oil Div., Amoco Oil Co.	Forest View, Illinois
* Holland Motor Express Inc.	Holland, Michigan
* Public Taxi Service Inc.	Chicago, Illinois
* Transport Service Co.	Hinsdale, Illinois
* Continental Air Transport Co., Inc.	Chicago, Illinois
* B&B Packing Company	Chicago, Illinois
* Transcon Lines	Lyons, Illinois
* Flash Cab Co.	Chicago, Illinois
* Northern Illinois Gas	Aurora, Illinois
* Osco Incorporated (Pet Distr.)	Chicago, Illinois
* Jay Foods, Inc.	Chicago, Illinois
* Pepsi Cola General Bottlers, Inc.	Elmhurst, Illinois
* Emkay, Inc.	Chicago, Illinois
Laurence M. Goodridge	Arlington, Virginia
Consumers Union	Orange, Connecticut
The Prestolite Company	Toledo, Ohio
Northern Arizona Council of Govts.	Flagstaff, Arizona
Institute of Environmental Sciences	Mt. Prospect, Illinois
U. S. Department of Agriculture	Washington, D. C.
U. S. Dept. of Interior, Bureau of Land Management	Lakeview, Oregon
Adidas	Detroit, Michigan
American Automobile Association (AAA)	Falls Church, Virginia
GTE Service Corp.	Stamford, Connecticut
Ford Motor Company	Dearborn, Michigan
A. D. White	Houston, Texas
General Motors Corp.	Warren, Michigan
C&E Enterprises, Inc.	Jacksonville, Florida
Fiat	Torino, Italy
Chrysler	Detroit, Michigan
Association Peugeot-Renault	Billancourt, France
Mobil Oil Corporation	New York, New York
Regie Nationale des Usines Renault	Billancourt, France
Bernadette M. Rudzonis	Keasbey, New Jersey
M. A. Bradburn	Houston, Texas
Kysor Industrial Ltd.	Whitworth, Lancs., U.K.
American Motors Corp.	Detroit, Michigan
U. S. Environmental Protection Agency	Washington, D. C.

*Submissions were identical, on form letter.

Docket Contributor	Address
Betty G. Fisher	Rochester, New York
I. E. Coufal	Pasadena, Texas
H. P. Lindee	Houston, Texas
Mueller Associates, Inc.	Baltimore, Maryland
Dudley A. Brayton	St. Louis, Missouri
Edith E. Brownsberger	Warrensberg, Missouri
Virginia Quick	Warrensberg, Missouri
**Laurie Hursig	Warrensberg, Missouri
**Barara Beeler	Warrensberg, Missouri
**Carolyn Luebbering	Warrensberg, Missouri
**Dian Mitchell	Warrensberg, Missouri
**Gregory L. King	Independence, Missouri
**G. M. Todd	WAFB, Missouri
**Krouse Foods Cooperative	Peach Glen, Pennsylvania
**Space-Kom, Inc.	Santa Barbara, California
**Miles Instrument Company	Milwaukee, Wisconsin
**Milwaukee Legal Services, Inc.	Milwaukee, Wisconsin
**H. M. Brobst	Alamo, California

IV. EFFECTIVENESS OF MPG METERS

Forty-nine of the sixty-one contributors feel that the use of mpg meters would have a negligible effect on the nation's fuel consumption and that the meters' usefulness is soley to provide information or to serve as a reminder to the driver. Many contributors feel that most drivers would ignore the meters. Chrysler, for example, estimates that fewer than 5% of the new-car buyers would be guided by the mpg meter for any significant time period. Similarly, the Department of Agriculture suggests that drivers, except for those technically oriented, would have little appreciation for what the instrument was telling them and that although there might be a small initial reduction in fuel consumption, drivers would soon tend to ignore the meters.

The form letter, submitted by 19 contributors to the docket, was against the mandatory installation of an mpg meter and

**Contributors with the position that mpg meters would be effective in increasing fuel economy.

states it is preferable to force manufacturers to design and make a more efficient and trouble-free engine and drive train.

The Institute of Environmental Sciences also expressed the opinion that only a small percentage of U. S. drivers would employ meters as a means of saving fuel, and that there is no justification for considering equipping used cars with them.

The following paragraph is typical of a number of responses regarding the effectiveness of mpg meters.

> "In normal traffic conditions, excluding the highway trip with low traffic density, the driver is constrained by the behavior of other drivers who, in turn, are constrained in their driving by the particular characteristics of their automobiles and the traffic. Therefore, in normal traffic, only a few cars can be driven with the best fuel economy. The indications of an mpg meter can be more readily followed during highway trips with low traffic density. Under these conditions, however, it is sufficient that the driver know the average fuel economy of his particular car for a steady speed without reading this value directly on an instrument. The driving environment restricts the mpg meter's usefulness because heavy traffic and urban areas allow limited freedom to change driving habits."

Ford replied that in their limited experience with mpg meters, primarily for dealer demonstration, they encountered many difficulties, including incorrect and erratic readings, installation problems, and failure to operate. Similar experiences were reported by another contributor, who, because of his dedication to energy conservation, has so far used three driver aids on his 1966 VW, including an mpg meter. In his particular installation, the car vibrations caused rather wide needle fluctuations at constant speed. He has so far replaced two of its three main components to keep the device working. It now reads 21 mpg when actual mileage is something over 30 mpg in road tests in which he divided fuel

consumed by distance, as measured by his odometer.

The Mobil Economy Driving Program, developed in 1974, showed that a group of typical motorists, by studying brief written instruction, were able to improve gasoline mileage an average of 15% without the use of special instrumentation. The vacuum gauge was useful but not essential as a training aid. Mobil noted that motorists who studied and applied the economy-driving instructions obtained no additional mileage when also provided with a vacuum gauge.

SpaceKom, Inc., a manufacturer of mpg meters, noted that feed-back from some of their customers indicated that, after they installed the meter, they improved fuel economy by an average of 10%, because they avoided rapid acceleration and were able to pick the most economical speed. SpaceKom also explained that the problem in installing mpg meters is due to the difficulty in getting at the speedometer and/or fuel line on many cars. This difficulty makes installation expensive in some cases. Additionally, many auto mechanics do not have an electronics background and are frequently unable to install the mpg meter correctly.

Many contributors stressed the lack of in-vehicle experience and test or survey data which are necessary to estimate the effectiveness of the meters in increasing fuel economy. They suggested that field studies are required to determine the effect of mpg meters on fuel consumption in actual private-owner usage. SpaceKom further suggested that it might be educational to equip a portion of the government automobile fleet with such instruments

to obtain answers about their effectiveness in fuel conservation, installation problems, and other factors.

The AAA, which represents 17.5 million motorists, suggested that such a study be broadened to include other devices because of the questionable value of information obtained from mpg meters.

Consumers Union, on the other hand, has been testing and reporting on mpg meters for many years. They do not believe this device would be cost-effective or influential in promoting voluntary reduction in fuel consumption. They also concluded that vacuum-gauge type economy reminders, although much more reasonably priced, are still not cost-effective.

Supportive arguments made in favor of the mpg meter given by Milwaukee Legal Services were:

- The presence of the gauge would make the driver more concerned about the maintenance of his automobile.
- The gauge would encourage people to accelerate more moderately, cruise at a lower speed and drive in the appropriate gear, and would help to offset the menacing horns of other drivers who are impatient and slow to learn.
- When the meter demonstrates to a prospective new car buyer that smaller cars give better mileage, the shopper may be inclined to purchase the small car. This would lead to long-range gas savings.

V. INSTALLATION ON USED VEHICLES

Several contributors to the docket expressed strong sentiment against installation of mpg meters in used cars. Several reasons for this position were expressed.

American Motors noted that, due to the complexity and probable high cost of installation, mandatory installation on all used automobiles would be impractical. This statement on the difficulty of installation is supported by the input submitted by SpaceKom and Ford.

General Motors raised some questions on the safety aspects of installing mpg meters on used cars. They contend that under no condition would it be prudent to equip used cars with such devices. Fuel systems are designed to meet rigid safety, crashworthiness, and emission standards and contain a minimum of joints and connections to minimize leaks and potential fires. Cutting into the fuel lines to install fuel meters will undoubtedly result in serious problems for many motorists and might even cause damage to the automobile.

Chrysler raised questions on the economic feasibility of installing mpg meters on used cars. Since the average used car has a shorter life expectancy than a new car, and since retrofit cost can be higher than original equipment costs, they cannot foresee any conditions of favorable cost/benefit that would justify equipping used cars in the manner proposed.

The Miles Instrument Company strongly supports equipping used cars, since "there is a shameful waste of fuel by vehicles today." The Northern Arizona Council of Governments contends that "any proposal to retrofit existing automobiles would be particularly discriminatory and is patently absurd".

VI. SAFETY

Questions concerning the safety of the mpg meter were not mentioned by any of the 11 contributors to the docket who believed that the devices will be useful in increasing the fuel economy of the automotive fleet. On the other hand, several of the contributors who took the opposite position expressed concern over safety. The concern expressed was that the time to check on excessive fuel consumption is while accelerating from a stopped position or passing, which is precisely when the driver's attention should not be diverted from his driving. Chrysler noted that a considerable amount of driver attention must be given to read instantaneous miles-per-gallon indications to effectively determine the most economical driving patterns. This requirement diverts the driver's attention from watching road and traffic conditions and competes with other items necessary for safe vehicle operations.

Mounting locations for the device that meet crash safety requirements and afford good visibility of the gauge are essential. Finding such a location is difficult, and, for this reason, Ford does not offer its accessory vacuum gauge on many of its automobiles.

VII. COST EFFECTIVENESS AND PRICE

SpaceKom has manufactured automotive gas mileage meters since 1971. Their distribution channels are Sears, Roebuck & Co.; J. C. Whitney; and direct mail order. They stated that because of inflation, passenger-car owners are willing to pay a maximum of $60 for such an instrument. One contributor to the docket was willing to pay up to $50 for an mpg meter.

In a national telephone survey undertaken by the Adidas Corp., 45% of the respondents thought the gauge was very useful and desirable, 23.7% thought it was somewhat useful, 30.3% thought it was not at all useful or desirable, and 1% did not know. Of those who thought it was very useful or desirable, 33.9% said that $20 would be the maximum they would pay if they were responsible for installation; 24% said $25; and 22.6% said that $30 would be their maximum price. Of those who were somewhat interested, 54% had $20 as their maximum, 11.3% had $25 as their maximum; and 12.2% were willing to pay up to $30 for the device. The total price of $10 to $20 installed was also suggested by docket contributors.

Chrysler Corporation noted that they were unaware of any mpg meter of the type described in the docket notice which has the necessary degree of operating accuracy and is in a price range that could be considered feasible for either mandatory or general optional equipment usage. The potential fuel economy improvement assigned to or claimed for use of an mpg meter or similar driver aid can be achieved by the development of good driver habits, as suggested in the 1976 publication, "Guide to Fuel Economy".

Ford Motor Company suggested that, to be acceptable to the consumer for non-commercial applications, the total price of the device should not be greater than the cost of fuel the driver would save as a result of using it in 1 year. They noted that as the fuel economy of cars increased, the required improvement in fuel economy required to break even also increased, making it even more difficult to justify the devices.

American Motors suggested that the savings in fuel cost over a two-year period must equal or exceed the installed cost of the meter. The Association of Peugeot-Renault does not feel significant savings in fuel cost would result from installation of mpg meters.

The Department of Agriculture estimates that the potential for improvement in fuel economy is less than 6%, based on the 18 mpg fleet-average fuel economy for model year 1978. Based on $450 cost of fuel consumed on the average by FY75 (USDA data), recovery of investment would be about $27 a year. This is barely adequate to offset the initial cost as original equipment, estimated at $75 to $100, and subsequent maintenance cost over the life of the vehicle. They also do not believe that the installation of mpg meters would be an effective means of reducing fuel consumption.

Eleven contributors to the survey who thought that mpg meters would be effective in increasing the fuel efficiency of automobiles made the following cost statements:

3 contributors stated that cost was not a concern.

1 contributor stated that cost was a concern.

1 contributor stated that the cost should be less then $50.

1 contributor stated that passenger car owners are willing to pay up to $60.

5 contributors made no cost statements.

VIII. MARKETING EXPERIENCE

An indication of the extent to which the public would purchase, use, and benefit from driver aids is market demand. The sales

history of these devices was provided by both their manufacturers and the manufacturers of automobiles.

Retail sales of Ford's accessory "Fuel Sentry" vacuum gauge were 20,000 units in 1974, fewer than 1,000 units in 1975 and fewer than 100 units thus far in 1976. The installation rate of the Opti-Fuel Monitor Warning Light on Ford passenger cars is currently at slightly over 1% compared to 2% for model year 1975. The retail price for this device is approximately $15-20, plus installation for the accessory gauge. In a memorandum to SpaceKom, Inc., a supplier of mpg meters to Ford, Ford stated that several factors had influenced their inability to sell the meters in the volume they had originally desired:

- A change in consumer concern with gasoline consumption appears to have resulted from increased fuel supplies.
- Accordingly, dealers do not want to address this issue unless it is raised by prospects.
- Many dealers have had difficulty installing the meters and claim they spent three or more mechanic-hours in installation time.

The retail price of SpaceKom's analog mpg meter is $39.50; the price of the more sophisticated digital mpg meter $99.50. Sales are about 10,000 units a year, with the exception of the fuel-shortage period in 1974, when sales were about 25,000 units (including 10,000 units purchased by the Ford Motor Company).

American Motors offers a fuel-economy gauge as optional equipment. The average custom-installed price over all model lines was $21.00. They noted that customer acceptance is very poor, based on an average installation rate of 0.8% at this point in the 1976 model year.

General Motors offers a vacuum sensing gauge. Presently, an average of 7.5% of GM cars are being purchased with this option at a cost of $35 or less. GM noted that if the price was increased to the $100 range, sales would most likely become negligible.

The economy of a particular car has meaning to the customer which he uses to make his buying decision. Similarly, a driver-aid device which is effective in improving fuel economy would have meaning to the car buyer. The degree of value perceived by the customer depends, of course, on the relative price and availability of gasoline.

The Prestolite Company, a manufacturer of motor vehicle equipment, stated that mpg meters, flow meters, and vacuum gauges which provide instantaneous indications of fuel consumption have been on the market for some time, but have not been purchased and installed by a large number of consumers. The forced installation of such devices, according to Prestolite, will only increase the cost of the vehicle without attaining the desired voluntary driving changes necessary to achieve meaningful fuel savings.

IX. ALTERNATIVE DEVICES AND SUGGESTIONS

Contributors to the docket who did not believe that mpg meters would be effective in increasing fuel economy most frequently suggested as an optional alternative a vacuum-gauge driver aid.

They stated that it costs less and is simpler in construction and operation. General Motors Corp. noted that there is some indicated potential for reducing fuel consumption with an mpg meter if it is conscientiously used. They see no indications that a meter calibrated in mpg is any better than a relative meter, such as a lower-cost vacuum gauge. The latter may be more easily understood by the driver than a rapidly changing mpg meter as would be encountered in urban driving.

Chrysler suggested that its own Chrysler Fuel Pacer is a driver aid that merits consideration by new-car buyers, but they do not believe it should be mandatory. The Institute of Environmental Studies disagrees with the mpg meter approach and suggests that the best solution is to design a basic vehicle that embodies all of the necessary safety, economy and social features.

The argument was made that perhaps the most important area of driver-influenced fuel economy gain is in driver education. Indeed, some contributions to the docket included summaries of good driving techniques.

Other suggestions which were forwarded to the docket include:

- Outlawing automatic transmissions.
- Requiring all autos to be equipped with over-drive gear ratios and radial tires.
- Prohibiting the use of passenger cars on certain days, and requiring involuntary car pooling.
- Building cars to 1960 size and weight.
- Removing anti-pollution devices.

X. STIMULATING THE MARKET

Two manufacturers of driver aids--SpaceKom, Inc., and Miles Instrument Company--argue that stimulation of the market is very important. SpaceKom, for example, contends that 25% of automobile owners would purchase the instrument if they knew of its existence , its operation and the potential savings. They believe that government action in publications, advertisements, etc., would be necessary, since it is extremely expensive for a private company to reach 100 million potential customers. They also took the position that car manufacturers should be instructed by the government to issue their dealers procedures for installation of mpg meters.

The automotive manufacturers contend that if effective meters are developed and drivers find them cost-effective, sales will automatically be stimulated. Supplying the prospective customer with firm evidence that the mpg meter will reduce fuel consumption to the extent that it will pay for itself will stimulate its acceptance by the consumer.

The U. S. Department of the Interior (Lakeview, Oregon) believes that stimulating effective use of such a device will not be much of a problem if adequate testing is conducted and positive results are obtained. They went on to add that the price of fuel alone is enough to stimulate widespread acceptance if the device is proven to be a fuel saver. However, they warned that imposing a mandatory requirement for installation of an unproven device of questionable value must be avoided.

XI. MANDATORY AND VOLUNTARY INSTALLATION

Three of the sixty-one contributors to the docket thought that the installation of mpg meters should be made mandatory. These contributors also thought that the devices would be effective in increasing the fuel economy of automobiles. Another three contributors thought that the devices should be optional equipment.

There was also very strong sentiment expressed against the idea of considering legislation. Some contributors recalled the "seat belt interlock debacle" of 1974. Others noted that legislation of several features in automobiles has already driven up the cost of automobiles in the last few years. In the case of used cars, a parallel situation in the state of California was cited. Retrofit programs implemented in California to install positive crankcase ventilation (PCV) valves and oxides-of-nitrogen (NO_x) control devices brought such adverse public reaction that the California legislature repealed the program in the case of the PCV valves and substantially cut back the NO_x retrofit requirement.

The impact on automobile sales was also highlighted. American Motors forecast a unit sales loss of about 0.7% or 2800 units if devices costing $50 were mandatory. They concluded that legislation calling for mandatory installation must be avoided. GM argued that it can be assumed that not all drivers want to change and that mandatory mpg meters for all cars would produce results little better than offering the device only to those who want one as an option. Even if such devices were proven to be effective, GM contends that a mandatory requirement would not be necessary or desirable.

The GTE companies, which operate a fleet of approximately 29,000 vehicles, contend that requiring all new and used cars to have an mpg meter will increase the cost of such vehicles without resulting in substantial fuel conservation. The cost of equipping their automobiles would result in an increase in the cost of service to their consumers. They concluded that the government should be very careful in mandating action that can kindle inflationary pressures. GTE was not opposed to a voluntary program encouraged through tax incentives to the auto manufacturers to offer mpg meters on some or all automobiles.

APPENDIX C. REFERENCES

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