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MONITORING REPORT

AUTOMOBILE VOLUNTARY FUEL ECONOMY IMPROVEMENT PROGRAM

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APRIL 1976

FINAL REPORT

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16. Abstract

On October 8, 1974, President Ford announced the goal of a 40% improvement in fuel economy of automobiles to be achieved in the 1980 new car fleet compared to 14.0 MPH for 1974. The Secretary of Transportation was given the lead in developing the program to evaluate manufacturers' progress to achieve their fuel economy goals, to make periodic analyses of future plans of each manufacturer, and to report findings to the Energy Resource Council. This report discusses the domestic manufacturers' progress to date, reviews the manufacturers' future plans in general, and assesses the likelihood of their meeting the goals.

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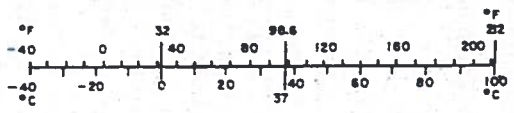
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. INTRODUCTION AND BACKGROUND

On October 8, 1974, President Ford announced the goal of 40 percent improvement in automotive fuel economy to be achieved in the 1980 model year new car fleet. This achievement would yield a production weighted average 19.6 miles per gallon (mpg) for the 1980 new car fleet compared to 14.0 mpg for 1974. The Secretary of Transportation was given the lead by the Energy Resources Council (ERC) to develop this program in conjunction with the Environmental Protection Agency (EPA) and the Federal Energy Administration (FEA). A voluntary approach was pursued, and industry cooperation was requested at a White House meeting on October 28, 1974. Subsequently, industry representatives endorsed the voluntary approach and pledged cooperation in working toward improving fuel economy.

To achieve the 19.6 mpg goal for 1980, a specific goal of 18.7 mpg was suggested by the Secretary of Transportation for the largest three U. S. manufacturers and a goal of 24.7 mpg for the average fuel economy for all other manufacturers. The goals for specific manufacturers were based on a number of factors, including historical patterns, technology feasibility, capital requirements, and production capability.

In January 1975, the Chairman of the ERC requested each automobile manufacturer to make a public commitment to achieve the 1980 model year fuel economy goal. The commitments were to be based on the following assumptions:

a. Emission standards no more severe than .9 gm/mile for hydrocarbons (HC), 9.0 gm/mile for carbon monoxide (CO), and 3.1 gm/mile for oxides of nitrogen (NO_X) for model years 1977-1981, as measured by the current EPA procedure.

b. Weight increases due to safety and damageability standards no greater than 100 pounds.

In response to this request, each automobile manufacturer made public commitments to the fuel economy goals under the stated assumptions about emission and safety standards. They also agreed to cooperate with the Federal Government in reviews of their progress and plans to achieve the goals.

The Fuel Economy Monitoring Program was established within the Office of the Secretary of Transportation under the direction of the Assistant Secretary for Systems Development and Technology. The purpose of the program was to: evaluate actual manufacturers' progress; make periodic analyses of future plans of each manufacturer, with sufficient lead-time to act upon identifiable shortfalls; and to report these findings to the ERC.

This report summarizes the findings of the monitoring program up to the enactment of the Energy Policy and Conservation Act (EPCA) in December 1975, which establishes a fuel economy regulatory program. Consequently, this report makes no findings with respect to the average fuel economy of automobile manufacturers subject to fuel economy regulations established or authorized by the EPCA.

2. MANUFACTURER'S ACCOMPLISHMENTS

The 1973 fuel crisis and subsequent spiraling gasoline prices focussed consumer interest on fuel efficient automobiles. This interest, coupled with the attention of the Federal Government, has stimulated manufacturers to make significant improvements in automobile fuel economy. Table 2-1 presents the 1974-1976 Model Year Fleet Fuel Economy for the cars produced for the 49 states, exclusive of California. This table reports a single measure of fuel utilization; namely, fleet average fuel economy. The general approach used to obtain these results was to use the EPA composite fuel economy (CFE)* and corresponding production and/or sales data for vehicle configurations from each manufacturer to compute the production (or sales) weighted harmonic average fuel economy for each manufacturer; and then to calculate the production (or sales) weighted harmonic average fuel economy for all manufacturers to obtain the fleet average fuel economy. The results for the 1974 and 1976 model years were calculated by the EPA using projected sales estimates, as supplied by the manufacturer to the EPA. The 1975 values were calculated by DOT using actual 1975 model year production data, as supplied to DOT by the manufacturers. The manufacturers are divided into two groups; the first including the "big three" domestic manufacturers: General Motors Corporation (GMC), Ford Motor Company, and Chrysler Corporation, and the second group containing American Motors

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* The CFE is based on the estimated miles traveled and fuel consumed in the urban and highway driving schedules developed by the EPA. A harmonic weighting of the fuel economy results from these two driving schedules of 55 percent and 45 percent, respectively, is done to obtain the composite fuel economy.

TABLE 2-1. 1974-1976 49-STATE* FLEET FUEL ECONOMY

Manufacturer	Fuel Economy						
	1974	1975		1976 (Projected)		1980 Goal	
	MPG	MPG	Percent Change '74-'75	MPG	Percent Change '74-'76	MPG	Percent Change '74-'80
Chrysler	13.8	16.0	+16	16.6	+20	18.7	+36
Ford	14.2	13.8	- 3	17.4	+23	18.7	+32
General Motors	12.0	15.3	+28	16.7	+39	18.7	+56
TOTAL (big three)	13.0	14.9	+15	16.9	+30	18.7	+44
American Motors	16.3	19.2	+18	18.6	+14	23.4	+44
Imports	21.9	24.5	+12	25.0	+14	25.7	+17
TOTAL (Other)	20.6	22.8	+11	22.9	+11	24.7	+20
TOTAL Fleet	14.0	15.7	+12	17.7	+26	19.6	+40

* California data is not included for model years 1975 and 1976 because the current California emission standard is more severe than those standards agreed upon under the Voluntary Fuel Economy Program. The addition of the California data would decrease the total fleet fuel economy by approximately 1 percent.

Corporation (AMC) and all imports, including those sold by the "big three" manufacturers, e.g., GMC Opel.

As presented in Table 2-1, the total new car fleet fuel economy is projected to increase from 14.0 mpg in 1974 to 17.7 mpg in 1976 for an increase of 26 percent. In other words, in just two years the manufacturers are projected to achieve 66 percent of the progress needed to meet the 1980 fuel economy goal. The "big three" manufacturers have done slightly better by increasing their fuel economy from 13.0 mpg in 1974 to 16.9 mpg, which represents 68 percent of the progress toward their 1980 goal.

The total 26 percent fuel economy gain since 1974 can be attributed to the fact that most manufacturers chose to install catalytic converters to control the exhaust emissions for their post-1974 model year automobiles. Use of the catalyst allowed the automakers to make adjustments to their engines that increased fuel economy. However, the approach with the most far-reaching, long-term implication is the growing trend toward smaller, lighter cars with smaller engines. Other contributions to fuel economy include improved transmissions, lower rear axle ratios, improved carburetion, and better accessory-power management.

Information concerning specific technical modifications, which have been provided by the domestic manufacturers to demonstrate their commitments to increase fuel economy, are:

a. General Motors Corporation - GMC has increased fuel economy by 39 percent since 1974 primarily by the addition of the catalyst to all vehicles in their

fleet. They also initiated much of the groundwork for the growing trend to smaller, lighter vehicles with introduction of the Cadillac Seville (approximately 1000 pounds lighter than its sister Cadillacs), the first domestic produced mini-car, the Chevette (approximately 500 pounds lighter than the subcompact Vega), and other Vega-like subcompacts, i.e., Astre, Monza, etc.

b. Ford Motor Company - Ford had a decrease in fuel economy of 3 percent in model year 1975 due to the limited use of catalytic converters in 1975. In 1976 the Ford fleet showed a 26 percent fuel economy gain over 1975. This gain was primarily derived from the greater use of catalysts on all Ford models, thus allowing the engines to be retuned for better fuel economy. Several new, lighter weight cars, i.e., the Monarch and Granada, were also introduced.

c. Chrysler Corporation - Chrysler has increased fuel economy by 20 percent since 1974 primarily due to the introduction of catalytic converters to its fleet. The introduction of two new compacts, the Volare and Aspen, in 1976 strengthened their small car market share. In addition, in 1976 two lightweight modifications of existing compacts were introduced which achieved 25 percent better fuel economy than their counterparts and weighed about 150 pounds less.

d. American Motors Corporation - AMC increased fuel economy 14 percent since 1974, primarily by the use of catalyst technology. In 1975 their largest size car, the Ambassador, was dropped from the model line, underscoring the company's position as a builder of only small cars (in 1975 approximately 80 percent of AMC cars produced weighed less than 3500 pounds). In early 1975, AMC introduced a new compact, the Pacer.

In general, all domestic manufacturers are employing the same basic technical and strategic approaches toward improved fuel economy. They are evolutionary and have thus far produced sizable fleet fuel economy improvements.

These weight reduction programs do not require innovative manufacturing technology but do incorporate some increases in the use of substitute materials such as aluminum, plastics, and steel alloys. It is likely that material cost per pound will increase in the future due to the substitution of the higher cost materials for steel. However, the overall cost of materials may decrease due to reduction in weight. The introduction of lighter weight materials will continue to be determined by availability and in-place cost.

The reduction in size and weight of automobiles allows the use of smaller engines while maintaining the same or slightly lower acceleration performance. Currently, there are three four-cylinder engine lines in operation in the U. S. and by 1980 there may be as many as seven. Production on six-cylinder engine lines is being maintained at maximum levels. Three quarters of engine production capacity is in V-8 engine lines. Most companies have begun to curtail production of large displacement V-8's of 350 and 400 cubic inches and higher and are beginning to convert these lines to smaller displacement engines such as the Olds 260, the Ford 302, and the Chevrolet 307. Conversion of an engine line costs about half as much as developing a new line. There are also reductions of the development costs and reduction in risks attendant with development of an all new engine. Automobile manufacturers are planning to convert some lines to the production of small displacement engines before developing completely new engines for large and intermediate size cars.

3.2 Technology

In addition to the fuel economy benefits that can be derived from vehicle and engine size reductions, additional fuel economy improvement can be obtained through improved engines, engine control, drive train and more efficient emission control technology. It is possible that in some cases, depending on the particular vehicle model, fuel economy gains obtained by technological improvements may equal those due to the weight and engine size reduction. The industry has indicated plans that would result in fuel economy benefits by 1980 in the following areas:

- o Engine modifications and introduction of diesel engines;
- o Engine control improvements;
- o Drive line changes.

Although projections of fuel economy benefits due to technological improvements are more difficult to estimate than improvements due to weight and engine size changes, it is estimated that these benefits will improve fleet fuel economy up to 15 percent. This estimate assumes 1975 Federal emission standards (1.5/15/3.1 gms/mile) and implementation of ongoing and planned efforts to improve the technology.

As projected by the manufacturers, engine modifications include: (1) improved intake and exhaust manifold systems, (2) increases in compression ratios, and (3) changes in combustion chambers. Improved combustion chamber design should improve fuel economy as well as reduce hydrocarbon emissions. Also, diesel engines may be powering several of the 1980 automobile models.

Conventional (Otto Cycle) engine control improvement efforts include improved spark advance control, better air-fuel metering (also during engine idling and deceleration), and more efficient exhaust gas recirculation schemes. Drive train improvement includes the introduction of "lock-up" torque converters that eliminate unnecessary friction in the automatic transmission and lower rear axle ratios which allow the engine to operate at more efficient operating conditions. Manufacturers have also indicated the expanded use of an additional gear in manual transmissions that would allow the engines to operate more efficiently, especially at higher vehicle speeds.

In summary, during the 1975-1980 period, automobile manufacturers have made plans which will reduce the weight and size of automobiles, reduce engine size, and introduce technology which will improve fuel economy. The statements of the manufacturers regarding their product plans, as well as observations of the industry, together with recent introductions into 1975-1976 car lines indicate that those plans are being carried out.

4. FUEL ECONOMY ASSESSMENT OF THE MANUFACTURER'S FUTURE PLANS

Based on data provided directly by the manufacturers, information found in the industry trade publications, and data obtained from the DOT Automotive Energy Efficiency Program, an analysis of projected 1980 fuel economy was completed for each of the domestic manufacturers. This analysis involved:

- o estimating the range of weight and engine size reductions between now and 1980 for each class of vehicles, i.e., compact, mini, etc., and
- o calculating a fuel economy for each vehicle class using actual 1976 EPA fuel economy test data, then
- o estimating the range of improved fuel economy due to technological improvements to be incorporated in the fleet between now and 1980, then
- o estimating the 1980 sales mix range for each vehicle class, and finally
- o calculating the individual manufacturer's fleet fuel economy.

A summary of this analysis is presented in Table 4-1. Actual 1974, projected 1976, the 1980 goal, and DOT's 1980 "high" and "low" fuel economy projections are presented for the domestic "big three" manufacturers, other manufacturers, and total fleet. An explanation of the two 1980 fuel economy projections follows:

5. CONCLUSIONS

DOT's analysis indicates that the automobile manufacturers will be producing automobile fleets that will "most probably" meet or exceed the President's 1980 fuel economy goal of 19.6 mpg as the average for the total new car fleet. This conclusion is based on the following:

- Each U. S. manufacturer has publicly pledged to reach and/or exceed its 1980 fuel economy goal.
- To date, the manufacturers have already exceeded their interim 1975 and 1976 fuel economy goals. The planned model year fleet 1977 goal of 16.7 mpg is projected to be achieved in model year 1976.
- Planned future weight and engine size reduction programs, coupled with the introduction of new technology, will be more than sufficient to reach the 1980 fleet fuel economy goal of 19.6 mpg.
- The manufacturers implemented their product plans for model years 1975 and 1976 and are currently implementing their production plans for the future model years.
- The emission standards for automobiles do not vary significantly from the present level of 1.5HC/15CO/3.1NO_x.